Essays in the Political Economy of Automation:

Power, Politics, Institutions and Labour-Saving Technological Change in Europe

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Abstract

Automation, or technology that substitutes labour in production, is central to most advanced capitalist democracies. As an important factor of productivity growth, it benefits most in society over the long-term by helping to taper over existing inequalities all the while making strenuous, tedious and low value added jobs redundant. However, in the short-term automation often proves injurious to individuals or even groups of workers who see their skills devalued or their jobs destroyed. This combination of economic potential and sociopolitical peril has sparked much research on the topic over the last decades. As a result, social scientists have offered a range of different theories to understand the development of this process. These existing accounts predict labour-replacing technological change should thrive in liberal economies, where there exist few barriers managerial power and labour is relatively unorganised. In this dissertation I shed light on these claims by analysing the relation between institutions, politics and automation in advanced capitalist democracies.

Over the course of three papers, I use of a range of different methods, from comparative case studies to multivariate statistical analysis to untangle this relation. I show that automation is not simply a market-driven process, filtering routine tasks out of the economy, but is deeply rooted within institutionally defined models of growth and redistribution. Contrary to conventional wisdom, I find that systems where capital has to share its political power with labour often automate *more* not *less*. What is more, my findings show that when automation is an institutionally negotiated process its short-term adjustment costs are distributed more fairly, leading to lower levels of anti-incumbent voting. As such, this thesis contributes to debates in comparative political economy by demonstrating the embeddedness of automation within capitalist growth models and by highlighting how this type of technological change cuts across the perennial tensions between capitalism and democracy.

Declaration

I certify that the thesis I have presented for examination for the PhD degree of the London School of Economics and Political Science is solely my own work.

Paper one is published at *Comparative European Politics.*

I declare that this thesis consists of approximately **49.018** words.

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List of Abbreviations

ACD	Advanced capitalist democracy
AI	Artificial intelligence
ATM	Automated teller machine
BAWe	Bundesaufsichtamt für den Wertpapierhandel
BAKred	Bundesanstalt für das Kreditwesen
BIS	Bank for International Settlements
BoE	Bank of England
BuBa	Bundesbank
CPE	Comparative political economy
CME	Coordinated market economy
DSGV	Deutscher Sparkassen- und Giroverband
EC	European Commission
EPL	Employment protection legislation
ESS	European Social Survey
EU	European Union
FIC	Free-if-in-credit
F&O	Frey and Osborne Index
GAAP	Generally Accepted Accounting Principles
H&G	Hall and Gingerich Index
H&K	Hicks and Kenworthy Index
ICT	Information and communication technology
ICSED	International Standard Classification for Education
IFR	International Federation for Robotics
IPO	Initial public offering
IMF	International Monetary Fund
ISIC	International Standard Industrial Classification of All Economic Activities
LME	Liberal market economy
KapAEG	Kapitalaufnahmeerleichterungsgesetz
KfW	Kreditanstalt für Wiederaufbau
KonTraG	Gesetz zur Kontrolle und Transparenz im Unternehmensbereich
LSE	London Stock Exchange
MBS	Mortgage backed security
MNE	Multinational enterprise
NRW	Nordrhein-Westfalen
NUTS2	Nomenclature of Territorial Units for Statistics 2
OECD	Organisation of Economic Cooperation and Development
RBTC	Routine-biased technological change
RPA	Robotic Process Automation
SBTC	Skills-biased technological change
SME	Small-and medium-sized enterprise
VoC	Varieties of Capitalism

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Voor Febe

1

Introduction

The Puzzle of Automation – Thinking about Automation in Social Science – Political Economy & Automation – Structure & Contribution – Concluding Remarks

1.1 The Puzzle of Automation

Halfway through James Joyce's classic Ulysses, his protagonist, Mr Bloom, rides a carriage to the funeral of Paddy Dingham - a man who confirmed all the worst Irish stereotypes by dying in a drunken stupor. On the way there, the carriage passed a railway point, which during Joyce's early 20th century was manned by a so-called "pointman" whose job it was to manually raise the standard and allow passage for the carriage. While watching this labour-intensive process unfold, Mr. Bloom reflected: "Couldn't they invent something automatic so that the wheel [raise] itself much handier? Well but that fellow would lose his job then? Well but then another fellow would get a job making the new invention?"

In a way this vignette neatly encapsulates a central tension inherent in rich capitalist democracies. Capitalism relies on a dynamically efficient allocation of resources which often implies the use of new technologies, some of which displace certain groups of workers in favour of others: in this case, the pointmen for engineers and technicians capable of designing and maintaining self-raising standards. Clearly, the use of such innovation is crucial for long-term growth. Over the past centuries, waves of mechanisation and digitalisation have paved the way to a more productive economy that helps to provide a better standard of living for everyone in the industrialised world (Autor 2018; Atack *et al.* 2019). Whereas we previously relied on people who would day in day out raise and drop the standard at railway points to operate public transport, in our contemporary society this monotonous, strenuous and low value added job is automated, freeing up hands to do other, more fulfilling, work.

However, while everyone stands to gain from automation, or technology that substitutes for labour inputs in production, in the long-run, the short-term effects of this development are potentially highly asymmetric. Some people win while others see their skills devalued or even their jobs destroyed. While today it would be hard to find someone willing to trade a cosy office job in order to physically man -say- a tram-point, the loss of this very job to automation will likely have been a traumatic experience to pointmen and their families. In a world that primarily distributes income through labour, these structural shifts to work therefore become salient political questions.

Ever since the first Industrial Revolution, this nexus of economic potential and political peril has made automation a popular subject among social scientists (Ricardo 1821; Keynes 1930; Braverman 1974; Tinbergen 1974; Mokyr *et al.* 2015; Acemoglu and Restrepo 2018a). While different schools of thought have vehemently disagreed on what automation represents for our society and what drives it, competing accounts have nonetheless proven unified in their expectation of a relatively well ordered distribution of automation and its social consequences throughout the industrialised world. Rates of automation, it is generally thought, follow predictable patterns across advanced economies, thriving in particularly market-based economies where resources are allocated according to the logic of price mechanisms and capital owners have comparatively strong power resources. The most dominant version of this account proposes that employers efficiently allocate tasks to either capital or labour based on the routineness (or predictability) of the underlying activity and taking into account relative factor costs (Acemoglu and Autor 2011). Yet, only a cursory look at the empirical reality suffices to realise the temporal and spatial development of automation and its effects across advanced capitalist democracies has not followed the straightforward path predicted for it. Existing scholarship, it seems, has not yet given us the tools to fully understand the development of automation in the advanced capitalist world.

This thesis takes up the challenge to make sense of that puzzle. To do so, I will analyse the problem of automation from the angle of comparative political economy to understand more closely how automation is linked to what I propose is one of the most plausible sources of variation: domestic politics and institutions. Specifically I will develop an argument that proposes we should not expect automation to converge to a single equilibrium. Since automation in capitalist democracies cuts across the coordination of growth and redistribution, it presents itself as politically salient time inconsistency problem. Rather than being an exogenous vector of political strife, automation is therefore endogenous to the institutional settlements made over how growth is to be produced and redistributed in advanced capitalist democracies.

In what remains of this introduction I hope to lay the foundation of that approach by first discussing what I see as the three main theories about automation in social sciences and their problems. Building on these insights I will then make a case for a comparative political economic approach to the problem, before finally outlining the three papers that make up the main body of this thesis.

1.2 Thinking about Automation in Social Science

What drives automation? How can we explain differences in automation across different countries? And what is the relation between these technological divergences and social and political developments in the advanced capitalist world? These are the broad questions this thesis aims to address. While there exists broad disagreement on the key causes and effects of automation, conventional wisdom suggests labour-saving technological change thrives in liberal economies which put few barriers in the way of markets to pursue this type of innovation, even at the cost of vast social externalities. For automation to thrive it is thought efficiency should trump concerns about short-term equity (Okun 1975) in capitalist democracy. We can distinguish three broad lines of thinking in this regard, what I will call a neoclassical, a Marxist and an institutionalist account.

In what follows I will outline the arguments presented by these schools of thought as well as the limitations of these theories before I move onto discussing how my thesis aims to contribute to this existing body of work. To accomplish this, my discussion will focus on 'big' ideas and the causal claims they make about automation and the social world, rather than on an exhaustive review of the literature.

1.2.1 Neoclassical theories of automation: will there be work?

The first, and dominant, approach to thinking about automation comes from labour economics, and the answers it formulated to the central question of how technological change changes demand for labour in the long-run. I will call this the neoclassical approach to automation since these theories build on fundamental building blocks within the discipline that argue decisions over the relative use of different production factors are driven by a straightforward supply and demand model where firms pursue profit maximisation under conditions of perfect information. Barring the presence major of market failures, this line of thinking has argued that automation is the outcome of relatively simple market processes allocating tasks to different production factors in the most efficient way possible. Over the course of the last centuries this market-based approach to technological change has offered us a range of different answers to the underlying question of how this reallocation, mostly from labour to capital, will impact labour markets in the long-run. While not all of the accounts I discuss below, strictly speaking (and perhaps confusingly) adhere to what economists would recognise as neoclassical thinking today, they nonetheless share the basic assumption of market-based efficiency and have all in their own way paved the way for the current paradigm of routine-biased technological change.

Let us start with thinking developed during the first Industrial Revolution. Reacting to the early upheaval of late-18th-Century mechanisation, the first conception of automation was immediately the most pessimistic one. At the time, political economists building on Malthusian ideas proposed technology would irreversibly diminish demand for labour. This theory starts from the idea that the economy was relatively static with a naturally determined ceiling for labour demand. In such a world, any technology with a comparative advantage over labour would irreversibly diminish finite demand for work. Assuming technological change advanced uninterrupted, Malthusians therefore predicted the end of human labour altogether. Thomas Mortimer, who actually preceded Malthus, captured this quite well when he argued the machines popping up in English industry would "exclude the labour of thousand of the human race, who are usefully employed..." (1772, 104, quoted in Mokyr *et al.* 2015).

For Mortimer and others, capital was simply chipping away at the fixed stock of tasks in the economy. In hindsight, this has been proven wrong. Just consider agriculture. While mechanisation of farming contributed to reducing employment within this sector from around 40% of the total population in Mortimer's time to around 2-3% today, we lack neither food nor jobs (see Frederico 2015). Quite on the contrary, increasingly efficient food production paved the way for modern economies to escape the Malthusian trap, allowing the economy to grow and demands for labour to shift to other sectors. The notion that technology would erase the need for people to work in one clean sweep, based on a relatively fixed notion of the economy, has therefore become known as the lump-of-labour fallacy.

There are several ways in which technology has proven to be beneficial for aggregate labour demand. A first is sometimes dubbed the *Uber-effect*, or the idea that when certain activities become more efficient we can end up with *more* employment since the falling marginal unit cost of production leads to increased demand for said service/product. A second related mechanism, sometimes called the *Walmart-effect*, is that falling prices in one service or product open up disposable income which in turn spurs on consumption for other products and services, creating new employment along the way. In the not so distant past, households spent around 90% of their income on food, housing and clothing. Increased productivity has meant we now spend most of our income elsewhere and are left with *more* jobs as a result. Innovation, finally, also becomes the mother of necessity, creating new tasks and job categories along the way. Good examples here can be found in the universe of information technology (IT) jobs, such as artificial intelligence (AI) developer or cloud engineer. These are job categories that are clearly thriving but do not simply owe their growing importance to increased demand for previously existing tasks. They exist because innovation opened up new frontiers of activity so that we are no longer required to collectively toil the fields, or indeed lift railway standards, to provide for our basic needs (see Lin 2011; Autor 2021).

Still, the fact that automation has not *yet* led to structural technological unemployment does not necessarily mean it *could* not do so in the future. In fact, a second line of thinking, pushed by authors such as Leontieff (1983) and Susskind (2020), argues demand for work can expand, but over time the role of labour will nevertheless be reduced as the underlying range of tasks in which it can compete with technology (accounting for cost) is shrinking. This is an appealing theory that tries to square the circle between the insights that technologies (particularly AI) are ever more capable of handling complex tasks *and* the fact that we have not (yet) run out of work, by tweaking the lump-of-labour fallacy to account for demand effects. This line of thinking suggests innovation is pushing us to a so-called *horse equilibrium*, where human labour, like horses once did, will ultimately lose its comparative edge to technology. This argument, too, runs into some problems. That is to say, it is difficult to defend the notion that the range of human activity has become ever narrower. While we have definitely become more specialised, just consider the medical profession or the rise of long-snappers in American football, if anything we are performing a much broader array of tasks than we were in the past. Whereas kids born today can dream of becoming dentists, data miners and drywall installers, two hundred years years ago they would most likely have had to settle for subsistence farmer. While it remains hard to predict what AI has in store for us, the historical balance of proof therefore does not speak in favour of this account.

This insight that technology has made us far more productive *and* opens up scope for new activities and specialisation has led some to conceptualise its effects as mostly benign. The seminal skills-biased technological change (SBTC) literature mostly put labour-saving implications of innovation to the side, instead focusing on how newly emerging information and communication technologies (ICTs) *complemented* skilled work. ICTs, it was thought, above all make highly educated workers more productive, thereby pushing up demand and wages of these skilled profiles at a higher rate than those of workers not regularly using these new technologies in their jobs (Tinbergen 1982; Goldin and Katz 2008). Rather than destroying entire job categories, innovation was therefore seen to explain growing wage disparities in the economy through a mechanism of differentiated labour demand.

SBTC's record, I would argue, is mixed. On the one hand, it was right to point out how sweeping innovations in the digital sphere increasingly put a premium on education. In doing so, it has put forward a compelling account of the race for education that has taken place over the last decades across advanced economies. At the same time, SBTC probably offers too one-sided a picture of technological change. Technology does not *just* make some 'better' workers, it may also render other jobs redundant - when is the last time you saw a pointman? In fact, there is good reason to believe that the wage inequality SBTC was trying to account for is at least in part tied to precisely the labour-saving dynamics of technology.

This, at least, is one of the central claims of the influential routine-biased technological change (RBTC) paradigm which has highlighted the risks of automation for middle-skilled jobs (Autor and Acemoglu 2011). Sometimes dubbed the 'task approach', this version of the neoclassical theory proposes we should think of the impact of technology in the labour market at the level of tasks rather than jobs. Specific technologies, it is argued, are rarely able to perform entire jobs but they can be highly effective at performing specific tasks within those jobs. According to RBTC, technology particularly substitutes labour in routine (i.e. predictable or rules-based) tasks, as long as those tasks are not too embedded in other non-automatable tasks within a job, and the costs of using technology do not outweigh those of labour. According to RBTC, such routine tasks are highly concentrated in middle-skilled jobs: think of office clerks or factory jobs with a degree of specific skill requirements.

As technology challenges this segment of the labour market, workers are then thought to descend the occupational ladder, ultimately creating an increasingly competitive market for lower-skilled work. This process of labour market polarisation, however, does not necessarily mean the task approach predicts structural technological unemployment. Instead, recent thinking suggests that what we experience is a race between 'replacement' and 'reinstatement' (Lin 2011; Acemoglu and Restrepo 2018a; Autor *et al.* 2021) in which technology substitutes labour in routine tasks but also creates new ones along the way. The timing of these two mechanisms, however, is not necessarily aligned as new jobs often emerge later, in different places and/or with different skill profiles as well.

While there is good reason to believe in this idea of a race between replacement and reinstatement, the mere creation of 'new' jobs is therefore not a panacea for workers that are made redundant since not all tasks or jobs are created equal.

Just take the case of Mr Bloom's pointman. The hypothetical 'new' job in this fictional scenario was arguably much higher skilled and likely better paid than the one it replaced, meaning it might well have proven an unattainable job for unemployed pointmen across Dublin. That, of course, is not always the case. In recent years, automation has coincided with the creation of many precarious forms of work in personal services or so-called 'last-mile' jobs in delivery best exemplified by Deliveroo riders crowding many city centres. However, even when new jobs are of good quality and open at the right skill-level, they are not always attainable to workers facing automation because in open economies they can emerge in altogether different locations. The task literature has therefore extensively mapped the short-term socioeconomic costs of automation, linking it to labour market polarisation (Goos and Manning 2007; Autor and Dorn 2009; Jaimovich and Siu 2013) and falling labour shares (Karabarounis and Neiman 2013; Autor *et al.* 2017).

In short, a wide range of accounts on the impact of technological change on labour markets building on the notion that innovation is an efficient process. Current thinking proposes that this market-led phenomenon particularly filters routine tasks out of the economy, leading to a host of distributive consequences. In this line of thinking then, the causal chain runs from incentives over innovation and ultimately to shifts in relative socioeconomic fortunes.

1.2.2 Marxism: Automation as Class Warfare

While Marx would have disagreed with much of what neoclassical economics would go on to say after his death, he famously agreed that capitalism was a highly efficient system. Still, his work has laid the foundation for more recent Marxist thinkers to reject the basic proposition that automation is about efficiency and driving down costs; according to seminal Marxist accounts, automation *is* politics.

This basic argument of automation goes back to Marx himself. In his ultra-deterministic vision of technology, labour-saving technical change, like all types of innovation, was socially determined. That is to say, it was structured by the very nature of the class struggle: "The handmill gives you society with a feudal lord; the steam-mill society with the industrial capitalist" (Marx 1859, 219). Technology, therefore, was not exogenous to political economic conditions for Marx. Automation (or mechanisation), however, was a particularly revolutionary development in the history of social change. In writing "In handicraft and manufacture, the workman makes use of a tool, in the factory, the machines makes use of him" (Marx 1867, 461-462), he planted the seed for a deeply political appreciation of automation in which technological change became endogenous to the struggle between capital and labour.

Harry Braverman (1974) would pick up on this idea in *Labor and Monopoly Capital*, arguing automation was not a simple economic process but a blatant attempt by capital to increase its control over workers. In his analysis of Taylorism, Braverman argued mechanisation served to impose a managerial strait-jacket, stripping workers of their agency while deskilling them at the same time. Under this Marxist logic, machines dictating the rhythm of production enabled capitalists to extract the maximum labour power from workers while also conditioning them and ultimately thwarting their political power by reducing labour to unskilled and monotonous work. The upshot of this process, then, was the creation of a reserve army of interchangeable workers with minimal bargaining power. Automation was political since it reversed the relation between man and machine. For the first time, man became the subordinate in the relationship, and not by chance.

This political analysis of technology was taken even further by authors such as Marglin (1974) and Noble (1984). For Marx and Braverman, automation might have been a political move, but at least it was also a relatively efficient one since it limited the freedom of workers to determine how much labour power they would expend over the course of a workday, and therefore potentially earn more than they would merit in principle, based of their efforts. Not so, according to Marglin (1974) and Noble (1984). According to the former, what made the Industrial Revolution truly revolutionary was not the innate technical potential it unleashed into the world but the hierarchical organisational structure it imposed on the capitalist enterprise. Studying technological developments and choices in the American machine tool industry, Noble (1984) similarly noted how managerial control was systematically prioritised over commercial viability. Automation, from this point of view, was not even interested in extracting value and pursuing efficiency and the bottom line, it was simply concerned with controlling workers. Automation, then, was class warfare by means of technology.

In short, automation clearly has taken a prominent place in Marxist analysis. For later generations of Marxists, the issue with automation was no longer just whether or not it destroyed jobs. By the 1960s and 1970s, it had become relatively clear that technological change created new categories of jobs at a greater rate than it destroyed old ones. However, what mattered was the *kind of* employment that emerged in its wake. In the universal scheme of class struggle, automation's deskilling, constraining and alienating nature mattered because it eroded workers' labour-power and therefore their political power. Automation in that sense was a way to entrench existing political economic inequities and perpetuate capitalist interests. Automation, within capitalism, *was* politics and could therefore never help the working classes.

1.2.3 Institutionalist Theories of Automation

So far we touched on two juxtaposed arguments about the causal determinants of automation. On the one hand there was the neoclassical account which argued automation is primarily driven by market forces, substituting labour in routine tasks. On the other hand, we discussed Marxist takes on labour-saving technological change which disagreed that automation was about efficiency, instead suggesting this type of innovation was class politics. The final theory of automation I want to discuss falls somewhere in between these two positions. That is to say, starting from an appreciation that technological change since the Industrial Revolution has not played out the same across the world, existing institutionalist accounts have sought to explain divergences in labour-saving technological change by embedding markets into politics and history.

Many, if not all, of the institutional approaches to automation (and technological change more broadly) have their origins in the *Great Divergence* (Pomeranz 2001) debate which tried to make sense of the stark global divergence in productivity and growth, starting in the first Industrial Revolution. Inspired by Douglas North's analysis of transaction costs and the evolution of institutions (1981) the basic argument that emerges here is the following: the operation of free markets, which govern labour-saving technological changes, is conditional on a range of political and institutional factors. While there exists a range of different iterations of this story, I identify two important strands: one which sees an active role for politics and another one which suggests a causal yet passive role for politics and institutions and the spread of automation.

Starting with the latter, these passive accounts stress how institutional path dependencies disrupt the 'normal' operation of markets which might have otherwise led to the adoption of more efficient production processes. One prominent version of this argument points to the implications of slavery on the demand for labour-saving technologies (Lilley 1966). The link between slavery and technology is of course quite intuitive, the word robot even derives from the term *robotnik* which was used to designate unpaid serfs in feudal Hungary. In line with neoclassical theories, the idea here is that the institution of slavery distorts the capital-labour tradeoff in production towards labour because the marginal cost of using slave labour is negligible, thereby lowering the need for automation. Hornbeck and Naidu (2014), for example, find strong evidence to suggests that agriculture remained much more labour-intensive in areas of the American South where the effects of slavery persisted longer. In this version of events, institutions are passive distorters of market behaviour but nonetheless of primary causal importance in determining the adoption of automation.

On the other side of the spectrum, economic historians such as Mokyr (1998) and Horn (2008) have stressed how politics *actively* influenced technological trajectories of nations. In his analysis of the shifting fortunes of innovators throughout history, Mokyr traces the advent of the English Industrial Revolution to the Glorious Revolution and the emergence of a strong property rights regime that increasingly protected industrialists and their labour-saving innovations which would previously have experienced fierce opposition for their inventions. He particularly points to political coalitions formed to create the 1769 law which made the destruction of machinery, which had previously been common practice across Europe, punishable by death. Conversely, Horn (2008) argues that the unstable political environment of the French Revolution meant early French industrialists were unable to rely on similar protection from their government, rendering potential labour-saving innovations too risky to pursue for capitalists. Frey (2019) neatly synthesises the 'politics of mechanisation' literature by arguing that automation is not just a market-driven process guided by prices and wages, but one that rests on a fundamental political and institutional consensus for which support needs to be maintained. This literature therefore stresses the *active* role of politics in determining the fate of automation. England's competitive advantage regarding early mechanisation, it is reasoned, lied in the formation of a political coalition willing to side with innovators and capitalists against the interests of workers and guilds (Desmet *et al.* 2017).

1.2.4 Limits of the Current Literature

We have discussed three different accounts of automation, each with a distinct causal argument about the phenomenon. What is striking is that, from a comparative point of view, these three seemingly different versions of events each lead us to expect the same outcome: automation should be most advanced in highly liberal economies.

Let us start with the neoclassical theory. While these accounts do not think much about cross-country differences, they rest on the central assumption that free markets are most efficient and should see the highest levels of innovation. What is more, this implicit expectation is elevated by some explicit predictions that labour regulations and union power could stifle automation (Leontieff 1982; Acemoglu and Restrepo 2018a; Acemoglu *et al.* 2019). Existing work suggests that while unions provide incentives to automate, primarily in the form of higher wages, unionisation and labour regulations equally impose inhibitive costs to employers.

Interestingly, it is for the same reasons Marxists would predict automation to thrive in liberal settings. Marxism, of course, considers capitalism immutable, meaning automation should almost inevitably converge towards a single equilibrium across the globe. However, as far as there are differences between countries and industries, this reasoning would predict automation should be particularly strong in places such as the U.S. and the U.K., which have generally been earmarked as the most important capitalist nations (Weber 1979; Hancké 2009) - and those places in the advanced capitalist world where relations between capital and labour are most fraught. In fact, over the broad sweep of history, Marxists' insistence that automation is primarily used to *disorganise* labour should lead us to expect, the most labour-intensive forms of production in places like Germany or Belgium where relatively high levels of unionisation and coordination reveal the inability of capital to disorganise workers through innovation.

Existing institutionalist accounts, finally, also predict labour-saving technological change to be particularly dominant in the most liberal economies. After all, these are the settings where pro-capital coalitions circumvented the interests of labour, ensuring it was not afforded the institutional resources to thwart the advance of automation (Horn 2008).

It seems fair to say that existing theory more or less agrees on its prediction of how automation ought to develop across the capitalist world. The question, however, remains how useful that prediction is. While it is hard to exhaustively track multifaceted phenomena such as automation across time and space, most intuitive indicators suggest that the empirical reality is much more complex than what the seminal literature proposes. Take robots, which are a discrete and easy to quantify form of automation that has been pervasive in the dominant literature (Goos *et al.* 2014; Acemoglu and Restrepo 2018; Autor and Salomons

2018). Figure 1.1 plots the relative use of robots (robots/10k workers) across (western) advanced capitalist democracies. What becomes immediately clear is that typically liberal economies such as the United States, the United Kingdom, Estonia and Australia not do necessarily perform well on this dimension at all. Contrary to conventional wisdom, economies known for their relatively strong union movements, such as Belgium, Sweden, Germany and Denmark, perform much better in this indicator. Yet, not all automation is made equal either. While Germany is often cast as the epitome of efficient industrial organisation, the country is well known for being a digital laggard. For any parsimonious account of automation and technological divergence, this should be a worrying signal. Turning to outcomes of automation, aggregate measures of labour market polarisation (one of the most often touted effects of automation in recent decades) paint an even more complicated picture, with robotisation rates not mapping neatly on the patterns found in Figure 1.2 at all.

Without reading too much into these comparative statics, it quickly becomes clear that the topline observable implications of existing accounts are muddled at best. There are, however, also theoretical reasons to cast doubt on the validity of these claims. First of all, it is hard to square the causal logic presented by the task approach, with its focus on routineness, with what we know about occupational task structures in political economy. Not only is there little reason to think that the distribution of activities varies between countries quite to the extent as to explain automation differentials, but theoretical presumptions about that distribution might actually lead us to expect the opposite outcome. Building on the insight that the organisation of production does not necessarily converge to a single equilibrium within the capitalist world (Piore and Sabel 1984; Hall and Soskice 2001; Hancké *et al.* 2007), comparative political economists have tended

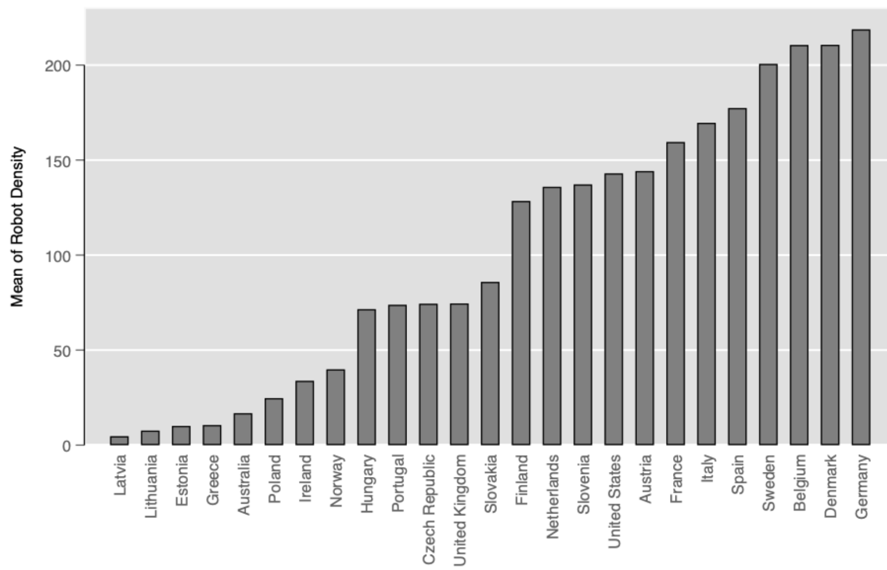

Figure 1.1 Relative prevalence of industrial robots in advanced economies
Source: Author's own calculations based on the International Federation of Robotics and the OECD

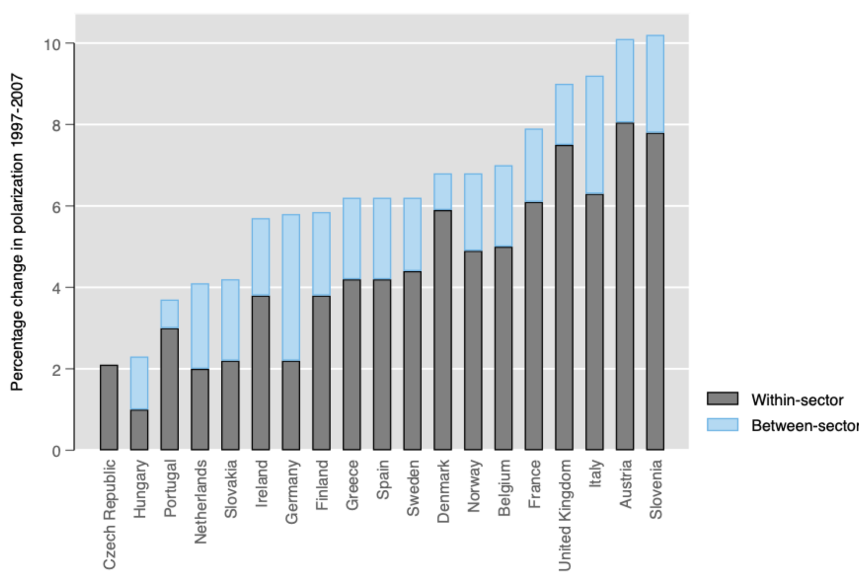

Figure 1.2 Within- and between-industry labour market polarisation in Europe
Source: OECD

to assume more complex and specifically skilled activities clustered in the thickly institutionalised settings of continental Europe. This begs the obvious question of why robotisation has advanced most in those places where we expect task structures to be least conducive to automation?

A second, related, point is that current thinking presents a deterministic way of understanding automation since both neoclassical and Marxists predict convergence to a single technological equilibrium. Given the availability of the right technology all routine activities would be filtered away if the price was right. Yet, literature on this topic has extensively mapped the persistence of technological dualisation (Piore and Sabel 1984; Hall and Soskice 2001) in the industrialised world, and the extent to which technological adoption is conditioned by institutional structures rather than mere market mechanisms.

The final theoretical problem I see, ties together the first two: existing theories on automation unfairly portray the process as almost exclusively zero-sum. This is quite clear for institutionalist and Marxist accounts, but I also believe it is true in the neoclassical story. While market-based theories generally do emphasise automation's long-term benefits (Acemoglu and Restrepo 2018), these diffuse societal gains are ultimately not considered part of the automation decision itself. This zero-sum thinking about automation matters because approaching the problem from such an angle narrowly defines the plausible paths towards automation as those pathways that allow innovators to side-step internalising the possible social externalities that come with automation. Yet, seen as how automation has thrived almost uniquely in capitalist democracies, it is hard to grasp how a development so central to growth as automation could plausibly have a structurally and deeply socially regressive short-term logic without evoking a Polanyian counter-movement (1944) (See also Boix 2019).

Table 1.1: Three accounts of automation

Theory	*Argument*	*Observable implications*
Neoclassical	Automation is a market-driven process that substitutes labour for capital in routine activities	Automation will thrive in liberal economies where the costs of subst- -itution are low
Marxist	Automation is a political tool employed by capitalists to control the working classes	Automation should thrive similarly across the capitalist world, differences might be explained by variations in stages of class antagonism
Institutionalist	The market-process driving automation is conditioned by institutions	Automation thrives wherever insti- -tutions and politics are most favourable to capital and innovation

1.3 Comparative Political Economy & Automation

In order to explain automation across rich democracies, I therefore propose we need to think of labour-saving innovation within the context of capitalist democracy and its institutional constraints. More particularly, I think, we should approach this type of innovation as a key time inconsistency problem that poses distributive questions and throws up coordination problems to rich democracies.

To ensure its stability, it is often thought capitalist democracy faces the perennial challenge of juggling the competing claims and logics of two juxtaposed systems (Hopkin and Blyth 2011; Merkel 2014; Iversen and Soskice 2019). That is to say, it needs to reconcile what seems to be irreconcilable; capitalism's hierarchical and profit-oriented drive for efficiency and growth, and democracy's focus on compromise, the common good and equity. To make matters worse, if it is to survive, capitalist democracy needs to perform this balancing act in a such way that it ensures stability and prosperity tomorrow are not jeopardised for social peace today, or vise versa (Jacobs 2016). In fact, political economists have tended to consider these two challenges as deeply intertwined since the sustainability of capitalism depends on the coordination of growth and demand over time, which itself hinges on the solutions rich democracies formulate to a number of key time inconsistency problems and interrelated distributive political conflict (Eichengreen 1996; Hall, 2007; Jacobs 2016). Simply put, for the system to thrive it requires productivity-based growth in lock-step with demand, all the while ensuring a critical majority of citizens buy into the system and are willing to invest in capital and the right skills for tomorrow (Iversen and Soskice 2019).

Automation, of course, is a key component of this growth equation. Labour-saving innovations, by their very nature, are essential to productivity growth in rich democracies as they allow us to produce the same goods and services a) at a lower cost while at the same time b) freeing up hands to do different work. We can essentially do *more* with *less*. At a societal level, it is no exaggeration to suggest labour-saving innovation is at the heart of the welfare rich democracies enjoy today. But, all that glitters is not gold. The short-term effects of automation have the potential to be highly asymmetrical (Goos and Manning 2007; Jaimovich and Siu 2012; Acemoglu and Restrepo 2018a). While automation helps investors to accrue often marginal gains, major personal costs can be inflicted to individuals or groups of workers falling on the wrong side of technical change.

Examples such as the Luddite rebellion or more small-scale protests by workers in French supermarket chain *Casino Géant*[1] can help us imagine how these costs can lead to popular revolt against this type of innovation (Frey 2019). Potential pitfalls do no end there. Indeed, even more peaceful examples of the Silesian

[1]https://wol.iza.org/news/french-supermarket-workers-protest-against-automated-checkout-stations

Weavers (who faced a similar fate to the Luddites in Germany) or of robotisation in parts of the Midwest, demonstrate how sweeping automation can cripple local economies by suppressing demand for labour and stifling opportunities for social mobility (Wilson, 1996; Brand, 2015; O'Brien *et al.*, 2021; Frey *et al.*, 2017; Berger and Engzell 2022). What is more, in the context of advanced economies which seek to precisely calibrate investment into capital and skills, deep uncertainty over what labour-saving innovation might bring in the future could stifle skill-acquisition altogether.

This means that the short-term effects of automation have the potential to not only derail finely attuned growth strategies, but, perhaps more problematically, democratic stability (Frey 2019; Boix 2019; Kurer 2020) and support for key tenets of capitalism itself (Thewissen and Rueda 2017; Gallego *et al.* 2021). In capitalist democracy then, automation presents itself as a time inconsistency problem that goes to the heart of the system. For the long-run it is a boon no polity can do without, but due to its underlying short-run distributive logic, labour-saving innovation can erode stability before societal benefits have a chance to land.

Of course, automation is a fact of life in most advanced capitalist democracies. Most car manufacturing today is dominated by industrial robots, banking and insurance industries largely rely on complex algorithms to assess risk and allocate capital, while a Californian start-up *Zume* went so far as to automate the fine art of pizza delivery. Thinking of this labour-saving innovation as a problem of time inconsistency forces us not just to consider how these innovations are achieved through an efficient allocation of tasks between production factors, but rather how power, politics and institutions coordinate conflicting individual-level and systemic interests through time, which is needed for automation to thrive *within* a stable capitalist democratic environment.

Such an approach, of course, intuitively borrows much from existing institutional work on automation. However, thinking about automation as a time inconsistency problem that is institutionally defined opens up a wide range of different possible equilibria. As Hall (2007, 42) pointed out, political economic institutions in the capitalist world are essentially geared towards 'contracting' such time inconsistency problems and tempering, if not solving, distributional conflict underlying them. Crucially, capitalist democracies throughout time and space have devised wide-ranging institutional solutions to these problems (Zysman 1983; Piore and Sabel 1984; Albert 1993; Dore 1999; Hall and Soskice 2001; Hancké 2009; Iversen and Soskice 2019). In fact, considering the constraints of capitalist *democracy*, it becomes increasingly untenable to believe only one highly capital-oriented institutional logic could yield sustainable progress for automation (Mokyr 1998; Horn 2009; Frey 2019). For labour-saving innovations to be a viable option in capitalist democracies in the long-run, it simply cannot ignore the constraints of majoritarian politics in the short-run.

Starting from that insight, this thesis will develop a comparative political economy approach to the question of automation in rich democracies. More specifically, this means I will examine the interplay between different models of capitalism, the institutions and politics of growth they engender, and automation. Central to this analysis is a concept of institutions. Institutions, I think, play two roles in the political economy. The first, which goes back to historical institutionalism (March and Olsen 1983; Hall and Taylor 1996; Thelen 2004), is to structure conflict. Like many theories, historical institutionalism proposes that contestation over scarce resources lies at the heart of political life. However, historical institutionalists particularly focus on the structuring role of institutions in this contest. Institutions here are considered as the formal and informal rules, norms and procedures that organise conflict and structure conflict by empowering some groups and demobilising others. Institutions, in a way, organise behaviour and conflict by setting out the structure by which individuals and groups seek to attain their goals. What makes historical institutionalism *historical* is the focus on path dependency: institutions and their legacies are 'persistent features' whose long shadows influence and structure new institutions and conflict over time (Hall and Taylor 1996).

However, aside from structuring conflict, implicit in my emphasis of automation as an issue of time inconsistency is that I also believe institutions play a more 'Northian' role in the political economy (North 1981; North 1991). That is to say, they induce cooperation, help to reduce transaction costs and collapse time inconsistency problems. They, put simply, pave the way for sustainable intensive growth. As key traditions within institutional economics and political economy have pointed out, a world without institutions would be riddled with market failures, coordination problems and other forms of deeply suboptimal non-cooperative behaviour inhibiting complex forms of economic activity to flourish (Axelrod 1984; Ostrom 1990; Coase 1992; Rodrik 2000; Hall and Soskice 2001; Acemoglu and Robinson 2012).

Implicit in many comparative political economic accounts is that these two key functions of institutions interact with each other. It is easy to imagine how institutional legacies and power dynamics structure the possibilities for economic coordination, while the subsequent presence or absence of successful coordination itself again confers economic resources that help to structure conflict. This thesis, however, will not delve deeper into the complex 'chicken and the egg' question of how institutions evolve or whether power conflict structures the role of institutions as facilitators of growth or vice versa. Instead, I will focus on how the interaction of these two functions structures conflict, incentives, *and* pathways for automation and its socio-political outcomes.

With this substantive focus in mind, this research project will focus on the evolution of automation within a specific type of country: so-called Advanced Capitalist Democracies (ACDs). Within that broad scope, I will specifically focus on western economies such as the ones found in Europe and the United States. It should be clear by now that this delineation is endogenous to both the puzzle this thesis addresses and the approach I want to develop. Indeed, the geographic focus is based on the empirical fact that these economies have, ever since the first Industrial Revolution, been trailblazers of automation and industrial change more broadly. If we are to understand why not all countries have done so at the same rate, ACDs seem like the obvious place to start. At the same time, this also informs my theoretical approach. Most highly-automated economies are what we can typify as (advanced) capitalist democracies, leading me to consider the evolution of automation within the constraining institutional structure of capitalism and democracy. At the same time, Western ACDs largely form the frame of reference for most scholarship in comparative political economy as they provide a rich and methodologically interesting universe of political and institutional variation within a set of countries that share similar historical, political and economic trajectories.

Furthermore, my research is not just limited in space but also in time. Over the course of my three substantive papers, I will roughly straddle the period ranging from the 1980s to the present. This corresponds roughly to what many scholars recognise as the period that runs from the third Industrial Revolution (centred on early ICTs and robotisation) over into the fourth Industrial Revolution (leveraging cyber-physical systems).

Methodologically and epistemologically, this thesis relies on a mixed-methods approach and the logic of cumulative causal adequacy. Throughout the different papers I use both qualitative comparative case studies and several multivariate statistical techniques to understand the (causal) relation between institutions and automation. While each paper in this thesis stands on its own, I believe the interplay of the different methods used throughout the papers works in a complimentary manner (Mahoney 2009), helping to narrow down the precise causal nature of this relation through the accumulation of causal and correlational findings regarding central questions and critical cases.

1.4 Structure and Contributions

Within that remit, this thesis analyses the political economy of automation over the course of three papers. In these three projects, I answer three different (but critical) questions to triangulate the important role of power, politics and institutions on automation. Table 1.2 summarises the key findings of each paper.

1.4.1 Structure of the thesis

Paper 1 starts the analysis off with a puzzle: if automation is in fact causally determined by occupational task content, as is proposed by the seminal literature (Autor and Acemoglu, 2011; Acemoglu and Restrepo, 2018a), why is it that the introduction of credit scoring influenced the similarly non-routine jobs of British and German bank branch managers so differently? In this paper, I tackle that puzzle using a comparative case study that traces the introduction of credit scoring technology in British and German banks in light of the transition towards market-led banking model (Hardie *et al.* 2013). Using a combination of archival work, secondary resources and elite-interviews I put forward the argument that the precise embeddedness of bank managers' tasks within an eroding model of bank-led finance (Zysman 1983), as opposed to *a priori* routineness of these activities, explains the uneven demise of this job category.

Whereas bank a manager's discretion and interpersonal skills were central to a world of banking where banks, as traditional intermediaries, relied on attracting household savings and issuing sound loans banks held until maturity, the rise of international markets for refinancing and securitisation changed that calculus, ultimately paving the way for credit scoring to dominate retail banking. While British banks, driven by government-led institutional change, quickly moved into the new world of internationalised finance, this process only started a decade later in Germany, and even then with differential intensity in each of its three banking pillars.

This paper plays an important part in the overall thesis since it analyses the interaction of automation and institutions in the *least-likely* case of financial markets. Finance, it is often thought, is one of the key sectors in the capitalist world that most closely mirrors free markets as described by the neoclassical model. By highlighting how institutional change drove technological choices, even in this critical setting, I therefore establish the strong first-order importance of institutions in structuring automation incentives. What is more, the specific case of how credit scoring supplanted branch managers in their highly complex, non-routine jobs, highlights the shortcomings of the task-literature's focus on *routineness* as a necessary condition for automation.

Having established the importance of institutions in one specific context, *paper 2* then moves on to examine the relation between labour-saving innovation and institutions more broadly. This paper challenges central assumptions of the existing literature by dispelling the popularly held notion that organised labour will, myopically, hold back automation when it has the opportunity to do so. In this paper, I analyse the relation between industrial robotisation, institutionalised cooperation between and within capital and labour, and redistribution. I compile an original index of cooperative institutions (Hicks and Kenworthy 1998) to pair with sectoral robotisation rates in a large cross-country panel analysis of 25 OECD countries between 1993 and 2017. Cooperative institutions are defined as institutions that seek to balance 'distribution/redistribution' and 'collective gain' in capitalist production through institutionalised cooperation within capital and labour and between both groups respectively, throughout different levels of the political economy (Hicks and Kenworthy, 1998).

My findings show that such cooperative institutions do not only predict a) higher rates of industrial robotisation but b) that these institutions also strongly intermediate the relation between robotisation and its effects on labour shares and working hours.

Institutionalised labour power, it seems, does not necessarily stifle labour-saving innovation at all. On the contrary, my findings suggest that active negotiation of short-term adjustment costs through institutional cooperation can lead to goldilocks equilibrium where high levels of automation are paired with inclusive growth. As such, this paper challenges zero-sum approaches to automation by highlighting how inclusive productivity coalitions dominate the world of robotisation.

In *paper 3*, I approach the question of automation from the angle of electoral politics to examine more closely the conflict around automation at the individual-level. If the constraints of capitalist democracy are in fact a valuable framework to understand the evolution automation, then we would want to observe the impact of labour-saving innovation and, crucially, different institutional approaches to it in the electoral arena. In this paper, I therefore use European Social Survey (ESS) data to study the interaction between individual-level labour market resources and occupational automation risk on incumbent support in 20 European Union (EU) countries since 2012. Combining occupation-level automation risk indices with individual-level information allows us a glimpse into the differentiated effects of automation on electoral behaviour for different types of voters and systems.

In line with existing ideas around the connection between automation, distribution and conflict in the capitalist world, my findings demonstrate that occupational automation risk is a strong predictor of anti-incumbent positions. That is to say, voters care about their occupational chances, and the risks automation poses to them, at the ballot-box. I find that voters in highly automatable jobs are, all else equal, around 13% more likely to vote against their government. However, the devil is in the detail. Following on from my conclusions in paper 2, I find that occupational risks are strongly intermediated by the power resources individual voters have at their disposal to adapt to technological changes, such as strong permanent contracts, collective bargaining rights and educational attainment. To put this into perspective, each additional year of education is associated with a 3.5% increase in the likelihood that voters in highly automatable jobs will support the incumbent. The electoral conflict that results from automation, I argue, is intimately connected to opportunities workers have to weather the storm.

The conclusion, finally, brings everything back together. In it, I briefly review the major findings and implications of each paper before opening up the discussion to the broader significance of my work on key debates.

Table 1.2: Summary of substantive papers

Paper	*Type*	*Key Findings*	*Status*
2. (De)Regulating Automation: The Rise of Credit Scoring and Market-Led Banking in the UK and Germany	Research Article	- Task routiness is neither a sufficient nor necessary condition to explain automation - Divergent uptake in automating credit scoring driven by a differential rise of market-led banking - Institutional change can be a driving force for automation	Published at CEP
3. Conflict or Cooperation? Exploring the Relation Between Cooperative Institutions and Robotisation in the OECD	Research Article	- High levels of institutionalised cooperation between capital and labour strongly predicts industrial robotisation - Liberal economies robotise more during recessions - The Impact of robots on the labour share is intermediated by cooperative institutions	Under review at BJIR
4. It's the Robots Stupid? Automation risk, labour market Security and Incumbent Support in Europe	Research Article	- Occupational automation risk predicts higher levels of anti-incumbent voting - However, the effect of occupational risk is conditioned by individual-level labour market resources of workers - Workers with the tools to deal with automation do not reject incumbents at higher levels	Under review at BJPOLS

1.5 Concluding remarks

This thesis presents a comparative political economy study of automation within capitalist democracy. By looking at the interaction between politics, institutions and labour-saving technological change it tries to embed this crucial form of innovation within a rich scholarship in comparative political economy. As I will show over the course of this thesis, automation seems to be part and parcel of the perpetual struggle between efficiency and equity in these systems. Far from being divorced from politics, I will argue automation *is* deeply political.

Given the scope of my analysis, there almost inevitably are more questions this thesis will *not* answer than there are those it will address. Do these insights hold for capitalist democracies outside of Europe and the West? How well do these arguments help us at explaining historical trajectory of automation? How should we understand the rise of automation in non-democracies such as China? How will AI shake up our societies? What about, yet, other technologies? While the analysis that follows might give us some hints about many of these pertinent questions, most of them will unfortunately remain unanswered. However, over the course of this thesis, I hope to establish a broad framework that might help us tackle whatever questions remain.

The crux of that way of thinking lies in the idea that most societies need to reconcile the goal of creating a better future with the concrete material and political constraints of the present. The production strategies we come up with and the bridges we build (or do not build!) to straddle the gap between the short-run adjustment costs and long-run societal welfare gains resulting from these strategies, I argue, play a defining role in guiding the trajectories of labour-saving innovation.

2

(De)Regulating automation: The Rise of Credit Scoring & Market-Led Banking in the UK and Germany

Introduction – Branch Managers & the Advent of Credit Scoring – Existing explanations – Political Economy of Bank Branch Restructuring – Conclusion

Abstract: AI and other forms of automation are causing a shift into a more capital-intensive form of capitalism. Many scholars have suggested that we can best understand this process as the cost-efficient substitution of labour by capital in routine-tasks based on relative factor costs. However, this model of firms, which has cast firms as endlessly chasing the productivity frontier, has not paid sufficient attention to cross-national divergences in technological changes. This paper builds a comparative historical case study tracing the divergent introduction of credit scoring in British and German bank branches to argue that the introduction of credit scoring was a result of a policy-led process in both countries. Increased liberalisation of financial market institutions benefitted the rise of market-led banking which fundamentally changed the business model of banks resulting in a devaluation of the services provided by branch managers. This case suggests we need to think about the role of politics and policy within our, often deterministic, models of labour-replacing technological change.

2.1 Introduction

In light of a rising tide of populism, scholars are increasingly turning their attention to the adverse effects of labour-saving technological change (Mokyr *et al.* 2015; Acemoglu and Restrepo 2018). However, while the idea of technological roots of political unrest is gaining traction (Kurer and Gallego 2022), the political and institutional origins of such biased innovation have not enjoyed the same level of consideration in political science. The existing literature on distributive consequences of technological change has mostly cast this dimension as playing second fiddle, only mediating the speed of adoption and/or the severity of distributive outcomes (Parolin 2019). This underappreciation of a potentially deeper and more structural role for politics and institutions is surprising given the strong tradition of scholars stressing the importance of domestic institutions on innovation and production in advanced capitalist democracies (Zysman 1983; Piore and Sabel 1984; Hall and Soskice 2001) as well as some clear empirical puzzles.

This paper contributes to this debate by analysing one such 'puzzling' case of cross-national variation; the introduction of credit scoring by British and German banks. Credit scoring allows banks to use algorithms, as opposed to employees, to determine when to extend credit and at what price to do so. The adoption of credit scoring has been widespread since the 1980s in Europe. However, not all firms implemented this technology in quite the same way. While British banks were quick to use credit scoring to substitute for labour, their German counterparts initially used it to complement their staff's skills. Two decades later, German banks also increasingly automated their branches, in a staggered manner, with commercial banks leading the charge and the public and cooperative pillars following a more conservative approach.

How can we explain this striking *between* and *within-case* variation? I argue that the substitution of bank branch managers' lending tasks in Britain and Germany was a function of financial market deregulation opening the door for a new model of 'market-led' banking, rather than mere technological progress, which has severely devalued manager's traditional tasks. In a world where banks increasingly focus on 'high-end' financial services and secondary markets, the model of the traditional intermediary, epitomised by branch managers, has been eroded. Reliance on international markets also invited sharper short-term commercial pressures, announcing ever leaner operations. Contrary to most assumptions, this process did not simply substitute capital for labour in *a priori* automatable tasks (Acemoglu and Autor 2011) but involved large-scale routinisation of complex activities. To build this argument, I present a comparative historical case study drawing on internal bank documents, interviews, balance sheet analysis, reports by central banks, as well as secondary literature to trace the restructuring of bank branches in the face of vast institutional changes in Britain and Germany from the eighties to early 2000s.

This paper makes two key contributions. Firstly, it argues we need to rethink the role of politics in the dominant model of automation. Rather than casting firms as the prime actors inevitably chasing the technological productivity frontier, I argue that politics and institutions have an important role in shaping markets in which some equilibria between capital and labour are more probable than others. In this case, I contend that financial liberalisation made the difference between credit scoring as a technology complementary to labour or one challenging workers' jobs. Secondly, this paper lends some micro-level empirical support to the contributions of Hardie *et al.* (2013), who have argued that the traditional distinction between 'patient' bank-based financial models and short-termist capital market models has eroded, by describing the strategic shift away from branches in both Germany and the UK.

In what follows I will first give a short account of some of the developments in retail banking from the 1980s to the early 2000s. I will then give an overview of the literature on this topic to subsequently trace the process of financial market liberalisation in the UK (1980s) and Germany (1990s-2000s) to demonstrate its impact on credit scoring in bank branches.

2.2 Branch Managers & the Advent of Credit Scoring

In order to get at the seemingly puzzling story of branch managers' demise, we first need to understand their traditional role within the banking sector. In their simplest form, banks are nothing more than financial intermediaries who pool savings and reactivate that capital in the form of loans or other financial products. Today many, if not all, of these actions can quite easily be performed within seconds on an app. This was of course not always the case. In a pre-digital era, deposit-taking banks relied heavily on vast networks of bank branches. These brick-and-mortar locations were crucial components in their strategy to attract savings and subsequently service clients.

As the name suggests, branch managers are the agents responsible for the running of these branches. In both Germany and Britain this job had two main components. On the one hand, managers were administrators responsible for the traditional day-to-day backroom activities required to keep branches operational. On the other hand, and more importantly, branch managers were a key conduit in the process of intermediation. That is, they were responsible for attracting savings and providing financial services, most notably issuing loans, at the local level (Hughes 1992, 32). In light of the present comparison, I will focus on this second aspect which is more strictly financial.

Firstly, managers were tasked with reaching out to new customers and as such acted as the primary agent responsible for business development in their local area. In many ways, they served as local brand ambassadors. German and British banks expected managers to be visible members of the community, to uphold the institution's name. *Lloyds Bank* training programme, for example, actively encouraged to participate in community life. More often than not this meant engagement in local business roundtables and membership of the local networking organisations like Rotary and golf clubs. Such strategies were generally aimed at attracting local small and medium-sized enterprises (SMEs) and high net-worth individuals (Fraser 2014). German banks were similarly renowned for their active community engagement and close business ties, with branch managers taking up a very active role in local business life (Deeg 1992).

This strong social position, in turn, aided managers in another core task; issuing credit. Apart from getting business through the door, these individuals were personally responsible for the sale of financial services in their respective branches. It is important to see that managers traditionally had considerable agency in this domain. In many cases, British and German managers lacked formal guidelines with regards to lending as head offices generally opted to judge performance on the overall profitability of their branches (Fletcher 1995). It is well-known in political economy literature on German finance, that cultivating strong community ties was key to gathering important information which could later be used in credit decisions (Hughes 1992). What is often underappreciated is that this was true for Germany as well as the UK during the 1970s. Not only was this mechanism used to acquire privileged information on firm performance but, especially in the UK, credit decisions were also strongly influenced by subjective social parameters (Hughes 1992; Leyshon and Pollard 2000). In fact, in the case of a new client, managers would generally base part of their credit decisions on whoever made introductions. In this model of banking, social status directly reflected on perceived solvency (Hughes 1992).

Despite some small differences in overall branch management such as the skill-profiles and responsibilities of clerical support staff (Baetghe and Oberbeck 1986), managers in both Germany and Britain on all accounts had very similar jobs. Banks' credit-issuing process, in both countries, was highly non-routine, requiring managers to perform complex interpersonal, analytical and decision-making tasks, building their cases on economic fundamentals as well as holistic social information. Moreover, banks in both countries relied on a model of stable personnel management inspired by loyalty and caution in which branch managers were skilled employees who enjoyed broad vocational training and moved up the ladder of the internal labour market. The prerequisite of becoming a branch manager in the UK was the completion of formal training at sector-specific institutions such as the Institute of Bankers (Cressey and Scott 1992; Quack *et al.* 1995). German branch managers, meanwhile, usually followed a similar trajectory, typically starting with apprenticeships.

Put together branches and their managers in both countries were, as Leyshon and Pollard (2000) put it the "foundation stone for retail banking, gathering of intelligence on local markets and costumers, processing and settling the days business and serving as a gateway for accessing services." Still, these similarities came to an abrupt end during the 1980s as the profession was coming under pressure by technology in Britain, while similar disruptions remained conspicuously absent in Germany until much later.

2.2.1 The Changing World of Retail Banking

Defined by Batt and Fowkes (1972, 191 quoted in Leyshon and Thrift 1999) as "Statistically based management tools for forecasting the outcome of extending credit to individuals", credit scoring models credit risk through multivariate analysis. It is important to note that this technology has been around since 1956, when William Fair and Earl Isaac launched the first credit scoring consultancy, initially leveraging the idea to discriminate between 'good' and 'bad' customers in the nascent mail-ordering industry (Marron 2006). This risk-management technique subsequently matured in the US (Yates 1993) before really taking off (and landing on European shores), when the rise in availability and power of personal computing made the introduction at scale viable during the eighties.

In light of these advances (as well as financial deregulation, as I will show later on) British banks returned to the drawing board to reorganise their services, fundamentally altering the position of branch managers. Firstly, the introduction of computerised credit scoring required a rationalised, standardised and streamlined process of credit issuance for the retail sector. Rather than relying on a highly informal process, spearheaded by managers, issuance of financial products such as personal loans and mortgages was increasingly boiled down to key statistical indicators while product offerings were standardised. Taking the 'thinking' out of this process allowed banks to transition to lower-paid clerical staff feeding algorithms with the help of computer terminals. This reduced the delivery of the products to a routine computerised box-ticking exercise in which the actual decision-making was digitalised. *Lloyds*, for example, announced the introduction of 'videotext terminals' in its branches to automate loan approvals in 1985 with a further £1 billion investment in ICT following in 1990. *Midlands*, meanwhile, installed some 3500 IBM computers in its branches by 1989 in an explicit effort to create a new model of 'automated branches' in cooperation with *Fitch & Co* consultants. *Barclays*, finally, opened its "electronic bank branch" in Cheshire (Financial Times 1982) in 1982, proudly referring to the branch's Apple computer as the "automated bank manager."

The digitalisation of retail services also went hand in hand with a push to segment retail from commercial services. Whereas local branches used to double up as a hub for household and SME banking, branch managers' commercial responsibilities were now uploaded to newly created regional offices. *Barclays* heavily restructured its branch network in 1987 as it shifted this responsibility onto 24 regional offices. *Midlands*, similarly, reduced its delivery costs by opening *Midlands* Enterprise Centres. While these regional offices at times offered refuge to former branch managers, they more heavily relied on younger graduate-level profiles (Ackrill and Hannah 1996, 224). This split of retail and commercial activities was part of the strategy by head offices to separate standardised product offerings and routiniseable tasks in retail banking from the more complex commercial side.

Unsurprisingly, branch networks shrunk as their responsibilities were increasingly hollowed out (see Figure 2.1). At the end of that decade, some 2000 already closed and by 2012 Britain experienced a net loss of nearly 7500 branches. (French *et al.* 2013) *Lloyds* alone, leveraged its heavy ICT investments to cluster branches in groups of 8 to 10 under the supervision of a single manager responsible for operational issues (Storey *et al.* 1999, 141), costing some 2000 managers' their jobs. Branch managers were therefore the undeniable 'losers' of this transition in which high street banks centralised, standardised and automated their activities. As

Hughes (1992, 42) put it: "the stereotypical manager appeared to be disappearing."

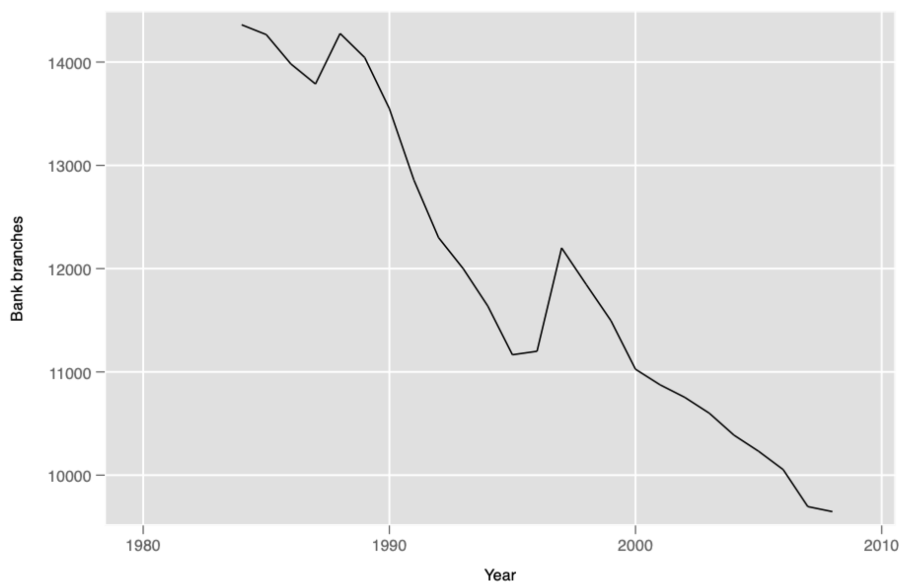

Figure 2.1 Evolution of bank branches in the UK

Source: British Bankers Association

While retail credit in the UK was now increasingly automated, German banking continued to act as a model of stability (Baetghe *et al.* 1999). That is not to say German banks branches did not digitise to the same extent. Rather, these innovations complemented rather than substituted the work that was done by managers during the 1980s and 1990. Indeed, Quack and Lane (2001) found that the construction of credit risk in German branches continued to rely on both quantitative and important qualitative information. This finding is backed up by Mason *et al.* (2000) who surveyed offices in the UK, US and Germany during the 1990s, concluding that senior management experience, previous banking records and more general information were more important in German banks relative to their Anglo-Saxon counterparts. Tacit knowledge and holistic appraisals were still the rule in Germany. Crucially, levels of computerisation were broadly consistent in all three countries. Yet, in contrast to their UK counterparts, German branch managers remained relatively autonomous agents, working alongside computers (Haipeter and Wagner 2008).

Still, the face of German banking, too, slowly started to change around the turn of the millennium (Oberbeck and D'Alessio 1997) as German banks, began to restructure their branch networks after decades of uninterrupted growth (Baetghe, D'Alessio and Oberbeck 1999). Like in the UK, this was a double process. On the one hand, restructuring involved the closure of some branches. As can be observed in figure 2.2, German commercial banks were amongst the first movers in this regard, with public and cooperative banks following later and more gradually. However, such closures were just the long shadow of a broader redesign of retail banking strategies towards more standardised and capital-intensive service provision in which financial firms increasingly automated service delivery by introducing automated teller machines (ATMs) and credit scoring. The range of services provided in branches was cut substantially, with remaining branches becoming a local sales hub for standardised products and branch managers being turned into sales managers (Haipeter and Wagner 2008). Credit decisions, meanwhile, have been substantially automated in light of centralised risk management policies.

All in all, this presents us with an interesting puzzle revolving around surprising *between* and *within-case variation.* While German and British branch managers performed similar tasks and had equivalent skills profiles, the introduction of technology in both countries, at least initially, resulted in different innovation strategies. In the UK, managers were confronted with mass layoffs during the 1980s while German banks initially employed the technologies to augment managers' skills. In fact, bank branches were only closed down or automated in Germany during the 2000s. This difference is even more interesting when accounting for the similar levels of ICT investment in both countries. What is more, within Germany commercial banks (like *Deutsche Bank*) made this transition much quicker than any other institution. In what follows I will discuss some of the key literature on this topic and outline the answer to this puzzle proposed in this paper.

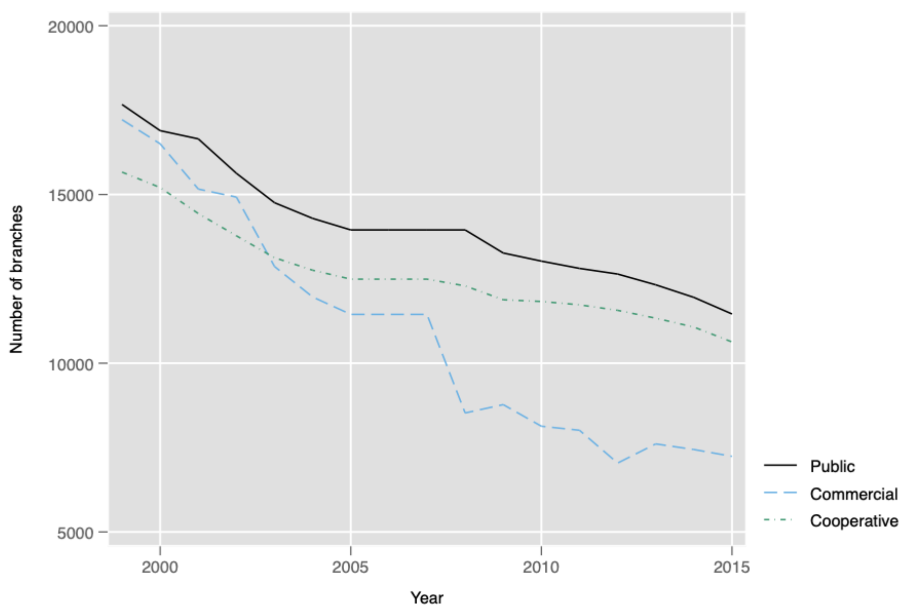

Figure 2.2 Evolution of German bank branches by sector

Source: Bundesbank 'Banking Statistics'

2.3 Existing explanations

In recent years, literature on technical change and automation has converged on the theory of routine-biased technological change (RBTC) (Autor and Dorn 2009; Acemoglu and Restrepo 2018). The main insight here is quite straightforward. RBTC proposes that technology is limited in its capability to carry out human tasks. While it struggles to compete with humans on complex and tacit activities it is more efficient at executing routine or 'rules-based' tasks (Autor and Dorn 2009). In the RBTC framework, then, firms seek to substitute routine tasks as long as they are not too intertwined with other non-routine tasks, and the costs of using capital outweigh that of labour (Acemoglu and Autor 2011, 1076). This framework has been particularly useful to explain several puzzling trends. Not only has RBTC been able to offer an explanation for rising labour market polarisation (Goos and Manning 2007; Goos, Manning, and Salomons 2009), but it has also offered compelling evidence suggesting routine-biased technological change might be a key driver behind the precipitous drop in the labour-share (Karabarbounis and Neiman 2013; Kehrig and Vincent 2018).

As with many theories of technical change, the task approach is fairly deterministic, leaving little scope to explain diverging models of adoption. In the case of credit scoring in bank branches, it is particularly clear that models relying on task content have little analytical leverage to explain the differences between the adoption trajectories given the similarities between the UK and German branch management. What is worse, bank branch managers hardly had a 'routine' job. If anything, their job description was packed with interpersonal, analytical and above all non-routine tasks. To understand what drove these differences, then, we need more granular theories of technological change.

One candidate is the argument about differences in labour power in the UK and Germany. Sigurt Vitols (2004), for example, argued that labour protection and co-determination rights significantly prolonged the lives of German bank branches. The idea here being that German banks simply did not have the degrees of freedom to pursue the same strategies their colleagues across the Channel had. This is a plausible explanation and one that offers scope for cross-national variation at that. There is ample evidence to suggest that substitution by automation tends to be dampened by unionisation (Parolin 2020) or strong employment protection legislation (De Stefano 2018; Manera and Uccioli 2021). However, if labour power truly explained the different trajectories of credit scoring adoption in the UK and Germany it is not clear what changed and why credit scoring started to be used in an automating way in Germany when it did. Moreover, this argument does not give us much leverage to explain the big differences in timing observed between different types of bank branches within Germany. While institutional arguments on power resources seem to account for the initial *between*-case variation (i.e UK and Germany), they fall short of explaining the *within*-case evolutions in Germany.

To get at this puzzling evolution I will also zoom in on institutions. But rather than merely focusing on the importance of power resources, my argument will highlight the functional importance of financial market institutions in conditioning bank strategies and the use of credit scoring within them. In particular, I will rely on the notion of market-led banking (Hardie *et al.* 2013) to argue that financial market liberalisation changed the role of banks within the economy and therefore also the functional role of bank branches more broadly.

2.4 Political Economy of Bank Branch Restructuring

The key to understanding the diverging trajectories of British and German retail banking is an appreciation of the sector within the broader political economic growth model. The classic dichotomy of financial markets has traditionally cast Britain and Germany as diametrically opposed financial models (Zysman 1983; Hall and Soskice 2001). Ever since Zysman (1983), the former has been dubbed as a capital market model in which firms pursue an equity financing strategy while the latter is designated as a bank-credit led model where banks provide long-term business loans, sometimes called patient capital, to firms. Within this model, banks are understood to be relatively one-dimensional intermediaries that finance themselves by pooling savings in order to issue credit and make profits on the back of interest rate spreads. Here, loans were expected to remain on balance sheets until maturity. The relative prevalence of bank credit in Germany vis-à-vis equity finance in the UK, then, explained different structural corporate governance incentives (Franks and Mayer 1997; Hall and Soskice 2001). As far as competition allowed, banks in this picture were insulated price-setters and relatively unburdened by international pressures.

Most indicators suggest this institutional divergence held for much of the post-war era. Yet, the notion of market-led banking (Hardie *et al.* 2013) has challenged this dichotomy following the post-crisis realisation that banks pursue more complex, and perhaps less innocuous, strategies. Even in Germany, banks are no longer traditional intermediaries coordinating savings and investment at the local level. Instead, they have become increasingly complex financial actors embedded within global markets. Basic operations now include refinancing on wholesale markets, hedging and securitising, which has ultimately rendered them price-takers on international markets (see Figures 2.3 and 2.4). Hardie *et al.* (2013) therefore argue that the distinction between short-term horizons associated with capital markets and long-term horizons related to 'traditional' bank financing no longer holds. Since deposit-taking banks have themselves become beholden to global financial markets, their degrees of freedom to manoeuvre, irrespective of short-term pressures, have collapsed.

In what follows, I will first trace the influence of this development in Britain and then move on to events in Germany to explain how this trend has affected bank branches. I will particularly emphasise how the rise of wholesale and secondary markets undercut branch managers, first in the UK and later in Germany as well.

2.4.1 United Kingdom During the 1980s

While the United Kingdom has traditionally been cast as a capital market-led model (Deeg 1992; Soskice and Hall 2001), it is important to realise it was not always the liberal financial hub recognised by scholars (Zysman 1983; Hall and Soskice 2001; Hardie *et al.* 2013). Not only were big British banks used to playing an active role in credit markets, but in many ways, the current paradigm is a function of financial reform during the 1980s, aimed at breathing new life into a 'stale' financial system. In this section, I will outline some key developments that took place during this time to argue that institutional changes laid the foundations of bank branch restructuring and automation in Britain.

During the eighties, several policy changes consolidated a previously segmented market for financial services in Britain. British financial markets most resembled an 'archipelago of cartelised islands' (Story and Walter 1997, 245) as a series of legislative barriers created a high level of sectoral segmentation and cartelisation among traditional banks, building societies and insurers. These barriers perpetuated an oligopolistic system failing to adequately service the market. High prices, unmet demand for mortgages and a lack of investment into domestic manufacturing all incentivised Harold Wilson's Labour government in 1976 to tackle financial reform (Moore 1981). Political interest in breaking up these cartels came from either side of the House[1], with Labour lamenting the dearth of the cartels' accountability and the Conservatives complaining about a lack of competition (Gough and Taylor 1979; Stephens 2007). The nature of the models' shortcomings equally fostered a desire for reform within the electorate, perhaps most notably among aspiring homeowners and SMEs. The rise of this relatively broad political coalition culminated in a series of reforms enacted by the Conservative government starting in 1979.

The first important policy was the abolition of capital controls in 1979 which had two immediate consequences. Firstly, it opened up British markets for foreign players such as Citibank and *Chase Manhattan Bank* to set up their operations in London, shaking up the banking cartel substantially (BIS 1999). Soon thereafter, the Bank of England (at the time still under political control) abolished the supplementary special deposit scheme (SSD or corset) which restricted credit creation and had affected banks' room to manoeuvre in mortgage markets (BoE 1983). This change went hand in hand with the abolition of credit controls as banks could in practice evade the SSD through overseas subsidiaries. In many ways ending capital and credit restrictions signalled to start of finance as we know it today. British banks could now massively expand their balance sheets,

[1]It has to be mentioned that some wings of the labour party entertained the idea of bank nationalisation to solve this issue.

compete internationally and enter burgeoning international wholesale markets as an external source of refinancing.

Another set of policy changes involved a realignment of the fiscal regime separating building societies and clearing banks. Previously, building societies had benefited from a highly lucrative composite tax system (BoE 1990; Stephens 1993) that corralled savers towards their services. To further the cause of competition, the Thatcher government here too levelled the playing field by extending the fiscal regime to deposit-taking banks, before abolishing it altogether in 1991. Finally, in the face of this regulatory challenge, building societies launched a lobbying campaign to expand their commercial rights and remain competitive. These efforts culminated in the Building Society Act of 1986 which gave them the freedom to diversify their services and offered the option of demutualisation, pursued by *Abbey National* and *Halifax*.

Aside from breaking up the cartels in credit markets, the Conservative government famously took aim at the, then, 'clubby' the *London Stock Exchange* (LSE). The LSE had become known for its restrictive practices which included fixed minimum commissions, the strict rules separating 'brokers' and 'jobbers' (i.e. the agent buying and selling on behalf of a client and the market-maker facilitating the transactions on behalf of brokers) as well as the exclusion of foreigners from LSE membership. From the viewpoint of the Exchequer, these 'archaic' rules had left the LSE under-capitalised. According to Nigel Lawson, then Chancellor of the Exchequer, they made London a 'backwater' for securities trading, a market which was thought needed to be developed if the City was to remain a global centre of finance (Lawson 2006). The government, in cooperation with reform-minded LSE Chairman Goodison, therefore overhauled this system in the (in)famous 1986 Big Bang.

In sum, these regulatory paradigm changes amounted to a strong institutional shift in British financial markets in which sectoral cartels and a clubby LSE were exchanged for a 'liberalised' system that pitted financial corporations against each other and integrated them into the rapidly developing global markets. For better or for worse, transforming the 'oligopolistic archipelago' into a financial Pangea created a more dynamic market, oriented towards performance and market-driven banking (Morisson 1988; Howcraft 1988).

For bank branches, the liberalisation of markets had at least two important consequences. Firstly, it put banks under increased cost pressure while on the other hand reducing their need for sprawling branch networks. In tearing down regulatory barriers, the reform package succeeded in the Wilson committee's goal to push down prices for financial services (BIS 1999). The introduction of the 'free-if-in-credit' (FIC) model initiated by *Midlands Bank* in 1984, promising free services for customers with outstanding debts, is a case in point. The upshot of this trend was that banks' profits came under pressure. Between 1981 and 1991 the interest rate spread, at the time the single largest source of revenue of the big four banks (*Barclays*, *Midlands*, *Lloyds* and *Natwest*), was halved (see Figures 2.5 and BIS 1999). As a result of falling profitability, banks pursued cost-cutting strategies anchored around strategic investments into ICT (Storey *et al.* 1999). All major banks outlined these changes in their annual reports, which subsequently manifested themselves on their balance sheets in, at least, two ways (see Figures 2.5 and 2.6 for reference). Banks started to push down cost ratio's during the 1980s by, first, divesting substantial parts of their real estate holdings while, secondly, steadily expanding the ratio of equipment as part of their capital stock. Taken together this constituted a structural shift towards a more automated and limited branch network.

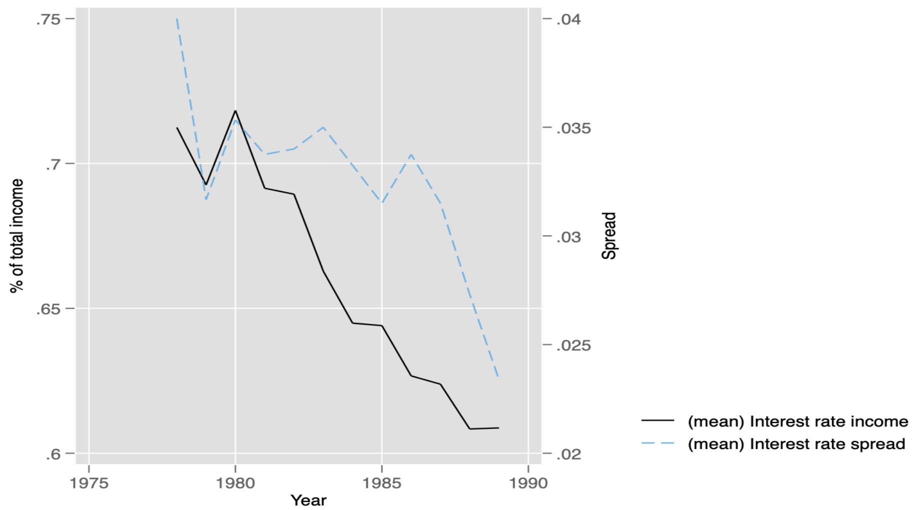

Figure 2.3 Evolution of interest rate income and spreads for British 'Big Four' banks

Source: Annual reports of Barclays, NatWest, Midlands and Lloyds

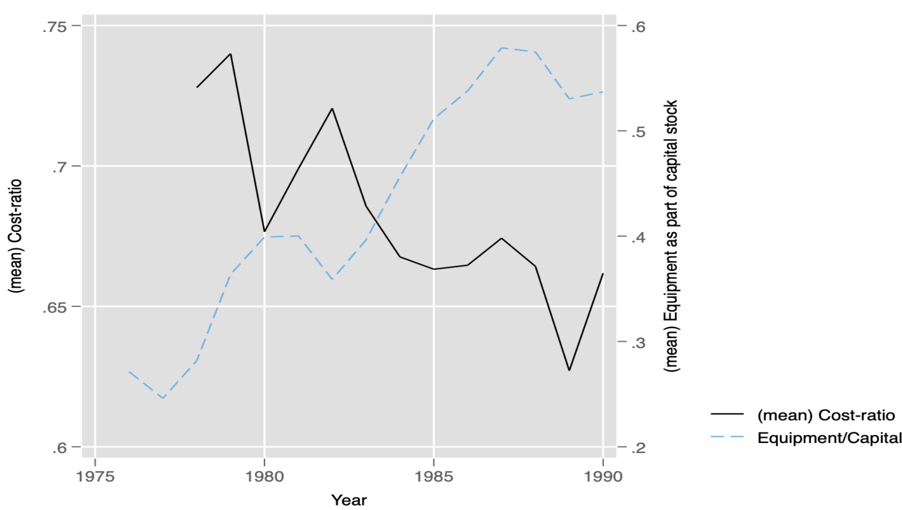

Figure 2.4 Evolution of the cost-ratio and equipment as part of capital for British 'Big Four' banks

Source: Annual reports of Barclays, NatWest, Midlands and Lloyds

Besides stimulating competition and allowing banks to seek new sources of refinancing, these institutional changes also challenged the traditional model of "price-setting intermediaries" by altering banks' approach to the asset-side of their balance sheets. It is during this decade that British banks start to engage heavily with wholesale markets and that the first Asset-Backed Security (ABS) was issued. Tellingly, building societies were able to negotiate their rights to issue mortgage-backed securities (MBS) as part of the 1986 Building Society Act. By the end of the decade, ABS markets would grow to roughly 2.5 billion pounds, demonstrating the success of the "originate to distribute" model of finance in which these loans became tradeable assets as opposed to instruments of patient capital.

Thinking of bank branches as the building block of a bank's intermediation process, one can start to see how the advent of market-based banking eroded the importance of the tasks performed by branches and their managers. Firstly, growing activity in wholesale markets reduced British banking's reliance on household savings, against a backdrop of disintermediation in which households increasingly invested savings in equity markets. Whereas banks traditionally relied on savers to provide liquidity via local bank branches, the growth of and access to wholesale markets provided banks with new sources of financing. New secondary markets also offered banks an appealing exit mechanism to sell off bad debt, even conjuring up perverse incentives to create debt in the absence of the SSD. Looking back at the FIC-model, banks' primary goal became issuing large amounts of credit. Concerns for quantity began to trump those for quality. This is a particularly important development to understand the decline of branch managers, considering the essence of their job revolved around issuing sound credit to local markets. The competitive advantage of human decision-making vis-à-vis standardised credit scoring relied on the ability of managers, using a broader set of qualitative information and tacit knowledge, to issue safer assets. Once the cost of issuing bad credit decreased and the incentives to originate to distribute grew, so the value of these tasks and skills plummeted.

From a corporate standpoint, then, restructuring branches, both through the closure and significant automation (think of *Barclays*' 1982 electronic bank branch in Cheshire), started to make sense given the intense competitive pressure at play during the 1980s. Substitution of branch managers by credit scoring was not simply caused by technological change capable of eating away at routine tasks. Rather, it should also be understood as the result of a process of institutional change, in product markets, depressing the overall value of branches and the tasks performed by managers within them. The upshot of these developments was the surprising decline of a highly interpersonal, analytical and deeply non-routine job, as branch managers in Britain started to lose their foothold in financial services.

2.4.2 Germany During the 1980s

In order to appreciate the extent to which this market-led banking model influenced bank branch automation, let us compare events in Britain with those in Germany. German banks were, like their British counterparts, quick to recognise the value in credit scoring during the eighties. However, unlike in Britain, the implementation of this technology did not initially lead to structural substitution. German banks continued to rely on managers' know-how and tacit skills while augmenting their judgement with credit scoring (Baethge 1999; Quack and Lane 2001). This employee-centered strategy which lasted until the turn of the millennium, only slowly started to give way to a labour-saving one (Oberbeck and

D'Alessio 1997). I will argue we can best understand these initial cross-country differences and subsequent staggered convergence by German banks as a function of the same institutional changes observed in the UK. That is, longer than in Britain, German financial markets remained domestically oriented and reliant on smaller banks acting as more traditional intermediaries. It was only when this model started to erode, first with the commercial banking pillar, that banks restructured their branch networks. I will first explain how three particular aspects of Germany's model safeguarded branch managers in the 1980s to then trace how institutional changes undermined this system.

What is striking about German finance during the 1980s and early 1990s, is the absence of strong capital markets. The 'coordinated' German post-war model (Hall and Soskice 2001) relied on an export-oriented manufacturing sector, anchored on stable labour relations, a skilled workforce, co-determination and long-term investment strategies. At the heart of this growth model, was Germany's credit-led bank-based financial system. (Zysman 1983; Hall and Soskice 2001). Here, 'patient' capital provided by banks was thought to allow firms to retain a concentrated ownership structure and pursue long-term strategies (Vitols 2001). Given this important link between bank lending and corporate governance for the German growth-producing sectors, this system essentially curbed the growth of strong capital markets and empowered bank managers for much of the 20th century. Several institutions, key to the country's growth model, stand out in this regard.

Firstly, corporate law favoured discretion and insiders as opposed to providing transparency for outsiders, as was the case in the Anglo-Saxon system. One example of such institutionalised opaqueness were accounting practices which, among others, allowed for management to calculate profits and losses over long periods (Fülbier and Klein 2015; Lütz 2000). These rules guaranteed shareholders stable dividends and ensured durable relationships, but 'failed' to transmit short-term business information to outsiders. Capital market development was further disincentivised by high capital gains taxes, curbing active markets for domestic equities. In short, German corporate governance institutions were not geared toward strong capital markets. This is obvious from the low levels of market capitalisation but also spilt over into a slower development of secondary markets and wholesale banking, which were already booming in the Anglo-Saxon world.

The upshot of this system was a well-developed system of bank lending built on branches and branch managers. The dominance of commercial lending in Germany is observable in the structure of banks' loan portfolios. Whereas British banks primarily held private debt on their books, their German counterparts were more active in commercial credit markets. This difference is of importance to the story of branch managers for the simple reason that the stakes are, on average, higher in commercial credit markets. In the traditional model of banking where loans (as assets) are held until maturity, the nature of commercial loans presents a strategic challenge to banks. Not only are they, generally speaking, larger and riskier but their size means banks (operating fractional reserves) get to issue fewer of them, leaving them with fewer degrees of freedom for failure. Banks tackle this problem in two ways. Firstly, through a holistic *ex ante* loan-appraisal process taking into account solvency, corporate governance and the destination of capital (i.e. what are they investing in). This is a more idiosyncratic process that requires deeper information and expertise and is, therefore, harder to automate than traditional household lending. Secondly, German banks have traditionally cultivated long-term relations, so-called 'relational banking' (Franks and Mayer 1997; Vitols 2001) with clients to reduce the risk of managerial failure, and ultimately default, down the line. To facilitate both strategies, German banks have tried to lower informational costs by taking equity stakes and board positions in firms. Local branch managers, play(ed) a crucial role in this process as banks relied on their expertise and tacit skills to manage risk in commercial markets while at the same time entrusting them with the day-to-day aspects of 'relational banking'.

Finally, the pillarisation of the German banking market into a commercial, public and cooperative pillar, reduced pressure for direct profitability. Whereas British markets in the eighties were subject to intense competition among commercial enterprises, their German counterparts (e.g. *Deutsche Bank*) shared the market with strong public and cooperative players. Within this setup, large commercial banks traditionally focussed on Germany's multinationals (MNEs) while the public and cooperative pillar historically had strong stakes in the regionalised markets for small and medium-sized enterprises (SMEs) (Deeg 1992; Ziegler 2000). These last two pillars in particular did not face particularly strong competitive pressures for much of the post-war era. Not only is neither type of institution traded, but their incentive structure is less profit-oriented. To be sure, both types of institutions are expected to be profitable, but they are above all expected to provide good services to stakeholders (Vitols 2004). This public goods goal is particularly strong for public banks. Owned by Länder, municipalities and districts, Landesbanken and Sparkassen are a staple of Germany's state-market nexus by playing a key role in Germany's *Mittelstandpolitik*[2] and regional industrial policy more broadly (Deeg 1996; Hackental 2004, 74). Far from putting profitability at the heart of their objectives, the central strategic goal of these public institutions is to internalise costs, both transaction and information, for consumers and businesses to facilitate long-term growth. Again, managers and 'relational banking'

[2]Term for the German industrial policy of supporting SMEs

practices play a crucial part in this, with government organisations leaning on deep localised information held by banks to facilitate government loan provision, often in co-financing arrangements with the public banking pillar.

However, aside from empowering local branch managers at a time when British banks were restructuring, German finance further promoted branches through competitive insulation of banks. Indeed, the regional nature of cooperative and public banks perpetuated a geographically segmented financial market, preventing institutions from competing with each other (Siebert 2004). Much of this segmentation is driven by public banks which are guaranteed at the regional and local level, ruling out consolidation from taking place (Deeg 2014). Finally, this guarantee historically obligated the state to keep public banks afloat and refinance them if necessary.[3] This, to the great irritation of their commercial counterparts, put the public pillar in a privileged market position.

In short, German bank branch managers were isolated from developments transpiring in Britain during the eighties. Compared to their UK counterparts, German branch managers retained an integral role in their country's growth regime by acting as a key conduit in its bank-led financial model and industrial policy. What is more, for a large segment of the German financial market, pillarisation provided substantial insulation to the market pressures raging across the pond.

2.4.3 Institutional Change in Germany

By now it should be clear that Germany's model of banking differed substantially from the increasingly market-led banking practised in Britain during the eighties. However, the German political economy underwent several changes over the

[3] Anstaltlast is an obligation to keep public-sector institutions solvent. Gewährträgershaftung a guarantee making the state liable for all the banks' debts in case of insolvency.

last decades (Streeck and Thelen 2005; Hardie *et al.* 2013; Röper 2018). I will emphasise how a mix of domestic and international pressures has led to an increasingly market-led model, resulting in a staggered convergence on bank branch restructuring.

To start understanding this shift, it is important to realise the growth of financial markets in the Anglo-Saxon world did not go unnoticed on the continent. For German commercial banks, in particular, developments across the pond presented both challenges and a source of inspiration. For one, domestic firms increasingly turned to Wall Street and the City, instead of players like *Deutsche Bank* or *Commerzbank*, to access high-end financial services (Haipeter and Wagner 2008). During the nineties, globalisation pressures pushed large MNEs towards pursuing equity-financing to compete internationally. However, high prices offered by domestic banks and an unaccommodating institutional environment led these firms abroad. Tellingly, *Daimler-Benz* switched to American accounting standards (GAAP) in 1993 as a prerequisite to be listed on the New York Stock Exchange. At the same time, German banks were also facing low interest rates, which chipped away at their core source of revenue. Commercial banks, with their large stake in MNE financing, therefore started to pursue a strategy of expanding fee-paying services to offset their loss of revenue. In an attempt to expand these capacities, *Deutsche Bank* and *Dresdner Bank* each acquired British investment banks, *Morgan Grenfell* and *Kleinwort Benson* respectively. On the domestic front, meanwhile, commercial banks lobbied the government to expand financial markets to align the regulations more closely to their international ambitions. As Vitols (2004, 5) noted, the German government was not unsympathetic to this idea. Not only did it see the potential of fuelling job growth in an internationally competitive sector, but several painful corporate failures (e.g. *Metallgesellschaft,* *Balsam* and *Bremer Vulcan*) had recently fuelled public debates on the modernisation of corporate governance structures in Germany.

As a consequence, the 1990s witnessed a domestic policy shift to strengthen Germany's position as a financial centre. This, almost inevitably, implied moving towards the Anglo-Saxon paradigm (Deeg 2005; Röper 2018). Throughout the decade several initiatives were taken to accomplish this project of *Finanzplatz Deutschland* (Dore 2000). Crucial in this regard were the Financial Market Promotion Laws enacted between 1990 and 2002. These reforms launched new markets in options and futures, whilst also creating a more liberal regulatory and disclosure environment. Equally important was the introduction of a federal securities trading supervisor *Bundesaufsichtamt für den Wertpapierhandel* (BAWe)[4], replacing the patchwork of regulation done at the level of the Länder (Lütz 1996; Detzer and Herr 2014). Finally, the KapAEG and KonTraG internationalised accounting standards and liberalised corporate governance, while Schröder surprised many by abolishing capital gains taxes in 1999 (Voss 2021).

Aside from substantial domestic reform, some consequential changes came from the side of the European Union. Crucially, the advent of the internal market and the monetary union increased competition within the banking sector throughout the continent. Indeed, the nineties witnessed waves of bank consolidation (BIS 2001) as firms adjusted to an increasingly, though far from entirely, Europeanised financial landscape. Against this backdrop, European competition authorities scrutinised the insulated German system. The European Commission (EC) particularly took aim at the practice of public guarantees for the public banking pillar in Germany in light of European State Aid rules, leading to an agreement in 2002

[4]In 2002 the BAWe merged with the banking supervisor *Bundesanstalt für das Kreditwesen* (BAKred) to form the *Bundesanstalt für Finanzdienstleistungsaufsicht*

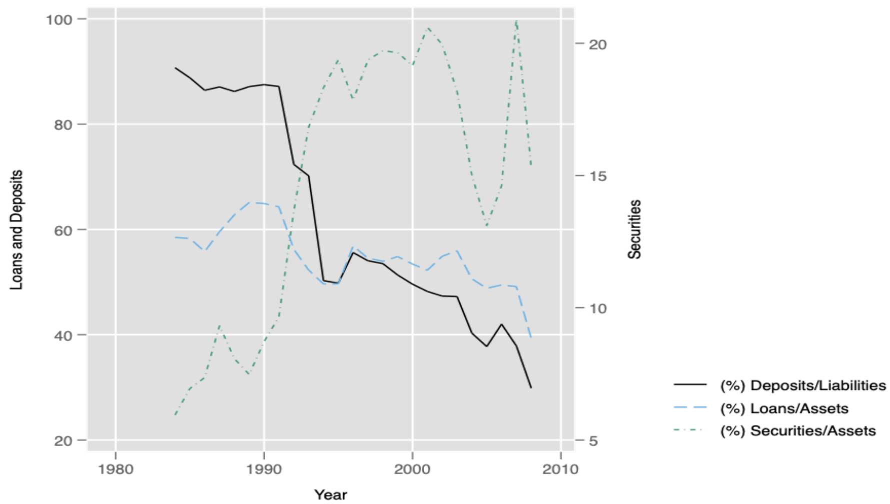

Figure 2.5 Evolution of the relative importance of securities, deposits and loans on British bank balance sheets

Source: OECD 'Bank Profitability'

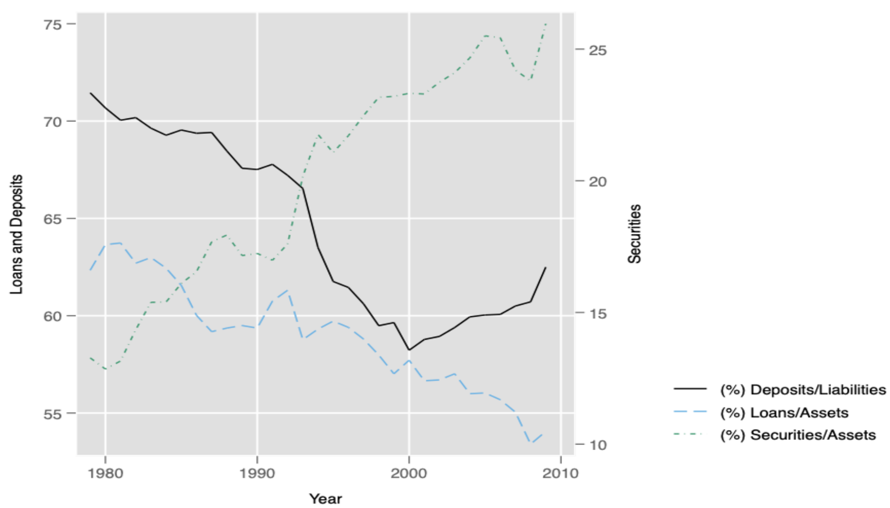

Figure 2.6 Evolution of the relative importance of securities, deposits and loans on German bank balance sheets

Source: OECD 'Bank Profitability'

to reform the system into a relationship “not different from a commercial owner”. Under this arrangement, the automatic and unlimited nature of guarantees was banned (EC 2001), putting banks across the pillars on a more even playing field.[5]

Put together, German finance significantly internationalised during the early 2000s, with German banks finding themselves in a more market-based financial model at the end of it. Chancellor Schröder captured the sentiment well by stating “We want to create a new shareowning culture. I belong to those who are happy when the DAX goes up” (Financial Times 2000). Crucial to the story of branch automation, this transition happened first for commercial banks. Not only had institutions such as *Deutsche Bank* and *Commerzbank* always been most directly affected by competitive pressures, even before reforms, but they expressly moved towards a more investment banking-oriented model during the nineties to compete with Wall Street and the City. Public and cooperative banks, meanwhile, remained more insulated. Still, public banks were equally put under serious pressure once their guarantee was pulled in the early 2000s. This is not to say these institutions forgot about ‘the public good’, but regulators had transformed profitability from a luxury into a necessity.

[5]It would continue to operate for assets created before 2001 while the guarantee would lapse in 2015 for newer assets

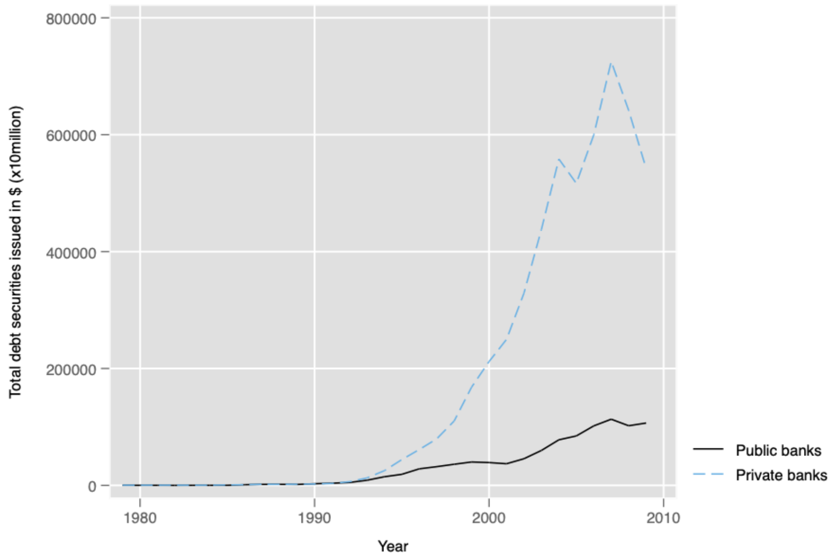

Figure 2.7 Volume of debt securities issued by German public and private banks

Source: Bank of International Settlements

Quantitatively, these trends are visible as well. Throughout the 1990s the number of initial public offerings (IPOs) soared with overall market capitalisation following suit while secondary markets started to see strong growth as well. German wholesale and securities markets have not caught up with the UK, but their development throughout the 1990s and 2000s is nonetheless remarkable. Public sector banks also partook in these activities during the early 2000s. Savings banks first started to shift loans off their own balance sheets and pool them within their group and then moved on to selling uncollectable loans on secondary markets (Blum and Martens 2008). Note how the public banking sector (accounting for half of all German assets) entered the market for debt securities later, and to a more limited degree than their commercial counterpart (Figure 2.7). Still, this action was sufficiently large to generate significant entanglement of Landesbanken in the subprime mortgage crisis in 2008, with some institutions having to stomach billion-dollar losses (Senkarcin 2015).

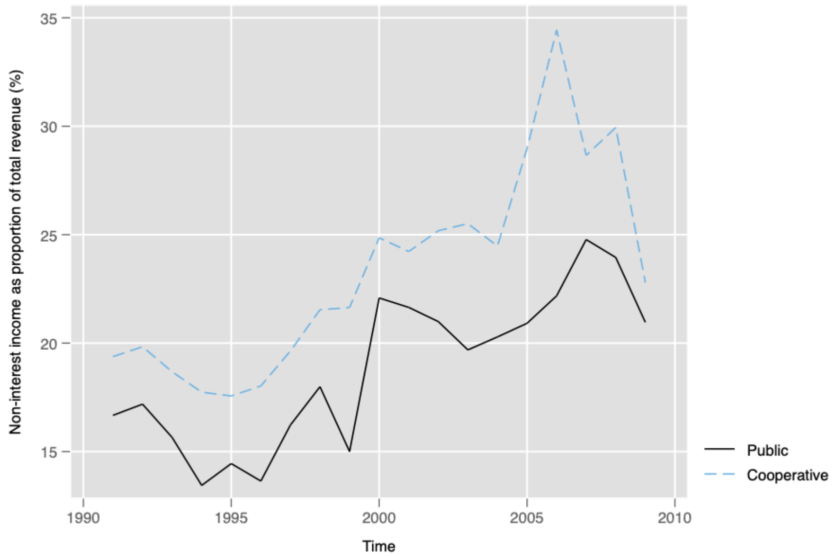

Figure 2.8 Non-interest income as part of total revenue for German public and cooperative banks

Source: Bank of International Settlements

Bearing in mind developments in Britain, the cascading introduction of market-led banking across different pillars explains the pattern of bank restructuring in Germany surprisingly well. As one would expect, the enthusiastic move towards wholesale and secondary markets by commercial banks was followed by a strong decline in bank branches in the 2000s and increased automation of remaining locations in the sector. *Deutsche Bank* is perhaps the best example of a German bank shifting its focus from retail and commercial markets to investment banking, opening its highly automated 'branch of the future' prototype in Berlin in the early 2000s.

Public and cooperative banks, meanwhile, took slightly longer to rethink their branch networks because they simply did not face the same commercial reality. However, from the late-2000s onwards these institutions, too, found themselves restructuring parts of their branch network as a reaction to financial liberalisation and the loss of their public guarantee. What is perhaps most interesting about this evolution is how German banks, and in particular savings banks, pursued a strategy of customer segmentation and branch dualisation (Haipeter and Wagner 2008). Many institutions have followed the UK in the realisation that the value inherent in traditional services of branches has dwindled for traditional retail services due to rising costs and competition. In spite of a definite turn towards restructuring of branch networks (WDR 2021; ZEB 2020), centered on the standardisation of retail products and credit scoring, public sector banks are continuing to play their role within the *Mittelstandpolitik*, increasingly focusing on non-financial services, most notably advisory services, to SMEs. For example, part of the restructuring process in the *Hannover Sparkasse* involved an 'upgrade' of remaining branches to 'advisory centres'. *NRW Bank*, meanwhile, has also strongly focused on these services as well, boasting an all-time high 30.000 advisory sessions in 2019 (NRW Bank 2019). This suggests we might expect bank branches to remain a key feature of German banking to the extent the public pillar remains a key player in industrial policy. Indeed, as the COVID-crisis has shown, strong local ties between businesses and banks were a key feature of the government's successful roll-out of financial aid (Hancké *et al.* 2021). For branch managers, this means there are opportunities to upskill, but that the job they performed for a long time has ultimately changed in Germany as well.

2.5 Conclusion

This paper started with a puzzle. Why, if the structure of bank branches during the early eighties was so similar in Britain and Germany, was the implementation of credit scoring in both countries so different? Existing accounts would suggest we need to look at either the tasks structure of occupations within retail banking or the power of labour to understand how this automation unfolded. This paper, on the other hand, argued that to get at this question we need to understand how changes in financial institutions have impacted the place of banks in the economy. More particularly, I argue that the rise of market-led banking has undermined the role of bank branches and their managers traditionally played in the process of financial intermediation, resulting in a labour-saving adoption of credit scoring.

Far from being inevitable, the staggered implementation of credit scoring as automation presented here was the, perhaps unintended, result of deliberate policy moves towards more liberal and globalised financial markets, dominated by debt securitisation and interbank lending. Interestingly for the debate on routine-biased change, this case has offered us an example of how *a priori* non-routine occupation ended up automated against the (theoretical) odds. Rather than calling to double down on the importance of tasks, this suggests that branch managers' demise should be understood as the interplay between technological innovation on the one hand and institutional 'innovation' on the other. For arguments about labour power (Vitols 2004), then, this means that institutions do matter, but in a slightly more complex way than portrayed by the literature. Institutions, it seems, do not just put the brakes on management when trying to implement a given technology, but instead, they co-determine firm strategy in the broadest sense of the word and therefore influence which technologies are adopted and how that is accomplished. In this case, institutional differences led to the adoption of credit scoring as a labour-saving innovation in the UK while it was initially used to augment workers' skills in Germany.

Put together, this suggests a need to guard against technological determinism. As the different adoption strategies of credit scoring during the eighties highlight, there is no single pre-determined scenario driving technological change in advanced capitalist democracies. German and British retail banks might have increasingly converged in their use of credit scoring but, as I discussed, this is the consequence of converging institutional practices in capitalist democracies rather than of technological necessity. For political science and political economy, this means that understanding the direction of innovation and the impact of automation on our society will require a closer analysis of the interaction between institutions, growth and technological change.

There are some limitations to this argument. For one, this story of bank branch managers is a narrow case study, which means we should guard against over-generalisation. Importantly also, the evolution of financial markets in the last thirty years is intertwined with ICT innovations in ways that are more complex than I have portrayed in this paper. The causal arrow between financialisation and innovation inevitably runs both ways in a mutually reinforcing process. There is also a good question about to what extent it is possible to separate out the effects of financial liberalisation from a potential weakening of labour power in Germany. Indeed, these trends have definitely gone hand in hand, and I do recognise the importance of Vitols' (2004) argument stressing the importance of industrial relations and union power. However, not only does this point not offer a satisfactory explanation for events within Germany, but it blends out the important functional relationship between credit scoring and evolving models of banking I highlighted in this paper.

In conclusion, this paper offers some interesting conclusions for political economy scholars. Firstly, it lays bare some of the organisational processes underlying the shift towards market-led banking. At the same time, the differentiated adaption to credit scoring in the German public banking pillar highlights how this convergence has not been a steamroller either. Liberalisation, it seems, plays out differently in different systems (Thelen 2014). More generally, this analysis, therefore, makes the case that there is no single way in which innovation has to be implemented and that the way in which it does cannot be understood in isolation from broader growth models. With regards to automation, this case suggests labour substitution is about much more than the *a priori* substitutability of discrete tasks. Finally, the story of branch managers highlights the complex interplay between innovation, business and the state in a sector which is currently undergoing rapid changes. As the differential developments in the UK and Germany suggest, it is worthwhile to remember none of these changes is as unprecedented, let alone inevitable, as some seem to think (Susskind 2020).

3

Conflict or Cooperation? Exploring the Relation Between Cooperative Institutions and Robotisation in the OECD

Introduction – Theory & Argument – Methodology & Results – Discussion – Conclusion

Abstract: Robotisation of production challenges the status-quo in the economy, some win while others lose out. Literature has argued automation causes redistribution, both between capital and labour as within either category. We also know that many economies have chosen to adopt cooperative institutions to negotiate the negative by-products of such economic changes. What is, however, less clear is how such institutions influence rates of automation themselves. This paper contributes to this debate by conducting a panel analysis of sectoral robotisation rates and cooperative institutions in 25 OECD countries between 1993-2017 using an original institutional indicator. The findings suggest that aside from simply redistributing the costs and benefits of automation throughout the productive sector, cooperative institutions also meaningfully predict higher levels of robot density, showing that more institutionalised economies do not lag behind in terms of automation. What is more, these institutions also seem to co-determine the rates of robotisation occurring during recessions.

3.1 Introduction

A fundamental question in comparative political economy concerns how institutions, and the conflict they engender, influence technological change, and more particularly labour-saving innovation. While automation has proven to be a benefit for the whole economy in the long-run (Atack *et al.* 2019), its short-run effects tend to be Pareto-suboptimal as some jobs and skills are destroyed or left severely devalued. In a world where work is the primary mechanism of income distribution, automation therefore almost inevitably elicits deep distributive conflict, particularly between capital and labour (Frey 2019; Carpettini and Voth 2020; Morlinder*et al.* 2021). This begs the question of how institutions that co-determine the power resources these competing groups have available to them, influence the pace of labour-saving technological change. Will workers who stand to lose from automation stop this type of innovation in its tracks if they can do so?

Automation is playing an increasingly important role in capitalist production. Just consider robots. The International Federation for Robotics (IFR) estimates that between 2018 and 2020 robotisation of manufacturing has increased on average by 12% annually, across the industrialised world. What is more, there is good reason to believe the pace of that transition has picked up in the wake of the global pandemic (Jaimovich and Siu 2012; Korinek and Stiglitz 2021): robots after all do not get sick nor do they demand wage rises. While workers are an indispensable part of the equation for most sectors, the prospect of advances in AI and robotisation has put a serious question mark on this basic proposition. However, when we delve into the real-world adoption of robots, what is striking is the highly skewed distributions of robots across the developed word. Some economies such as Germany and Sweden boast comparatively robot-intensive manufacturing sectors while others, like the UK, lag behind. How can we explain this?

Existing thinking has offered us three broad theories to answer that question. A first line of thinking suggests that institutions that constrain managerial power and/or force employers to internalise some of the social externalities of automation tend to impede labour-saving progress. Under this logic, excessive costs imposed by institutions such as strong unions, collective bargaining or works councils simply force employers to drop their attempts to innovate (Leontieff 1982; Alesina and Giavazza 2006) or to circumvent the purview of labour by offshoring activities elsewhere (Sabel 1982). At the same time, similarly antagonistic accounts of industrial relations predict an opposite effect: strong institutionalised labour power pushes employers to automate in an attempt to disorganise labour (Braverman 1974; Presidente 2020) . Finally, a wide scholarship in comparative political economy and industrial relations has highlighted the potential of key institutions to generate complementary interests between capital and labour, ultimately producing higher levels of, more inclusive, innovation (Olson 1982; Katzenstein 1985; Dankbaar 1988; Kochan and Tamir 1988; Hall and Soskice 2001; Kraft *et al.* 2009; Genz *et al.* 2018; Belloc *et al.* 2020).

To make sense of differential rates of adoption across the OECD this paper, therefore, investigates the relationship between cooperative institutions and industrial robotisation. Cooperative institutions are institutions that, according to Hicks and Kenworthy (1998), seek to balance 'distribution/redistribution' and 'collective gain' in capitalist production through institutionalised cooperation within capital and labour, throughout different levels of the political economy. Institutions such as tripartite policy-making, collective wage bargaining and works councils present an important avenue for workers to organise, make their voices heard and bargain over the negative externalities of structural changes in the economy such as automation. They, in effect, confer concrete power resources to labour and in some cases (such as in Belgium and Germany) even give workers the explicit co-determination rights over technological changes in the firm.

I compile an original institutional index to track the density and evolution of cooperative institutions over twenty-five OECD countries. Pairing this information with sectoral robotisation data from the International Federation of Robotics (IFR), I estimate a series of panel models to disentangle the relation between institutions, labour power, and key distributive outcomes (i.e. sectoral working hours and labour shares). In line with existing firm-level evidence by Kraft *et al.* (2009) and Jäger *et al.* (2020), my findings show that cooperative institutions predict higher levels of automation. Rather than thwarting innovation, highly cooperative settings are found to boost robotisation by 176% compared to liberal economies. What is more, I find that robotisation in highly institutionalised settings goes hand-in-hand with more equitable outcomes in terms of labour shares and working hours. Finally, robotisation in these places is also found to operate on a longer time horizon, not taking hold in the space of a recession (Jaimovich and Siu 2012). This all suggests that cooperation and bargaining between capital and labour can play a highly positive role in the development of automation, leading to more investment into productivity-enhancing changes all the while safeguarding social peace in the short-term.

The balance of this paper is organised as follows. I will first present the relevant literature on automation and cooperative institutions, which I will use to draw out the hypotheses at the heart of this paper. Section 3, subsequently, outlines my data and methodology to then, in section 4, present the results of the analysis. Sections 5 and 6 will, finally, offer a brief discussion of my findings and conclude.

3.2 Theory & Argument

Recent literature on automation suggests labour-saving innovations have a dual impact on the economy. On the one hand, this type of innovation eats away at routine tasks while on the other hand, it generates demand for a whole new set of activities (Acemoglu and Restrepo 2018; Autor *et al.* 2021).

The key problem is that this new demand for labour is by no means bound to benefit workers that see their jobs challenged by automation in the first place. New tasks do not necessarily appear contemporaneously with the disappearance of old ones, let alone in the same geographical location and they often come with different skill requirements. This mismatch between the so-called replacement and reinstatement of work means automation is strongly linked to (short-term) regressive social outcomes such as labour market polarisation (Autor and Dorn 2009; Dauth *et al.* 2017) and falling labour shares (Karabarnounis and Neiman 2013; Autor *et al.* 2017; Kehrig and Vincent 2018).

As Frey (2019) points out, this tendency to create 'winners' and 'losers' requires careful management and negotiation, at all levels of the political economy, if automation is to be politically acceptable in the long run. We know from extensive literature in comparative political economy that this type of game between workers and employers takes different institutional forms across rich democracies (Hall and Soskice 2001; Iversen and Soskice 2019; Hall 2021) with some economies heavily reliant on markets to allocate resources, some choosing to focus on dense networks of institutions to secure non-market coordination and predistribution, and others, still, focusing their efforts on *post-hoc* redistribution through extensive welfare provisions. What remains unclear is how these important institutional differences and the relative allocation of power resources between capital and labour they engender influence automation itself. In fact, one of the key questions in the automation debate is whether or not giving workers a voice in decisions that might affect their own future employability will stifle progress?

One line of thinking suggests labour will try to halt automation. Wassily Leontieff (1982) famously argued "If horses could have joined the democratic party, what would have happened on farms would have been quite different." Building on the insight that workers depend on selling their labour to secure an income, this argument suggests that well-organised labour interests will try to slow down the rise of automation since it diminishes demand for work and hence its ability to earn a living. Alesina and Giavazza (2006), for example, argue that (neo)corporatist institutions in Europe have inhibited investment in high-tech industries. Sabel (1982), meanwhile, argues that high fixed labour costs (i.e. fewer degrees of freedom to hire and fire) would not stop innovation altogether, instead predicting it drives firms (particularly SMEs facing uncertain demand) to pursue innovation outside of the union's purview through offshoring or outsourcing. Economic historians like Horn (2008), finally, have emphasised the importance of a stable and industrial-friendly political climate for automation to take hold.

All in all, this argument seems convincing. Why would those who stand to lose willingly put their livelihoods at risk when they have the power resources to hold back automation? However, the notion that institutions that limit management's power will stifle automation does not seem to square with the empirical reality that countries with more regulated labour markets and a stronger unions presence, such as Germany, Sweden and Belgium, are highly automated while other countries with highly flexible labour markets, like the UK, are not. Workers in most north-western European countries have allowed automation to advance, it seems, *despite* broad co-determination rights.

A second line of reasoning, therefore, turns this oppositional logic on its head to argue so-called labour-friendly institutions lead to more automation because they incentivise management to break labour's power through the use of technology. Indeed, the Radical school famously argued technology was socially determined and therefore undertaken by capital as an attempt to proactively disorganize labour (Braverman 1974; Marglin 1974): workers cannot organize against you if they have been replaced by machines. Presidente (2020) similarly explains high levels of robotisation in sunk cost-intensive industries as an attempt by employers to decrease the leverage workers have to make excessive wage demands in these settings where employers tend to be particularly vulnerable to hold-ups. Labour, according to this logic uses its institutional power to extract rents which in turn leads capital to pursue labour-saving innovations.

While this account ostensibly explains much of the cross-country variation we are interested in, there are nevertheless a couple of problems underlying this line of reasoning. First of all, according to this logic, we would expect the explosive growth of automation in recent decades to have eroded institutional protections for workers. However, existing work has reaffirmed the resilience of these structures in many of the most highly automated countries, particularly in the manufacturing sector (Hassel 2011; Baccaro 2014; Hope and Martelli 2019). Secondly, this argument on the disorganisation of labour falls apart when pushed to its logical extreme: if labour were so powerful to the point that automation was needed to stop workers from extracting rents, why would it allow capital to go ahead and undermine that power in the first place? In fact, contrary to what this theory would expect, there is good evidence to suggest firm-level employee representation is positively associated with long-term capital investments *without* any negative consequences to wages (Jäger *et al.* 2021).

Contrary to the assumption of these two arguments, I contend that the interests of capital and labour regarding automation are in fact more complimentary than often assumed. While some groups of workers stand to lose significantly from labour-saving innovation in the short-run, the long-term benefits of this type of innovation have proven to be in the interest of workers. Automation has not only made many jobs safer (Ling and Singleton 2021) and less strenuous, but in most countries, its broad productivity-enhancing nature has helped to raise wages and overall the standard of living (Atack 2019; Salomons and Autor 2018). At the firm level, meanwhile, job security is not only linked to specific production methods, but also to the firm's competitiveness (McLaughlin 2013). Employees, from this perspective, would halt automation at their own peril.

Barring the possibility of fully autonomous production, employers on their side also have a lot to gain from ensuring workers have a voice in decisions. Employees, for one, hold 'intimate' tacit knowledge about the production process employers need to tap into when making investment decisions (Harvey 1992). Sharing that information, however, becomes difficult when workers fear it could be used to substitute for their jobs. More importantly still, to ensure maximum return on these investments, employers need to generate trust and approval so workers are willing to invest in the right complementary skills (Hall and Soskice 2001) and do not organise potentially costly strikes (Finzel and Abraham 1996). A substantial literature in industrial relations has therefore demonstrated that trust and strong relations between capital and labour are important factors in innovation success (Kochan *et al.* 1985; Kochan and Tamir 1988; Haipeter 2020).

Still, despite having some key overlapping interests regarding automation, engineering iterated cooperation tends to be a tricky exercise (Axelrod 1984), and achieving it in most cases depends on strong institutions. In this respect, comparative political economy literature has emphasised how institutions do not simply confer workers with power resources (Korpi 2006), but in doing so also help to align the, often time inconsistent, interests of capital and labour (Olson 1982; Eichengreen 1996; Hall and Soskice 2001; Hall 2007). Within the productive sector, this is most commonly achieved through so-called cooperative institutions (Hicks and Kenworthy 1998, 1634) which seek to strike a balance between 'distribution/redistribution' and 'collective gain' in capitalist production through means of embedded cooperation between capital and labour through institutions such as works councils, sectoral institutions, wage bargaining schemes and bi-and tripartite policy-making.

Literature (Hall and Soskice 2001; Rhodes 2001) credits these institutions with creating productivity coalitions between capital and labour which address key employer concerns regarding competitiveness and innovation in return for negotiating the short-term adjustment costs and productivity-linked wages. Functionally, these coalitions are thought to operate at various levels of the economy. Institutions such as centralised wage bargaining allow social partners to keep wages in lockstep with productivity and demand, bi-and tripartite dialogue helps to align interests with policymakers, sectoral institutions play an important role in coordinating specific skill and investment needs while works councils structure coalitions at the firm level (Rigini 1995). Crucially, some existing country and firm-level evidence suggests this type of active employee involvement does not stifle investment (Belloc *et al.* 2020; Jäger 2021), perhaps because workers trade-off automation for the security of strong contracts and richer, non-automatable, jobs (Belloc *et al.* 2022). My first hypothesis (H1), therefore, posits that cooperative institutions predict higher levels of robot density.

To tease out whether a positive association between robots and these institutions is the result of cooperation or antagonistic attempts to disorganise workers, subsequent hypotheses are set up to test the observable implications of these two propositions. First, I will test the implications for cooperative institutions on the distributive effects of automation. If Presidente's (2020) argument about management using automation to circumvent hold-up problems is correct, we might expect automation to go hand-in-hand with regressive social outcomes. Likewise, if automation is driven by cooperative arrangements that seek to offset short-run costs in return for long-term growth, then we should reasonably expect robotisation to more positively influence distributive outcomes in highly institutionalised settings. Two of the most important outcomes we can anticipate at the sectoral level, in this regard, are working hours and the labour share of income.

As discussed previously, automation has in recent years been strongly linked with the falling labour share of income (Karabarbounis and Neiman 2013; Autor *et al.* 2017a; Acemoglu and Restrepo 2018a; Kehrig and Vincent 2018). Since labour shares give us a direct insight into the share of the pie going to workers, they are an excellent way of understanding the precise relation between automation and cooperative institutions. If these institutions do play an important role in negotiating negative short-term by-products of automation, then we would see this positively reflected in the labour share. For example, collective agreements might push employers to invest into reskilling employees as opposed to laying them off while strong works councils or employee representation on boards could lead to compromises over cuts (see Hirvonen *et al.* 2022 for an empirical example from Finland). As such, I predict that the negative relation between robotisation and the labour share is less pronounced in cooperative settings (H2).

Closely related, working hours give us a concrete insight into how much labour is being *consumed* in any given sector as opposed to telling us how much labour is being *compensated* as part of total output. Literature has so far, offered compelling evidence to suggest we might expect an overall decline in working hours at the sectoral level as a result of automation (Mann and Puttmann 2018; Acemoglu, LeLarge and Restrepo 2020). However, if robotisation and working hours in a co-operative setting are subject to bargains between workers and management, we would expect them to remain more stable for similar levels of automation compared to liberal economies. Burdin *et al.* (2020), for example, argue that employee representation is exactly complementary to robotisation because it helps firms in organising flexible working arrangements, retraining and job upgrading. I, therefore, hypothesise that the negative relation between robotisation and the hours worked at the sectoral level is less pronounced in cooperative settings (H3).

Another way to think through cooperative or antagonistic mechanisms is by looking at the timing of automation. There is good evidence pointing out labour tends to lose its foothold in the U.S. during times of recession (Jaimovich and Siu 2012). Job cuts during recessions, here, are followed by 'jobless recoveries' as firms leverage the opportunity of the crisis to invest in new technologies that cut costs for the future. However, if cooperative institutions are effective mechanisms to distribute the costs of negative shocks throughout the system, then we might expect differentiated patterns of automation between densely and lightly institutionalised economies during recessions. Indeed, in a world where robotisation is a truly cooperative outcome, it would most likely be the result of bargained long-term investment strategies as opposed to ad-hoc decisions made when labour is at its weakest. In that case, large-scale investments are unlikely to take place in the space of a technical recession. What is more, deeper investment in specific skills found in these settings as well as more expensive mass layoff procedures could act as important barriers for employers to lay-off workers while temporary unemployment schemes, such as the German *Kurzarbeit*, could help reduce the costs of recessions on employers. I, therefore, hypothesise (H4) that higher degrees of cooperation are inversely related to robot density during times of recession.

To summarise, this paper will test the following hypotheses:

- H1. Higher levels of cooperative institutions predict of higher levels of robot density
- H2. The negative relation between robotisation and the labour share is less pronounced in cooperative settings.
- H3. The negative relation between robotisation and the number of hours worked is less pronounced in cooperative settings.
- H4. Higher degrees of cooperation are inversely related to robot density during times of recession.

3.3 Data & Methodology

3.3.1 Model

To test these hypotheses I propose the following panel regression.

$$log(RD_{is(t+2)}) = \beta_0 + \beta_1 U_{it} + log(\beta_2 C^L_{ist}) + \beta_3 X^M_{it} + \alpha_{is} + d_t + \epsilon_{ist} \qquad (1)$$

Where RD denotes robot density (i.e. number of multipurpose industrial robots over 10.000 workers) in country i, sector s and year t+2. U_{it} represents the regressor of interest capturing the density of cooperative institutions, based on the self-constructed cooperative index. C^L_{ist}, then, is a vector of the theoretically important economic fundamentals L at the sector level. X^M_{it} is another vector of socioeconomic and regulatory controls M at the country-level which are expected to influence robotisation. I include country and sector fixed-effects α_{is} to absorb remaining cross-country heterogeneity while d_t are the year fixed-effects accounting for cross-sectional common shocks throughout time and the non-stationary nature of robot adoption. ϵ_{ist}, finally, is the error-term of the model. Logarithmic values are included for those variables which feature strong outliers, such as the robot density, output and wages. Moreover, the dependent variable in the equation is lagged by two years to account for the fact that the effects of institutional or economic changes take some time to filter through into robot stocks (BIC test indicates 2 year is the appropriate lag).

As mentioned, these estimations rely on fixed-effects using country, sector and year dummies. The inclusion of both country and sector dummies is based on the insight that robot density does not only likely to correlate with unobserved country-level factors but also manifests a highly sector-specific dimension. The automotive sector, for example, tends to be highly robotised while the textile sector is not (see Table B.2.1 in Appendix B). The Haussmann test indicates that there are systematic differences between random and fixed-effect models in this analysis, thus rejecting the null hypothesis on equality between the two. As such, the inclusion of fixed-effects is warranted (Allison 2009). I also test for multicollinearity and heteroskedasticity, both of which are absent. Standard errors are nevertheless clustered at the country-sector level.

The analysis will proceed in three stages. First, I will run the baseline model including the self-constructed cooperative institutional index. I will then examine H2 and H3 by looking at the hypothesised interaction effects between institutions on the one hand and the sectoral labour share of income and working hours on the other. Finally, the analysis will turn to the effects of recessions on the relation between automation and institutions.

3.3.2 Data

3.3.2.1 Dependent Variable

Automated production in the manufacturing sector is a function of an interaction between multiple types of innovations, ranging from digitalisation to advanced machinery. However, methodologically this phenomenon is generally operationalised by looking at robot density, which is defined here as the number of industrial robots over 10.000 workers.

In this paper, I use data compiled by the International Federation of Robotics (IFR) and the Structural Analysis database (STAN) by the Organisation for Economic Cooperation and Development (OECD) to compute this dependent variable for eight sub-sectors of the manufacturing industry in 25 countries between 1993 and 2017. The IFR provides us with yearly sectoral data on the number of operational industrial robots (ISO 8373) which are defined as "automatically controlled, reprogrammable multipurpose manipulator programmable in three or more axes". While the IFR is by far the best available source of data in this field (Gaertz and Michaels 2015; Acemoglu and Restrepo 2017b; Artuc *et al.* 2020) there are some notable limitations. Firstly, the IFR offers imperfect coverage, both in time and space, for certain countries and regions. This means that some countries (perhaps most notably Switzerland and Canada) fall out of the empirical scope for this analysis. Secondly, the IFR only accounts for 'multipurpose' robots and does not cover 'dedicated' automated controllers with a single industrial purpose. A final drawback of this dataset is that it leaves a portion of robots unallocated by industry. I, therefore, follow Acemoglu and Restrepo (2017b) by classifying these robots using the proportions observed in the classified data. Additionally, I follow Artuc *et al.* (2020) by constructing a stock of robots for every year-country-sector assuming a depreciation rate of 10%.

To construct a measure of robot density, I follow the IFR's sectoral classification based on the ISIC Rev. 4 and pare this with the OECD's STAN indicator on workers engaged per industry. Importantly, the structure of the IFR's classification requires this study to pool together ISIC Rev 4. 24-25 and 28 which in turn has been subtracted sectors 26-28 in all relevant indicators (see Table B.1.2 in Appendix B for further information). Table B.1.2 and Figure B.1.1 (Appendix B) offer some descriptive statistics for robot density by country and sector for 2017 (the last year covering our full list of countries). As we can see, there are some significant differences between countries as well as between certain sectors. For example, the transport equipment sector, which includes car manufacturing, seems to be significantly more automated than other sectors.

3.3.2.2 Main Independent Variable

While there exists a broad methodological consensus on the use of robot density, the literature on cooperative institutions, industrial relations and comparative political economy has long been divided on how (and indeed whether) to quantitatively capture institutional variety across countries. One of the key challenges is therefore to adequately operationalise the extent to which an economy seeks to negotiate or distribute negative by-products of economic changes within the productive sector through cooperative institutions.

Unsurprisingly, there already exists a wide range of such indicators, each with its respective strengths and weaknesses. Ultimately, I decided against using pre-existing indicators for both practical and substantive reasons. Firstly, while several measures of institutional variety, such as the Hicks and Kenworthy (HK) and Hall and Gingerich (HG) indicators (Hall and Gingerich 2009; Hicks and Kenworthy 1998) as well as Eurofound's Industrial Democracy (ID), are conceptually close to what this study tries to measure, these indicators often fall short in terms of their geographical and temporal scope. Conversely, existing (neo)corporatism indicators, such as the ones created by Jahn (2016) and Baccaro (2014), tend to have superior case coverage but substantively fit less well, as they only tend to cover a theoretical subcategory of the broader category 'cooperative institutions'. These indicators are particularly oriented at measuring macro-level institutional configurations such as peak organisations and wage bargaining structures.

As a result, I compile an original index to measure the density of cooperative institutions between 1993 and 2017 for 25 OECD countries. To reflect the multilevel nature of these institutional practices I pointed out previously, I compile this measure using indicators on formal institutions at the macro, meso and micro-level that facilitate negotiating negative by-products of change within the productive sector. It is worth noting that the choice of indicators does not just track the *presence* of cooperative practices but also speaks to concrete institutionalised power resources in the political economy. These indicators originate from Visser's (2016) ICTWSS dataset and include at the:

- Macro-level: Level wage coordination, bargaining coverage, and regular involvement in policy-making by labour and capital
- Meso-level: Presence of sectoral institutions
- Micro-level: Rights of works councils

The five variables have been tested for their statistical suitability through multivariate analysis in form of principle component analysis and Cronbach's Alpha, which suggest that the variables are internally consistent and usefully describe a unidimensional concept, without veering into multicollinearity. They are subsequently normalised using the min-max method and then aggregated with equal weighting to reach an index ranging from 0 (lowest possible level of cooperative institutions) to 1 (highest possible score). No particular weighting was added for two reasons. Firstly, drawing on the literature described previously, it is not a priori clear which institutions should contribute most to predicting higher levels of automation with some arguments pointing to the importance of peak institutions (Olson 1982), while others focus on firm-level cooperation (Burdini *et al.* 2022). Secondly, a disaggregated analysis of the individual institutions is included in Table B.4.1 in Appendix B. Table 3.1 reports the results of a correlation with other conceptually relevant measures and suggests that the composite indicator is usefully measuring what was intended.

Conceptually, this indicator captures the theorised multilevel nature of the relationship between cooperative institutions and automation quite well. Still, some questions might arise about how well this indicator, made up of data compiled at the national level matches the level of analysis of the independent variable, organised at the sectoral level. While some caution is warranted, I argue this approach is valid for several reasons. Firstly, most institutional data is simply organised at the country-level. Some sector-level indicators (such as union density) exist, but these data are traditionally patchy. While some surveys such as the European Company Survey (ECS) offer firm-level information on bargaining and representation, this granular data, unfortunately, gives us little leverage on robotisation rates. At the same time, the sectorally clustered nature of robotisation inhibits us from looking at the phenomenon at the country-level. While this leads to an imperfect match of the dependent and main independent variable, it is worth noting that cooperative institutions have traditionally been most closely aligned to the manufacturing sector which we are investigating here (Hassel 2011). What is more, while processes of institutional dualisation might have opened up a gap between the way institutions and regulation influence the operation of manufacturing and other sectors of the economy in some countries, the overall role of these factors does not tend to diverge *within* industries. As such, if cooperative institutions have some leverage on automation, we would therefore expect it to be greatest in the sectors analysed here.

The evolution of the cooperative index by country is included in Figure B.1.3. in Appendix B for further reference. As one would expect, the index picks up few large institutional swings, with the range of variation lying between -.13 and

12 and around 2.5% of all changes exceeding the .1 threshold. This reflects the fact that institutional changes tend to be incremental. Still, there is substantial variation on an annual basis since the index on average changes every other year for each country (see Figure B.1.4 in Appendix B for further reference).

Table 3.1 Cross-correlation table of indices

Variables	*Cooperative Index*	*Jahn*	*Indust. Dem.*	*HK*	*HG*
Cooperative Index	1.000				
Jahn	0.883	1.000			
Indust. Dem.	0.874	0.846	1.000		
HK	0.914	0.840	0.814	1.000	
HG	0.880	0.820	0.632	0.846	1.000

3.3.2.3 Control Variables

I also introduce several sectoral and country-level control variables that are relevant to explain robot density. First of all, at the sectoral level, this analysis controls for the price of labour which is measured as the average cost of an hour of labour (2016 dollar). The second control variable is the price of capital as measured by the price of capital formation (2016 dollar) which is found in the Penn world tables dataset. Put together these variables control for the variation we can expect to see in factor costs across countries and industries. Given that larger industries benefit from scale effects, we can expect them to reap the most benefits from automation. I therefore also control for output (2016). A further control for the proportion of value added as part of total output per sector (based on OECD STAN data) is included. At the national level then, I also control for the proportion of 15 to 64 year olds to check for demographic differences which might influence automation by affecting the labour supply (Acemoglu and Restrepo 2018). I also include social expenditure as part of GDP, as well as the growth rate into the model.

Aside from these economic controls, this analysis also includes a control for employment protection legislation (EPL). Authors such as Bartelsman *et al.* (2010) have argued that EPL is an important factor in the cost-benefit analysis made by firms since regulation can impose punitive costs on firms pursuing innovation. Manera and Uccioli (2021), meanwhile, show that falling EPL leads firms to shift investment from labour-cutting technologies towards product innovation. While EPL is conceptually not unrelated to our independent variable, it is important to note these two indicators are not strongly correlated and that EPL is at best an outcome of cooperation as opposed to a functional institution that actively negotiates the costs of change.

These controls are supplemented with extensive robustness tests. Firstly, baseline estimations were run using an alternative institutional index, Jahn's corporatism index. The denominator of the dependent variable, robot density, was then tweaked by changing the number of workers with total working hours. Thirdly, the baseline estimations were run excluding the automotive sector, which is a strong outlier in terms of robot density. More estimations were also carried out using a range of different lags to assess the model's sensitivity to the baseline 2-year lag. Fifth, estimations were rerun with jackknife and bootstrap resampling methods to test the model's sensitivity to the sample in question. Finally, the fixed-effects panel model was replaced with a mixed-effects model where sectors are nested in countries (the results of these checks can be found in Table B.3.1 in Appendix B).

3.4. Results

As stated before, the analysis is conducted in three stages. First, I will estimate baseline results. The analysis will then turn to the hypothesised mediating effect of cooperative institutions on redistributive outcomes. Finally, we will return to the baseline results under normal times and recession.

3.4.1 Baseline Results

There are at least two key takeaways from the baseline estimations presented in Table 3.2. Firstly, there is good evidence to suggest that cooperative institutions play an important role in the process of robotisation. Models 1 through 3 show that the cooperative index is a strong and highly significant predictor of robot-density rates. The institutional coefficient in Model 3 suggests a one-unit change in the index is expected to result in a 176% increase in robot density.

While this might intuitively seem like a particularly large effect, there are several things worth highlighting here. First, this effect is in part an artefact of the operationalisation of the cooperative index. Since the index ranges between 0-1, the coefficients found here substantively reflect an institutional change from a completely liberalised economy to a deeply institutionally cooperative one. This effect thus tells us the differences between the two most extreme cases. While this obviously does not reflect changes one might detect in the real world, it does allow us to neatly demonstrate the importance of institutions on robotisation by comparing the two poles.

Second, the magnitude of this effect, particularly when taking into account confidence intervals, actually lies well within the realm of expectations when we look at robotisation rates across the OECD. Comparing a highly liberal setting like the UK with some of the most deeply institutionalised ones such as Austria, Belgium or Sweden, it immediately becomes clear these countries do in fact employ at least double the number of robots relative to the UK. Importantly, this finding is both significant and robust with the introduction controls as well as fixed-effects. We can therefore safely accept H1 and conclude that cooperative institutions predict more robotisation, not less. The assumption that workers will myopically hold back innovation that might threaten their position, if they have the chance, simply does not seem to hold.

Looking at the other coefficients, the focus on factor costs in the literature is, unsurprisingly, vindicated. Higher wages consistently predict more capital-intensive manufacturing. Indeed, a one percentage point changes in the price of labour and capital are respectively found to correspond to a 0,68% rise in robot density (see model 3). Conversely, a lower price of capital formation is also correlated to robotisation though this result is far less robust. The same conclusions hold true for output, as the results robustly show that sectoral output is a good predictor of robotisation rates. This, again, is unsurprising as larger industries are not only expected to have easier access to capital but are also in a position to reap the benefits of scale (Stiebale *et al.* 2020). Growth rates are found to be negatively correlated to automation. This could well be explained by the fact that robotisation is most commonly adopted by more mature Western OECD economies which tend to grow at lower rates compared to economies in central and eastern Europe. Finally, the results for value added, social expenditure and the share of 15-64 year olds are less conclusive.

Table 3.2 Baseline Estimations

	(1) No Controls	(2) Controls	(3) Country FE
Cooperative Index	2.886***	2.144***	1.790***
	(0.391)	(0.375)	(0.663)
Price of Labour		0.763***	0.891**
		(0.175)	(0.365)
Price of Capital		-0.205***	-0.189
		(0.0445)	(0.271)
Ouput		0.382***	0.274*
		(0.0640)	(0.151)
Value Added (%)		0.566	0.784
		(0.944)	(1.055)
Share of 15-64 (%)		-0.0495	-0.0783
		(0.0471)	(0.0643)
Growth rate (%)		-0.0204**	-0.0198**
		(0.00912)	(0.00974)
Social expenditure (%)		0.0264	0.00917
		(0.0183)	(0.0252)
EPL		-0.179	-1.025
		(0.562)	(0.841)
Constant	0.792**	-2.376	1.021
	(0.401)	(3.485)	(4.836)
Year FE	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes
Country FE	No	No	Yes
Country-Sector Clusters	216	199	199
N	3006	2845	2845

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

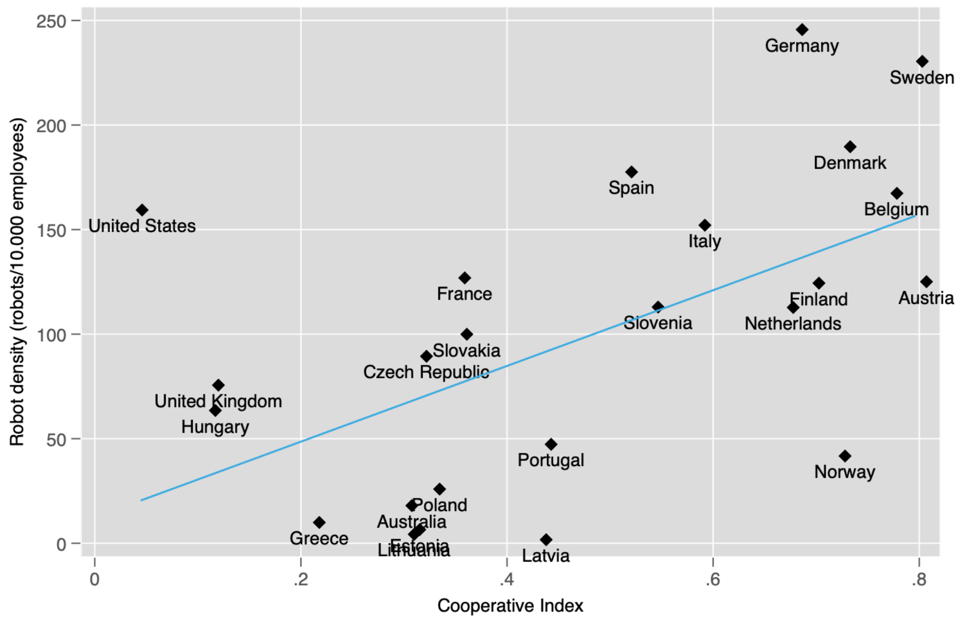

Figure 3.1 Robotisation and cooperative institutions in the OECD
Source: Author's own calculations based on International Federation for Robotics, OECD and ICTWSS

Looking at this picture in greater detail, Figure 3.2 plots the disaggregated effects of each individual institution.[1] These results indicate an interesting split between wage bargaining institutions and the remaining three indicators. That is to say, wage coordination and bargaining coverage are negatively correlated with robotisation. However, when we look at institutions that explicitly look to encourage dialogue between employers and workers, like the involvement of social partners in policy-making, sectoral institutions or works councils, we see a strong and positive effect. This signals cooperation helps to alleviate some of the coordination problems that could exist regarding automation, like complementary skill-investment and appropriate regulation. Importantly, the observed split between these two types of institutions highlights the limits of the labour hold-up

[1] These estimations are based on model 2 in Table 3.2. They are run with the simultaneous inclusion of all institutions. Table B.4.1 in Appendix B reports the full estimations for the analysis with several different model specifications

hypothesis (Presidente 2020). Indeed, if collective bargaining is leading to automation in an effort to stop labour from extracting rents, then we would predict a strongly positive association between automation and the two wage bargaining indicators.

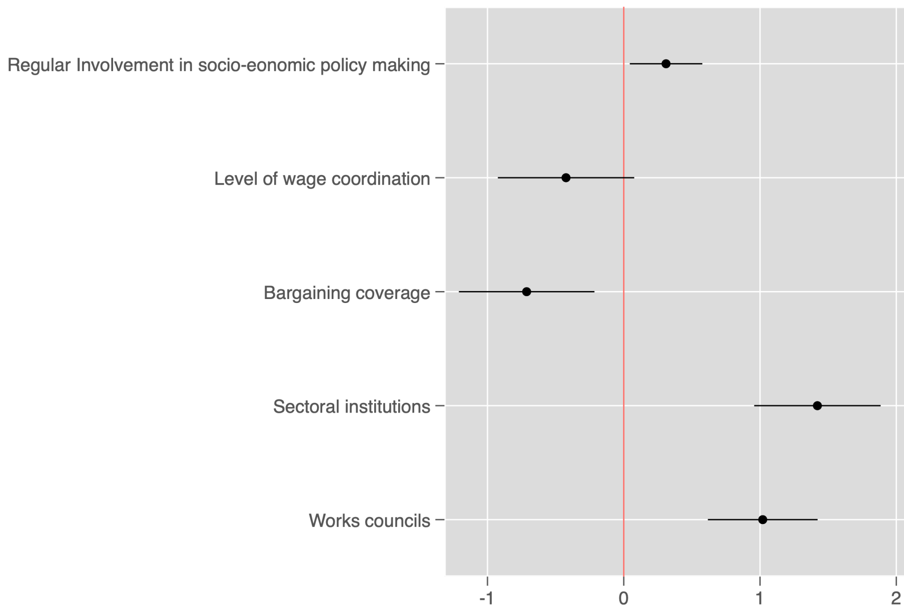

Figure 3.2 Effects of individual institutions

3.4.2 Conditional effects of cooperation

To understand the importance of cooperative institutions in the process of automation, we cannot solely rely on an understanding of the relationship between these two factors; we also need to substantiate their effects. In a world where automation is co-determined by cooperative interactions between capital and labour, we should expect these institutions to effectively mediate the distributive effects of that technical change. That is to say, if workers and capital-owners in cooperative settings come together to negotiate capital-investment decisions and their possible negative social externalities, we would expect to see the outcomes of that change to be more equitable than in liberal economies. If that is not the case, then this could signal the labour disorganisation thesis is on the right track by correctly predicting robotisation is used to stop rent extraction by labour. In this section, I will examine this hypothesised mediating role of cooperative institutions on two such key dimensions: 1) labour *compensation* in the form of the labour share of income and 2) labour *consumption* by looking at total working hours.

First, we look at the relation between robotisation and the labour share of income, as mediated by cooperative institutions. Table 3.3 plots the results of the estimations and strongly confirms H2. Firstly, while the main effect of the institutional coefficient becomes insignificant, increased robotisation is expected to negatively affect the labour share. This confirms the previous findings from the US (Karabarnounis and Neiman 2013; Autor *et al.* 2017) by showing how automation in liberal economies displaces labour for capital, thereby leaving a greater share of the pie to capital owners. Concretely, every 10% increase in robot density is associated with a 0.25% decrease in the labour share.

The story becomes more interesting when we take the interaction effect into account. In fact, the interaction between institutions and robotisation suggests that the negative effects of robotisation on the labour share are almost fully absorbed by cooperative institutions. Here the same 10% increase in relative robotisation is only associated with a minor 0.03% fall in the labour share. As such, while robotisation in liberal economies is strongly linked to falling labour shares, the same cannot be said for highly cooperative economies. Figure 3.4 plots this finding and exemplifies how deeply the relation between automation and falling labour shares in manufacturing is determined by institutions. In highly automated sectors, the predicted difference between highly cooperative and liberal settings is almost ten percentage points. Workers in places like Belgium, Austria and Germany seem to use the institutionalised political resources at their disposal to build a mutually beneficial coalition with employers to pursue productivity-enhancing innovation.

Turning to the estimations for working hours (see Table 3.3), a similar picture emerges. First, the strongly negative main effect of robotisation on aggregate sectoral working hours follows the basic predictions by the literature (Mann and Puttmann 2018; Acemoglu *et al.* 2020): automation in liberal settings chips away at sectoral demand for labour. A one percentage increase in robot density here predicts almost a 2,4% decline in working hours. This effect, again, does not hold up in cooperative settings. Cooperative institutions are again found to strongly intermediate the relation between robotisation and working hours, predicting an overall 0,5% expansion in working hours. This interaction is larger than the main effect but not as significant as the predictions for the labour share. Figure 3.4 helps us to understand what this means substantively: robotisation in countries with cooperative institutions is predicted to lead to an expansion of work at the sectoral level, but the differences are not very significant. This seems to broadly corroborate findings by Genz *et al.* (2019) who find that automation in countries such as Germany, Sweden and Belgium does not harm incumbent workers.

Table 3.3. The mediating effect of cooperative institutions on social outcomes

	(1) Labour Share	(2) Working Hours
Cooperative Index	-0.00566	-0.125
	(0.0279)	(0.0805)
Robot Density	-0.0109***	-0.0239***
	(0.00210)	(0.00733)
Cooperative Index*Robot Density	0.00986***	0.0286**
	(0.00348)	(0.0132)
Price of Labour	0.0266**	-0.668***
	(0.0118)	(0.0491)
Price of Capital	0.0395***	0.134***
	(0.00671)	(0.0286)
Output	-0.0157**	0.717***
	(0.00616)	(0.0262)
Value Added (%)	-0.0748**	1.360***
	(0.0359)	(0.161)
Share of 15-64 (%)	0.00357***	0.00160
	(0.00127)	(0.00508)
Growth Rate (%)	-0.00168***	-0.00555***
	(0.000244)	(0.00145)
Social Expenditure (%)	0.00228***	0.000698
	(0.000707)	(0.00200)
EPL	0.0464	-0.00948
	(0.0316)	(0.0705)
Constant	0.449***	0.137
	(0.113)	(0.501)
Year FE	Yes	Yes
Country FE	Yes	Yes
Sector FE	Yes	Yes
Country-Sector Clusters	199	199
N	2773	2773

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

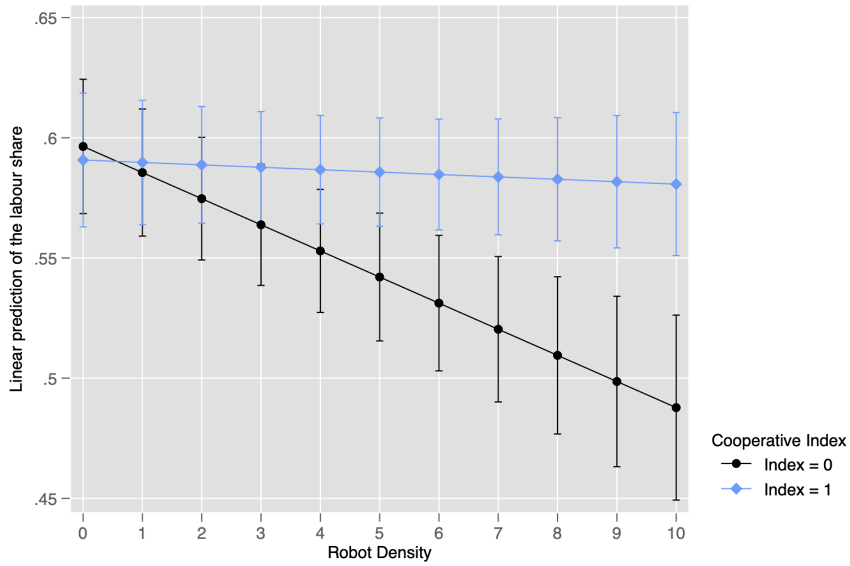

Figure 3.3 Predicted effect of robotisation on the labour share by type of institutional setting

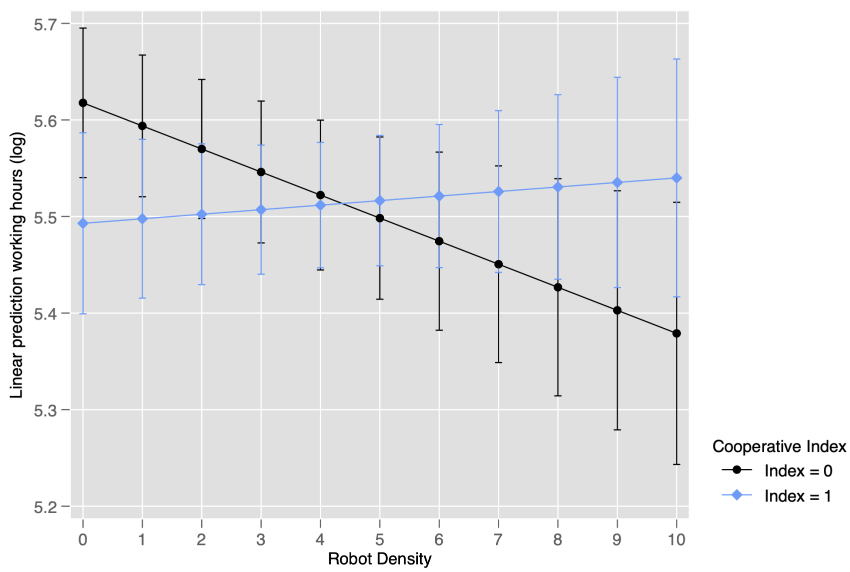

Figure 3.4 Predicted effect of robotisation on working hours by type of institutional setting

The controls in both models also help to lend credibility to the findings. As we would expect, wages predict higher labour share but lower working hours. Similarly, social expenditure is found to significantly correlate with increased labour shares. This makes sense because the measure that is included in the model includes state expenditure on active labour market policies that help to up-skill workers. Finally, EPL also predicts increased working hours but seems to bear no weight on the labour share.

Put together these two models tell us two important things. First, they strongly point in the direction of the theorised cooperative institutional mechanisms, against the notion of labour hold-ups. If capital was truly being used to disorganise labour, we might have expected much more regressive outcomes in highly institutionalised settings. Instead, these institutions seem to absorb much of the shock automation presents when institutionalised cooperation is absent. Secondly, these findings act as an important robustness test for the baseline results. These strong and highly significant findings give us a sense that institutions are not coincidentally correlated with robotisation but in fact play a functional role in the process of labour-saving innovation.

2.4.3 Automation, cooperation and recessions

The results found in Table 2 and 3 suggest that robotisation in many countries is in part driven by the positive externalities generated through institutional cooperation. Far from inhibiting long-term capital investments into labour-saving technologies, cooperative practices seem to be strong predictors of automation. To test that finding further, this section will examine the relationship between institutions, automation and recessions. Jaimovic and Siu (2012) previously pointed out how technologically-driven labour market polarisation tends to be cemented in the labour market during recessions. According to this account, routine workers who are laid off during downturns do not recover their jobs when the economy bounces back since firms exploit the opportunity to invest for the future, leading to "jobless recoveries." However, if cooperation between labour and capital is important in determining the pace and distributive consequences of automation, then we could also expect them to dampen the recessionary investment drive. We would expect more cooperative settings to slow down the displacing effects of automation resulting from recessions since this change should be a more drawn-out, bargained and ultimately inclusive process. Conversely, if the positive relation between automation and institutions we found previously is a function of employers seeking to circumvent potential hold-ups by labour, then recessions might be the perfect time to 'strike'.

Turning to Figure 3.5, we find the estimates of the baseline regression (model 3) decomposed along the lines of recessionary and non-recessionary periods. To obtain these results, recession dummies for each country were coded using the International Monetary Fund (IMF) definition of two consecutive quarters of decline in a country's real GDP. The baseline was then run for normal times and recessionary periods. The first plot shows us the estimations for the former. It broadly confirms the findings in Table 1 with the noticeable exception that the effect of institutions becomes even stronger. During normal times, the one-unit change in the index (from 0 to 1) is significantly associated with a very significant increase in robot density. However, as predicted by H4, these results are largely turned on their head for recessions as that same shift in the institutional coefficient predicts a decline in robot density. Three conclusions stand out. Firstly, the estimations indicate that higher levels of institutionalised cooperation are negatively correlated with robotisation, and significantly so. Secondly, recessions also seem to weigh on the relative importance of factor costs and the price of labour in particular. It seems that recessionary automation does not challenge workers in the most well-paid sectors but rather their lower-paid counterparts. Finally, like the institutional coefficients, employment protection legislation also comes into play during recessions as a negative predictor of automation. This further strengthens the suggestion that recessionary investment into automation is likely to siphon off jobs in lower-paid countries and sectors that enjoy fewer protections.

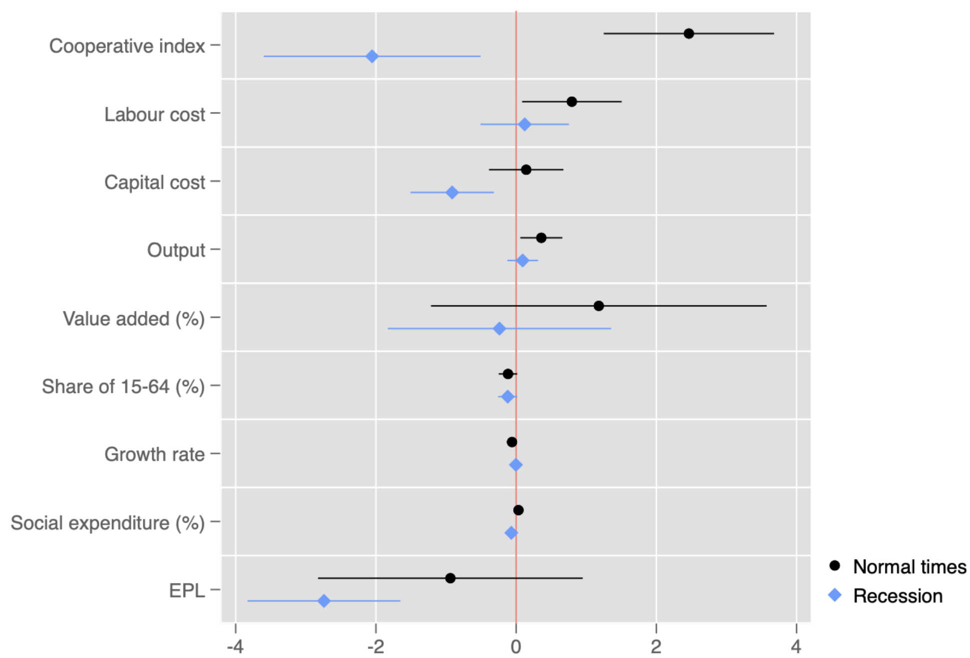

Figure 3.5 Beta coefficients normal times vs recession

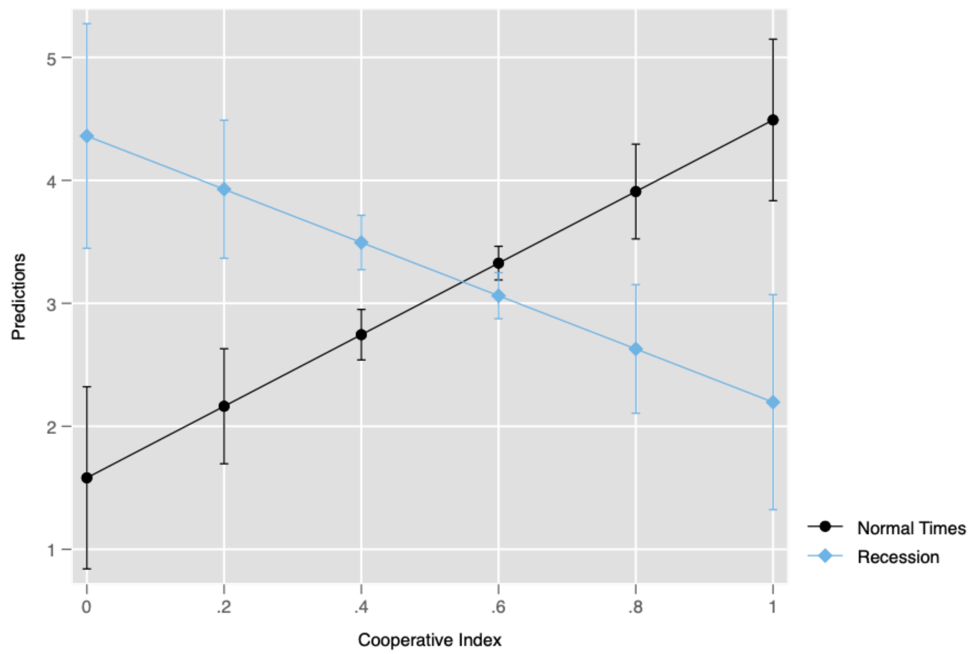

Figure 3.6 Predicted margins of robotisation by institutions for normal times and recessions

3.5 Discussion

The key takeaway from this paper is that institutions matter to the process of automation. Taking a step back from the particularities of specific hypotheses tested here, it is clear that the data strongly suggests that institutionalised cooperation in economic life plays a significant role in stimulating labour-saving technological change. Contrary to what many would believe, 'negotiated' forms of capitalism seemingly stimulate these kinds of process innovations. What is more, there is good reason to believe cooperative institutions also generate more equitable outcomes along the way. The findings of this paper, therefore, carry significance for political and economic debates in both academia and policy circles.

For the debate on biased technological changes, these findings ought to shift the attention from the idea of single-minded market discipline, focusing on raw factor costs and automatability of tasks, to broader questions of political economy and distributive politics. While the sectoral data presented here makes it impossible to credibly control for routine intensity of task structures, the institutional variables were on the whole stronger and more robust predictors of robot density than many of the economic fundamentals. Looking at the individual effects of particular institutions, the results indicate that regular involvement in socioeconomic policy-making and strong work councils are important drivers of innovation. This suggests that the industrial relations literature which has emphasised the positive externalities of collective bargaining in the areas of skill formation, information transmission and ensuring the overall productivity of investments is vindicated (Katz *et al.* 1983; Katz *et al.* 1985; Olson 1982; Streeck 1984a; Kochan and Tamir 1989). It is worth emphasising that these results are robust and that further analysis on marginal effects (see Table B.3.1 in Appendix B) also corroborate the notion that automation is a far less market-led process in cooperative settings.

What is more, the findings of this paper also speak directly to the important distributive side of the story. Both the results on sectoral labour shares *and* working hours suggest that workers in cooperative institutions are significantly cushioned from some of the most adverse effects of automation. This suggests that in liberal economies, the gains from labour-saving technological change tend to accrue in the form of corporate rents while in cooperative economies capital and labour seem to share the benefits more equally. Still, it should be noted that the sector level data used here is too crude to make any inferences about the skill-specific or intra-firm distributive consequences found by Dauth *et al.* (2017) and Acemoglu *et al.* (2020) respectively. These findings, nonetheless, do offer some support for the conclusions by Montobbio *et al.* (2020) who found that American patents are more explicitly labour replacing than European ones as well as Martelli and Hope (2019) who find that labour market institutions can still successfully shelter workers from structural changes. Jaimovic and Siu's (2012) seminal findings about 'jobless recoveries', meanwhile, are also suggested to be, in part, a matter of political economic negotiation. In short, we cannot start to understand the socioeconomic dynamics of structural industrial change without considering the power dynamics underlying them.

There, of course, remain some questions about potential alternative explanations. Firstly, recent scholarship has linked asymmetric evolutions in the growth of capital-intensive production and subsequent productivity to rising market power among large 'superstar' firms (Autor *et al.* 2017; Stiebale *et al.* 2020; Eeckhout 2021). There is good reason to believe this is not what this paper is picking up. Not only do we know that much of the industrial base in high automated Continental European countries, such as Germany, is made up of relatively small but highly productive industrial firms (the infamous *Mittelstand*) but the market power literature has also pointed out market concentration actually seems to be decreasing in Europe (Phillipon 2019). Crucially, the finding that cooperative institutions not only produce *more* robotisation but also coincide with *higher* labour shares goes against the predictions set out by the market power literature which would have assumed firm power is used to squeeze the share going to workers (Eeckhout 2019).

Secondly, another potential intervening factor could be generally differing rates of capital investment across countries. The UK, for example, is notorious for the sluggish investments into capital stock made by its productive sector in recent years. Again, I do not think this constitutes a problem for the analysis in this paper. There is ample evidence in comparative political economy (Hall and Soskice 2001; Hancké 2009 *et al.*; Iversen and Soskice 2020) to suggest institutions structure firm strategy (Hall and Soskice 2001) in important ways and therefore co-determine who invests in what, at what rate and when. Rather than being an altogether alternative explanation for diverging robotisation rates, I, therefore, think this argument is most likely a more generalised version of the same underlying question.

It is worth noting that there still remain several important limitations to this research. Firstly, this paper is built on the assumption that formal institutions are meaningfully reflected in everyday economic interactions. Yet, we know levels of political economic cooperation can diverge substantially from the letter of the law. Katz *et al.* (1983), for example, show that even in the critical case of the U.S., levels of shop floor cooperation differed dramatically from plant to plant. Still, by looking at formal institutions this paper does, arguably, effectively gauge the relative power dynamics in different political economies as well as approximate the actual degree of cooperation that might exist. Most importantly, we can expect legally enshrined rules and procedures to act as 'floors', limiting the scope for variance in highly institutionalised countries.

Relatedly, these results are highly sector-specific. Institutionally speaking, cooperative practices are traditionally much more important in the manufacturing sector. As such, institutional dualisation, which is particularly pronounced in Germany, presents a serious limitation to the generalisability of this research. The same story is true on the level of technology, robotisation (as defined by the IFR) is a trend specific to manufacturing. Consequently, these results can not be generalised to the broader economy. Thirdly, it is important to stress that, even in the specific context of manufacturing, the operationalisation of our dependent variable, automation, by looking at robots is imperfect. Labour-saving technological change takes many forms, ranging from conveyor belts to robots. Indeed, the latter often only represent a fraction of all process automation. Still, the discrete nature of robots makes for a useful instrument that will likely approximate broader trends of automation in this section of the economy quite well.

3.6 Conclusion

Innovation is without a doubt one of the key drivers of economic progress. However, it is commonly understood that technical change, and automation in particular, is not a neutral process. It benefits some and imposes costs on others, particularly in the short-term. While there exist numerous strategies to deal with such 'negative by-products', advanced capitalist democracies have often developed institutions to deal with these biased changes. Comparative political economy has particularly emphasised the importance of cooperative or coordinative institutions which seek to curb the dynamics of 'crash, bang, wallop' capitalism in favour of a negotiated form of change. This paper has sought to understand how cross-country differences in these institutional arrangements influence robotisation rates within the manufacturing sector.

While the discussion in the literature surrounding this broader question has yielded opposing views, often based on small-n case studies, I present a series of estimations that suggest that Leontieff (1982) was probably wrong in his assessment that labour-power would be used to hold back the 'tide' pursue automation. In fact, countries that have institutionalised cooperation between labour and capitalism as well as within those respective categories are expected to have a significantly more robotised production within their manufacturing sectors. Despite the capital-intensive nature of production, or perhaps exactly *because of it*, cooperative settings are also found to produce a more equal distribution in terms of the labour share and enjoy expanding working hours at the sectoral level. What is more, recessions are found to play less of a role when it comes to these structural changes as workers in cooperative economies seem to be insulated from short-term pressures to cut costs.

Put together, these results offer compelling evidence of the benefits of cooperative institutions on robotisation. This type of cooperation between employers and workers, it seems, provides the preconditions for robotisation to thrive. Indeed, on balance, the evidence suggests that, in manufacturing, institutionalised social agreements which, have formed the basis of successful industrial strategies for many continental economies since the post-war era, are still fit for purpose. Countries with more negotiated forms of capitalism have successfully developed complex mechanisms that allow them to effectively push their productivity frontier by striking a bargain between the potential winners and losers of economic change.

4

It's the Robots, Stupid?

Automation Risk, Labour Market Security and Incumbent Support in Europe

Introduction – Automation & Politics –
Occupational risk, labour market resources & the incumbent –
Data & Methodology – Results – Conclusion

Abstract: As automation challenges labour markets across Europe, political science research is pointing towards the socially corrosive link between such technological change and political dissatisfaction. In this paper, I extend this research agenda by looking at the relation between automation risk and incumbent support in 20 European countries between 2012 and 2018. I find strong support for the notion that workers with substantial exposure to automation risk are more likely to reject governments at the ballot box. Importantly, however, these findings also show that this very same type of anti-incumbent voting is less prevalent among theoretically at-risk workers who enjoy some level of protection, in the form of solid contracts, co-determination rights or higher educational attainment. As such, this paper argues that technological occupation risk should be seen as feeding into broader labour market risks faced by voters.

4.1 Introduction

How does automation affect democratic politics? Investment in research and development has paved the way for a world where there is seemingly always something new "right around the corner." However, as it turns out, what *exactly* lies around that corner is not always quite as rosy for everyone. As robotisation and digitalisation have eaten away at routine tasks in the economy (Autor and Acemoglu 2011), many workers have witnessed their jobs disappear entirely, or in the best case, seen their skills severely devalued in the perennial "race against the machine" (Brynjolfsson and McAfee 2011). In a system where work is the primary mechanism to distribute income, it is evident that technologies with the ability to fundamentally shake up the world of work could play a significant role in political life. This paper, therefore, takes a closer look at the role automation, and individual workers' capacity to adapt to that type of technological change, play in the electoral arena.

Existing work distinguishes between two potential mechanisms underlying the relation between automation and electoral behaviour. On the one hand, a straightforward political economy mechanism links the labour market risks of automation-exposed voters to political preferences for labour protection, social reinsurance, and increased welfare. Since automation adversely affects some voters' job security and therefore potential capacity to make a living, they turn to traditionally left-wing policies and parties as a source of protection (Thewissen and Rueda 2019; Im 2020; Kurer and Häusermann 2022). A second account, meanwhile, suggests exposed voters are politically activated because they fear the adverse effects of automation on their status in social hierarchies (Im *et al.* 2019; Kurer 2020): automation leads above-all to what Seymour Lipset once labelled "status politics"

(1955). Voters who hold down automatable jobs are therefore predicted to vote for far-right parties who play into sentiments of decline, through what is thought to be a process of misattribution (Gallego and Kurer 2022).

In this paper, I advance this burgeoning literature by proposing a more differentiated approach to understanding automation risk and its relation to electoral politics. The risks routine workers face, I argue, are not only a function of how susceptible their job contents are to automation but also of the labour market resources at their disposal to absorb those technological shocks. Factors such as the nature of the employment contract, co-determination rights and/or educational attainment regulate how easily workers are laid off, the scope for negotiation with employers and their ability to transition into new jobs. As a result, they are crucial in differentiating between employees with resilient careers and what I call "sitting ducks." As Pahontu (2021) points out, these within-occupation sources of variation are crucial to help us correctly gauge the role broad occupational risks play in determining political preferences. Because market policies and institutions that distribute these resources to workers vary widely across advanced economies, we should therefore also expect automation to have vastly different electoral effects across different countries.

Workers who end up on the wrong side of this equation, I argue, primarily care about automation as a source of material risk (Dekker *et al.* 2019) since they face the very real possibility of economic precarity when automation renders their jobs and skills redundant. Employees in these automatable jobs without many tools at their disposal to handle technological risks will therefore look to voice anxiety about their precarious labour market status at the ballot box. However, as Gallego and Kurer (2022) point out, automation is an issue that very few parties mobilise on. It is also a process that has progressed incrementally over the last decades

– often with centre-left parties very much on board. As such, it can be hard for voters who face technological redundancy to correctly attribute blame or identify potential allies in the political arena (Wu 2021; Gallego and Kurer 2022). This ambiguity means automation-exposed workers do not necessarily translate their economic grievances into straightforward support for left-wing parties or policies, but instead opt to punish incumbents.

I begin this paper by reviewing arguments about the relation between automation risk and political behaviour. In doing so, I will highlight the importance of considering the intermediating role of individual workers' labour market resources. The analysis in this paper then proceeds via two steps. First, I draw on the last four waves of the European Social Survey (ESS) to estimate the effect of occupational automation risk (using Frey and Osborne 2017) on support for the government in 20 EU countries. Here the analysis shows there is a robust link between occupational automation risk and anti-incumbent voting. In a second step, I introduce respondent-level labour market resources (see Pahontu 2021) into the equation. More specifically, I look at the mediating role of contract-type, co-determination rights and education on the relation between occupational risk and incumbent support.

My findings suggest that workers facing occupational automation risk in otherwise strong labour market positions are in fact quite likely to express support for the government since they are more well-equipped to meet the challenge of new technologies.This paper, therefore, emphasises the importance of broader labour market institutions and the welfare state in mediating the short-term Pareto-inefficiencies inherent in automation, to limit political dissatisfaction among at-risk workers. Automation risk is only one part of broader and interconnecting labour market insecurities faced by workers.

4.2 Automation & Politics

Most citizens in advanced democracies rely on work to secure an income, making the jobs we do not just important markers of social status but essential to sustain a decent standard of living. Since liabilities and other expenses tend to be more certain than jobs, for most households it does not just matter how much they earn (Downs 1957), but also how secure that income is. A large literature in political economy has therefore sought to identify how various sources of occupational insecurity, ranging from immigration, over globalisation to evolving labour market regulation, affect the political preferences of workers (Rueda 2005; Cusack *et al.* 2006; Anderson and Pontussen 2007; Rehm 2016; Abou-Chadi and Kurer 2021).

In an age of ubiquitous innovation, one increasingly important source of such labour market risks is automation, or technology that replaces workers. While technologies such as robotics and AI of course complement some forms of work, we know from labour economics and economic sociology that this technology challenges the economic prospects of workers in routine jobs (occupations that have a highly predictable and rules-based task content) in at least, two ways. In the worst-case scenario, workers in automatable occupations lose their jobs and find themselves re-entering the job market with severely devalued skills. However, as Mitchell and Brynjolffson (2017)[1] remind us, such cut-and-dried job losses are only a small part of the story of automation. In many cases, the adverse effects of innovation manifest themselves less straightforwardly, with automation leading to job re-engineering, re-assignment and/or declining working hours. It goes without saying that these scenarios too are likely to lead to direct economic pain (most households can ill afford a decrease in their work hours) or at the very least

[1]https://www.nature.com/articles/d41586-018-07501-yref-CR6

increased anxiety about the future.

Existing work has presented two broad arguments on how this increasingly salient source of labour market risk affects politics in advanced democracies. On the one hand, there is work that proposes voters challenged by automation make redistributive claims on the state. Both Thewissen and Rueda (2019) and Sacchi *et al.* (2020) suggest automation exposure leads to increased support for redistributive policies in a future-oriented attempt to mitigate their own labour market risks. Contrary to most Downsian accounts of political behaviour, however, Thewissen and Rueda's (2019) focus on risk leads them to argue that these distributive preferences are particularly pronounced among higher-earning workers since automation presents a relatively larger downside risk to their income. What is more, these workers seem to be "picky" in their particular preferences. Kurer and Häuserman (2021) find that risk-exposed workers tend to support increased spending on unemployment benefits but not on pensions, while Sacchi *et al.* (2020) find these individuals to prefer traditional welfarist measures over newer proposals such as Universal Basic Income. Im (2021), finally, identifies strong support for active-labour market policies among European workers in automatable occupations. According to this account, at-risk workers look to hedge their uncertain futures by turning to the state.

A second strand of literature challenges this traditional political economy mechanism, which has had some mixed results (Lim 2020; Gallego *et al.* 2021), by pointing to a surprising link between automation and far-right support. Building on the insights of Gidron and Hall (2017), this literature argues that at-risk voters primarily suffer from status anxiety. That is, rather than being purely concerned about their future earnings as such, these voters worry about the loss of social status they will experience if they lose their jobs to automation. This argument suggests material risk blends in with other socio-cultural anxieties to manifest itself as support for anti-establishment parties. Frey *et al.* (2017), for example, demonstrate strong support for Trump in Midwest commuter zones that have been highly exposed to robotisation leading up to the 2016 presidential elections. Anelli *et al.* (2021) similarly exploit regional robot exposure rates as well as individual-level voter data to link automation to far-right support in Europe. Im *et al.* (2019) also find this connection using survey data. One of the most compelling accounts comes from Kurer (2020) who tracks employment trajectories to argue that the perception of economic decline leads voters to right-wing populist parties. Baccini and Weymouth (2021), finally, argue that group identities are crucial in understanding the backlash against the incumbent resulting from industrial decline in the U.S. Midwest.

In the most well-articulated version of this story, Gallego and Kurer (2022) hypothesise that routine workers fail to support parties and policies that could help to soften the risks they face, via a mechanism of misattribution. On the one hand, it is hard for voters to pin-point what parties will best represent their grievances: not only is automation is a marginal issue that does not neatly fit into existing cleavages (Marenco and Seidl 2021), it is also an incremental process that has been ongoing under the auspices of an ideologically diverse set of incumbents most of which traditionally support speeding up technical change (Köning and Wenzelburger 2019). Secondly, given the confluence of automation and other potentially divisive sources of social status decline like migration and globalisation, workers might be led to misattribute the exact source of their problems. Workers in automatable jobs, it is argued, fail to support the 'correct' policies because they are led astray by far-right parties.

4.3 Occupational risk, labour market resources and the incumbent

This debate has been very successful at unpicking the specific preferences of at-risk workers as well as pointing out that the voting patterns of this group have not necessarily been congruent with those policy preferences. To do so, existing literature has relied on occupational indicators which measure automatability by looking at the task structure of jobs and determining how susceptible these activities are to automation. While this is a useful tool to tackle this complex question, existing work has not yet fully taken into account the basic premise that objective automation risk is not simply a matter of job content but is very likely co-determined by the labour market resources workers have at their disposal to absorb that occupational risk. In fact, Pahontu (2021) has highlighted the importance of contextualising measurements of occupational risk with individual-level parameters.

Just consider two colleagues performing the same job. One of the two has a permanent contract and post-secondary education while the other started working right out of high school on a zero-hour contract. While these two employees might perform the same day-to-day tasks and therefore hold down equally automatable jobs, the objective labour market risks they face are far from comparable. Not only will one, by virtue of having an indefinite contract, be harder to lay off and depending on labour market rules likely command severance payment, but having completed post-secondary education we can expect this employee to have an easier time transitioning into a new job if automation risks were to realise. In fact, we know from a wide-ranging literature in comparative political economy that there are a number of important parameters which help to make employees more resilient to labour market shocks and therefore play an important role in preference formation (Rueda 2007; Burgoon and Dekker 2010; Emmenneger 2012; Vlandas 2013; Rehm 2016; Halikiopoulou and Vlandas 2016; Pahontu 2021).

In this paper, I identify three key factors. First, the type of employment contract workers have is potentially very important. There is ample evidence suggesting patterns of political behaviour differ significantly between workers in temporary employment and those benefiting from permanent contracts (Rueda 2007; Burgoon and Dekker 2010; Emmenneger 2012; Häusermann *et al.* 2015; Halikiopoulou and Vlandas 2016). All else being equal, such unlimited contracts shield workers relative to colleagues with short-term work arrangements since they tend to be more difficult and expensive to fire. These workers are also more likely to have well-circumscribed jobs and fixed work hours, leaving them altogether less exposed to incrementally adverse occupational changes. Not only would such workers, all else being equal, be more difficult to fire but they might also have greater leverage to negotiate the outcomes of innovation with their employers.

In a similar vein to fixed contracts, we can expect co-determination, or increased voice in company decisions, to intermediate workers' perception of their occupational risk. A significant body of literature (Genz *et al.* 2018; Bellman *et al.* 2018; Haipeter 2020) points to the fact that workers with extensive information and consultation rights display greater job satisfaction *and* feel more at ease with firm-level innovations. There are, at least, two mechanisms along which co-determination might influence incumbent support among workers facing automation risk. The first one is purely *mechanical*: workers who have a say in company decisions can shape future automation in the firm and negotiate the contours of its consequences. All else being equal, it is therefore easy to see how co-determination can substantially decrease the objective risk of automation for workers. However, there is a potential second *psychological* dimension as well, as information rights simply reduce the uncertainty and potential anxiety about what is to come.

Finally, whereas the first two parameters give us an insight into the power resources workers bring to bear on the process of technological change, a final mediating factor, education, primarily determines workers' capacity to adapt to new production processes or to 'bounce back' when automation risk does materialise (Grafstein 2005). Skills and training are generally touted as being the silver bullet in strategies to adapt to technological change (Neufiend 2018; Bessen *et al.* 2020). With regards to voting behaviour, differences in skill levels could therefore play a major role in several ways. Firstly, workers with higher levels of educational attainment might be more likely to 'survive' automation due to their capacity to adapt and learn new tasks within the production process. What is more, even when they are laid off, we can expect these workers to experience a smoother transition into a new job because they are more attractive to potential employers and can work a wider range of jobs than peers without much education. As a matter of fact, findings by Battisti *et al.* (2017) suggest that the German apprenticeship system allows for the retraining of affected workers, thereby smoothing out adverse labour market consequences. In short, workers with higher levels of educational attainment might be altogether less fearful of automation since their enhanced skill profiles suppress some of the material risks they face.

The interaction of various factors, finally, also seems to matter for the impact of automation in the workplace. Belloc *et al.* (2022), for example, have argued that the introduction of technological change in Germany has predominantly coincided with job upgrading as opposed to job loss. Here, co-determination rights and strong skill profiles allow productive bargaining between capital and labour over how incumbent workers can be kept on board in the face of innovations.

There are good reasons to believe that a range of labour market resources play an important role in determining the objective risks automation poses to individual workers. These within-occupation sources of variation (Pahontu 2021), I think, differentiate workers in *a priori* automatable jobs into two categories. On the one hand, workers with enough tools to partially absorb the labour market risk automation throws at them and who therefore have resilient careers. On the other hand, employees without many resources to fall back on: so-called 'sitting ducks'.

Table 4.1 Two-by-two of the basic argument

	Low automation risk	*High automation risk*
Weak LM-resources	No automation anxiety	Significant automation anxiety
Strong LM-resources	No automation anxiety	Limited automation anxiety

How can we expect automation risk, and the different ways in which individuals might experience it, to materialise at the ballot box? Work is of course an important marker of social status. The notion that employees might externalise anxiety about technologically induced status decline, by voting for far-right parties (Im *et al.*. 2019; Kurer 2020; Kurer and Gallego 2022), is therefore quite plausible. Yet, if automation risk is an important part determined by workers' broader labour market status, then there is reason to believe their primary concern is potential material deprivation. At the same time, the difficulty resides in determining what parties are to blame for that risk and what platform will best serve their interests means we should not necessarily expect votes to reflect those concerns.

Existing work on the relation between automation and far-right support theorises that workers who hold down automatable jobs experience anxiety of occupational downgrading and the associated loss of their social status (Kurer and Palier 2019; Kurer 2020). However, when taking the role of broader labour market conditions on board there is reason to believe concerns of at-risk voters are primarily material. Theoretically, it makes sense that employees in objectively precarious labour market positions want to raise concerns about their material status. Not only can we expect these individuals to, all else being equal, have lower social status to begin with, but having few labour market resources to fall back on, the spectre of economic deprivation also looms larger for them. In fact, existing public opinion research indicates individuals in weak economic positions are not only more concerned about technologies such as robots, but that these concerns are primarily egocentric and economic (Dekker *et al.* 2017). Sitting ducks, therefore, likely primarily care about automation as a risk to their material wellbeing.

Still, we know from the established literature that these concerns are probably not congruent with the voting patterns of routine workers (Gallego and Kurer 2022). Employees in automatable occupations, it seems, do not turn to left-wing parties but are diverted to support other political causes. The most plausible mechanism for this is that they misattribute the source of their grievances and/or find it difficult to identify the right platforms to channel their concerns (Wu 2021; Gallego and Kurer 2022). It is easy to see why at-risk voters could be led astray. First, automation tends to be a marginal issue that infrequently makes it onto the agenda of political parties and does not easily fit into existing cleavages (Marenco and Seidl 2021). However, whenever parties in advanced democracies do communicate about it, most tend to support speeding up the pace of technical change (Köning and Wenzelburger 2019). The incremental nature of technical change also means it is a phenomenon that has been ongoing for decades, with many different parties implicitly or explicitly supporting it. In sum, it can therefore be particularly hard for voters to correctly identify potential allies in the electoral field on this issue or to effectively attribute blame for the risks they face. In line with previous work by Baccini and Weymouth (2021) and Gallego *et al.* (2021), I argue that this ambiguity leads voters to reject incumbents out of blind retrospect (Achen and Bartels 2017).

To validate these claims, I will test four hypotheses. First, I test the basic claim that automation risk leads voters to reject incumbents. My first hypothesis (H1) therefore proposes voters with high levels of occupational automation exposure are more likely to vote against the incumbent.

My following three hypotheses then delve into the interaction between occupational automation risk and within-occupation variation in terms of labour market resources to tease out whether or not workers with resilient careers have different attitudes than sitting ducks. Based on the discussion, I test three mechanisms. First, I hypothesise that voters who are exposed to occupational automation risk are less likely to vote against the government if they have a long-term contract (H2). My third hypothesis (H3) subsequently proposes that voters who are exposed to occupational automation risk are less likely to vote against the government if they have firm-level co-determination rights. Hypothesis 4 (H4) predicts voters who are exposed to occupational automation risk are less likely to vote against the government if they have enjoyed more education.

To summarise, this paper will test the following hypotheses:

- H1. Voters who face high exposure to automation are more likely to vote against the incumbent.

- H2. Voters who are exposed to automation are less likely to vote against the government, if they have a long-term contract

- H3. Voters who are exposed to automation are less likely to vote against the government, when they have firm-level co-determination
- H4. Voters who are exposed to automation are less likely to vote against the government, if they have enjoyed more education

4.4 Data & Methodology

4.4.1 Model

I test these propositions using the last four waves of the European Social Survey (ESS), running from 2012-2018 in 20 European countries by estimating the effect of automation risk on government support among voters who are in employment. The case selection is based on EU membership, to ensure the highest possible degree of political and regulatory comparability, as well as data availability which leaves us to drop eight (mostly smaller) member states from consideration. Similarly to the geographical scope, the time frame of this study is also based on broadly methodological considerations. I look at the last 4 waves of the ESS because these use the most recent update of occupational classification on which the main independent variable of interest is based (more on this below). Limiting the historical scope of this analysis to these years, therefore, limits potential empirical slippage on this crucial parameter

Within the remit of this study, the ESS provides an excellent source of pooled cross-sectional data about individuals, their work, lives and political behaviour across Europe. I use this survey to estimate a logistic fixed-effects model with election, region and wave dummies (other specifications are included in Table C.3.2 in Appendix C). Where, our outcome is the probability of individual i, in election e, region r in year t to vote for an incumbent party. Automatability indicates the level of exposure faced by the respondent while C^{L}_{iert} represents a vector of individual-level controls. α_{ert}, then, are the election, regional and wave fixed-effects, while ϵ_{iert} is the error term of the equation.

The use of regional fixed-effects here is to account for unobserved local-level heterogeneity, principally in the form of socioeconomic conditions that could mediate support for incumbents. The use of election dummies, in turn, is based on the insight that factors related to election-cycles (such as the nature of the incumbent, campaign dynamics, scandals, etc.) are likely to play a significant role in explaining incumbent support. These fixed-effects also help to control for the possible effects of electoral institutions, which we know play an important role in intermediating voting behaviour and particularly shape the ability of voters to hold governments to account. Since proportional representation systems (PR) prioritise representativeness over accountability, they offer relatively less clarity to voters on the topic of electoral responsability, making it harder to effectively sanction their delegates compared to voters in majoritarian systems (see Lijphart 1984; Lijphart 2012).

$$Pr(Incumbent_{iert} = 1) = \beta_0 + \beta_1 Automatability_{iert} + \beta_2 C^{L}_{iert} + \alpha_{ert} + \epsilon_{iert} \quad (1)$$

For these estimations, I use a binary dependent variable in which voters are designated as voting *for* or *against* the government based on whether or not the party they supported in the last national election was in government or opposition, at the time. While the use of such recalled vote is not without any risk (Weir 1975), since voters can forget or distort the vote they cast in the past, it nevertheless remains of the most popular and effective ways to measure the effects of broader socio-political and economic trends on voting patterns in the literature.

As I indicated previously, for the main independent variable I exploit respondents' job information in the ESS. In the survey, respondents' occupations are categorised using the ISCO08 classification (ISCO88 before 2012) which allows me to determine voters' exposure to automation. To do this, I use the Frey and Osborne (2017) index (F&O), ranging between 0 to 1 (in which higher values denote more risk). It measures the likelihood of automation for each job category building on the task approach in labour economics, which defines jobs as being composed out of different discrete output-generating work activities (Autor and Acemoglu 2011) - or tasks. In this framework, job automatability is based on the range of tasks performed within that job, as well as the automatability of those discrete tasks. Frey and Osborne use expert judgement (in the form of Oxford University Engineering Department researchers) as well as identification of technological bottlenecks to determine the automatability of tasks. Task automatability is then translated into overall job-level risk by using O*NET data on the tasks performed within each job category.

According to this model, then, people employed in occupations, composed out of a narrow set of tasks, that engineers can reasonably expect to technically emulate in the future, are designated as being highly prone to automation. Workers in highly diverse, unpredictable and interactive jobs, on the other hand, will be scored lower on the automatability scale. I use the Frey and Osborne index over other similar indices like the one compiled by Arntz *et al.* (2016). The reason for this choice is that the Frey and Osborne's index allows us to compare a much broader range of countries. Still, this comparability comes at a cost. Unlike, Arntz *et al.* the index used here assumes automatability is equal for all jobs within broader occupations and for all these occupations across countries. See Figure 4.1, for an idea of what the idea looks like in practice as well as Appendix C for a further discussion.

To test H2-4, I use specific questions within the ESS that are repeated across all observed waves. Firstly, to test the importance of contract types I use respondents' classification of their contract as being "unlimited" or "limited in duration". To capture co-determination I use a question that proxies this dimension by asking respondents to rank between 0 and 10: "I am allowed to influence policy decisions about the activities of the organisation?" Finally, education is also measured as a continuous variable as the total years of schooling enjoyed by respondents at the time of their response. All of these variables are then individually interacted with the main occupational indicator by Frey and Osborne (2017).

The baseline model also includes further controls at the individual-level. Here, I follow the literature (Thewissen and Rueda 2019; Gingrich 2019; Im *et al.* 2019) by controlling for some of the most important parameters in the form of age, income, education, religiosity and whether or not the respondent lives in a city. To capture income, I follow Rueda (2018) by transforming income bands in the survey's show-cards into their survey-specific midpoint.

I also conduct a series of robustness tests. Firstly, parallel to my baseline model I run a mixed-effects model where voters are nested in regions (NUTS2) and elections (these are reported alongside the main results in the text). Secondly, I conduct a series of tests to understand the difference between anti-incumbent support and radical-right voting.

Table C.3.2 in Appendix C, finally reports on the remaining robustness tests. Here the robustness of the main independent variable is first tested by swapping out the F&O for the Arntz *et al.* index. However, both indices of automation risk are occupation-based approaches that measure risk at the level of ISCO-groupings. Yet, we know that occupational groupings are also important sites of preference formation (Oesch 2013; Kitchelt and Rehm 2014). To ensure my occupation-based independent variable is actually picking up automation risk, as opposed to broader sectoral or occupational patterns in political behaviour, I run robustness tests with controls for occupational groups using 1-digit ISCO dummies as well as sectoral dummies at the 1-digit NACE level. What is more, as the data sampled here all lies in the wake of the 2008 financial crisis, I also test for government spending to control for any negative effects of austerity on incumbent support. To control for any relation between automation risk and offshoring, I also test for job offshoreability. Further tests include testing for some remaining individual-level factors such as migration attitudes and the social background of respondents' parents to check for potentially important lingering social and cultural factors. I also rerun the baseline model on a sample of exclusively western European countries.

In a final series of robustness tests, I unbundle my regional dummy and estimate the baseline model with a series of regional economic indicators into the real rate of economic growth, unemployment rate, net rate of migration *as well as* a robot exposure measure. This last index is derived from previous work done by Acemoglu and Restrepo (2018b) as well as Anelli *et al.* (2021) and effectively measures robot-exposure[2] by normalising the rate of robotisation across national

[2]Formally this is calculated as: $RobotExposure_{crt} = \sum_j \frac{L_{crjt}}{L_{crt}} * \frac{R_{cjt}}{L_{cjt}}$

industries by the proportion of all workers in a given region who are employed in those activities. This indicator is compiled at the regional level and effectively aims to separate out the effects of respondents' individual level of occupational risk from actual rates of automation in their direct environment. What we are then left with, is an estimation of individual-level job related automation risk on incumbent support which can be compared across Europe. Of course, the focus on robots in this index means that is at best an imperfect proxy of automation, and might particularly be skewed towards automotive manufacturing. While these results should therefore be analysed with some caution, the index does arguably offer us an instrument to isolate *occupational* automation risk more precisely from anxiety induced by technological developments on the ground.

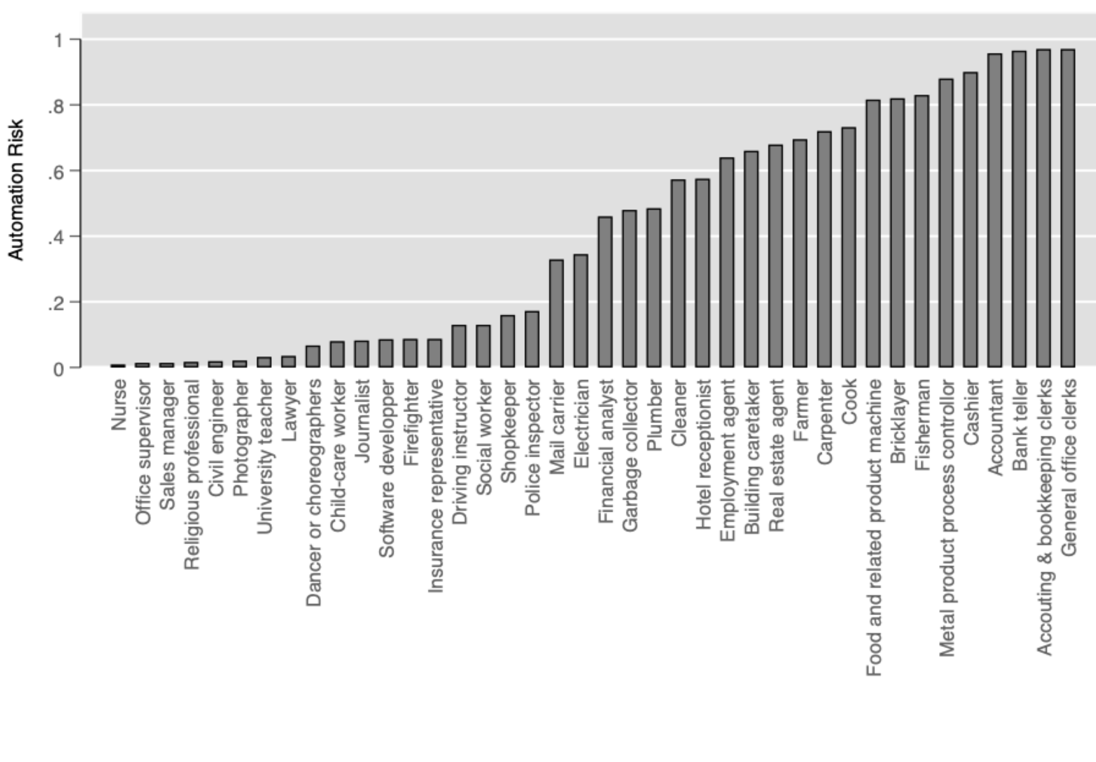

Figure 4.1 Automation risk by job (selected)

Source: Own calculations based on Frey and Osborne (2017) and ESS

4.5 Results

4.5.1 Baseline Results

I first investigate the fundamental question of whether automation risk influences incumbent support. Table 4.2, reports the baseline linear fixed-effects model (columns 1 and 3) as well as the mixed-effects robustness checks (2 and 4). The first takeaway is that automation risk is strongly and significantly predictive of anti-incumbent voting across all the models. In fact, it strongly predicts elevated levels of such votes, even when controlling for key parameters such as income, education and gender. The operationalisation of the independent variable between 0 and 1, means we can neatly infer this amounts to a 12,9% increase (with a 95% confidence interval between 8,3% and 17,5%) in the overall likelihood of voting *against* the government among voters in fully automatable occupations.

Conversely, other coefficients that we might take to signal higher degrees of labour market security such as age, income and education, all point in the other direction. That is to say, older, better-educated and better-paid voters are much less likely to vote *against* the incumbent. In fact, each extra year spent in education predicts around a 2% increase in the relative likelihood of voting with the incumbent. The effects of jumping from one income decile to another or a one year increase in age, meanwhile, are around 11% and 1.7% respectively.

Finally, the findings from the mixed-effects estimations in models 2 and 4 echo the same story while also confirming the notion that there is significant variation from election to election as well as between regions. Taken together, these findings lend credibility to the basic notion that across Europe, voters in automatable jobs externalise anxiety about their precarious labour market position by rejecting the government, plausibly through blind retrospect. Not only is this in line with previous findings regarding automation, globalisation and deindustrialisation (Autor *et al.* 2016; Jensen *et al.* 2017; Kurer 2020; Baccini and Weymouth 2021), but it strongly confirms H1. This story is depicted in Figure 4.2.

So what does this mean on a more substantive level? To provide some more context, these findings suggest that when a nurse and an office clerk walk into adjacent voting booths, the latter is around 1/6th *less* likely to support the incumbent. While this corroborates the basic intuition that incumbent support is tied to labour market position, this finding goes somewhat beyond well-established arguments about voting behaviour among labour market outsiders (Schwander 2019) - or voters in 'bad' jobs. Many of the jobs that score high in terms of automation risk are in fact deeply middle-class. As the task approach in labour market economics has shown, the most automatable jobs tend to be concentrated in the middle of the labour market (Autor and Acemoglu 2011). Automation risk, therefore, seems to cut across some of the well-established economic, and perhaps even cultural, lines in the literature.

Table 4.2 Baseline estimations of incumbent support

	(1) incumbent	(2) incumbent	(3) incumbent	(4) incumbent
F&0	-0.398***	-0.407***	-0.138***	-0.145**
	(0.0302)	(0.0618)	(0.0368)	(0.0496)
Education			0.0193***	0.0192**
			(0.00363)	(0.00697)
Income			0.103***	0.104***
			(0.00497)	(0.0100)
Age			0.0168***	0.0170***
			(0.000965)	(0.00190)
Gender			-0.00128	-0.00118
			(0.0233)	(0.0459)
Urban			-0.126***	-0.117**
			(0.0254)	(0.0442)
Religiosity			0.0269***	0.0271*
			(0.00399)	(0.0110)
Constant	-0.125	-0.682***	-3.370***	-2.812***
	(0.113)	(0.206)	(0.470)	(0.225)
var(Election)		0.464***		0.416***
		(0.0917)		(0.0890)
var(Region)		0.135***		0.141***
		(0.0224)		(0.0256)
Wave FE	Yes	Yes	Yes	Yes
Election FE	Yes	No	Yes	No
Region FE	Yes	No	Yes	No
N	60,577	60,800	48,309	48,514

Robust standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

4.5.2 Individual-level Labour Market Resources and Occupational Automation Risk

We now turn to the hypothesised interaction effects which predicted a difference between incumbent support for workers with resilient careers and sitting ducks. More specifically, I proposed that the likelihood of voting against the incumbent would be smaller for workers facing occupational automation risk *if* they had either a. a permanent contract b. firm-level co-determination and/or c. extensive education. Figure 4.3 presents the results with regards to contract type where for the purpose of clarity I plot two critical reference groups: low automation and high automation risk workers, defined as individuals who are on or above the .9 or below the .1 FO threshold respectively (full regression results are presented in Appendix C). These results have been obtained using the same specifications as the baseline model in column 3 of Table 4.2 where the main regressor is interacted with the labour market resource in question.[3]

Three things stand out here. First of all, the main effect of contract type is strong. This tells us that support for the government is greatest (an estimated difference of some 18,7%) among workers who enjoy the comfort of a stable employment contract. However, the clear importance of contracts does not wipe out the main effect of automation risk: routine workers in precarious contracts remain more prone to vote against the government than non-routine workers holding the same type of contract. Most importantly, we can clearly observe how poor contracts amplify the effects of automation risk on incumbent support. That is to say, the gap in the probability of voting for the government between workers with and without automation risk is much more pronounced for employees in *temporary*

[3] $\Pr(\text{Incumbent}_{iert} = 1) = \beta_0 + \beta_1 Automatability_{iert} * \beta_2 LMResource_{iert} + \beta_3 C^L_{iert} + \alpha_{ert} + \epsilon_{iert}$

contracts. This lends strong credibility to the notion that automation anxiety is as much a phenomenon driven by voters' individual labour market position as it is about technology's raw potential to displace work. Interestingly for the existing literature, this seems to suggest workers are most likely clear-eyed about the relative danger automation poses to them and internalise that awareness at the ballot box rather than being convinced the source of their problems lies elsewhere (full regression estimates for these interactions can be found in Appendix C Table C.3.1).

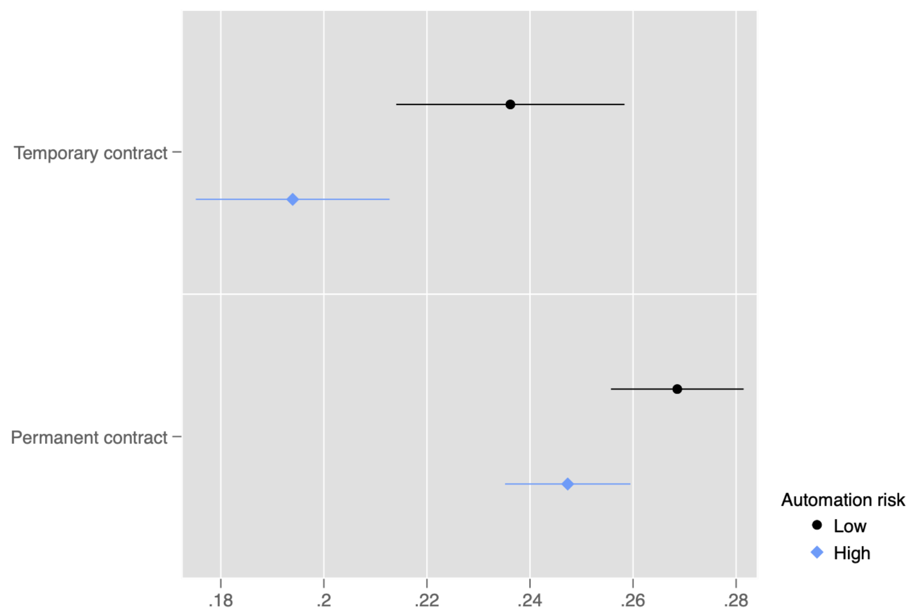

Figure 4.2 Interaction effects between automation risk and contract type on incumbent support

Figure 4.4, then, presents the results for co-determination and a similar, but slightly weaker, picture emerges here. Firstly, the main effect of co-determination is very strong here. The main effect of automation risk, meanwhile, is less pronounced. Substantively, this suggests that differences between levels of co-determination are more important for incumbent support, than are differences in automation risk within those categories. For workers in unautomatable jobs, this means we expect a 37% drop in incumbent support for workers without meaningful co-determination compared to those with maximal influence. This effect is compounded by another 13% for those facing substantial automation risk, though this finding is not statistically significant.

Realistically, real-world differences in firm-level co-determination, particularly within countries, are unlikely to be so binary but the magnitude of this effect means that even marginal differences are likely to matter for incumbent support. It is worth emphasising that the relative importance of co-determination here does not necessarily go against the argument about automation anxiety presented here. For one, the main effect of automation risk remains statistically significant while can also clearly observe an interaction effect, similar to the one found for contract type. Most importantly, from an institutionalist perspective this finding makes perfect sense: being in an automatable occupation is likely to be a far less of a fazing experience when you hold significant power over firm decisions.

As indicated before, many workers in north-western Europe can rely on broad institutional guarantees which ensure they have the right to bargain with their employers over the introduction of new technologies in the workplace. In many ways, this collective power-resource provides a similar, if not stronger, form of security to employees than the individual protections offered by contracts. Put simply, having the ability to shape decisions in the first place might reduce anxiety to a greater extent than having the capacity to absorb adverse decisions. As such, this finding confirms the intuition that such added layers of (institutionalised) *voice* (Hirschman 1970) as well as information about what lies ahead, dampen anxiety about occupational risk.

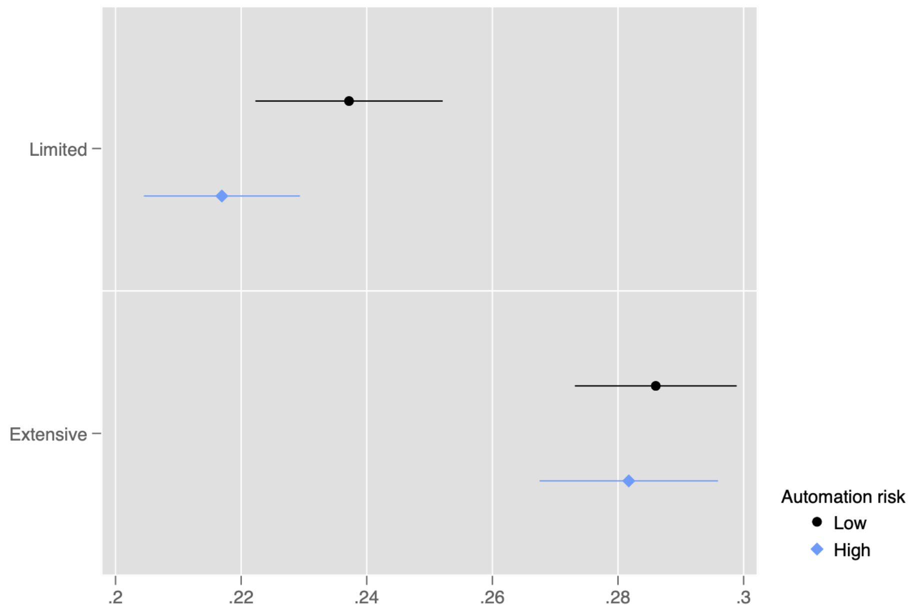

Figure 4.3 Interaction effect between automation risk and co-determination on incumbent support

Finally, we turn to education in Figure 4.5 The importance of education on voting behaviour is of course well-established (Kriesi *et al.* 2008; Antonucci *et al.* 2017), and was also re-emphasised by the baseline findings in Table 4.2 However, the findings from this estimation nevertheless present some interesting conclusions. More than in the two previous estimations, the effects of education seem to strongly go hand in hand with those of automation risk. That is, workers in automatable jobs who have only completed minimal education are significantly less likely to support the government than any other group, even other employees with similar educational backgrounds. Each additional year of education, meanwhile, decreases the likelihood that workers in these at-risk jobs vote against the government by some 3.5%. Put together, this paints a very stark picture that strongly suggests skills and automation risk are pieces of the same puzzle when it comes to incumbent support, and political (dis)satisfaction more broadly. Workers with a relatively greater capacity to adapt in the so-called 'race against the machine' (Brynjolffson and McAfee 2011) seem to be more at ease with the political status quo allowing automation on its watch.

Taken together with the findings for H2 and H3, this strongly suggests that, to the extent, automation drives voting behaviour, voters internalise the potential effects of technological change on their future well-being only in relation to their broader labour market position. Rather than observing a clear sense of status anxiety among relatively well-entrenched workers in automatable jobs, these results suggest anti-incumbent voting is a more dominant tool in the political repertoire of those workers facing the highest degrees of *objective* material risk.

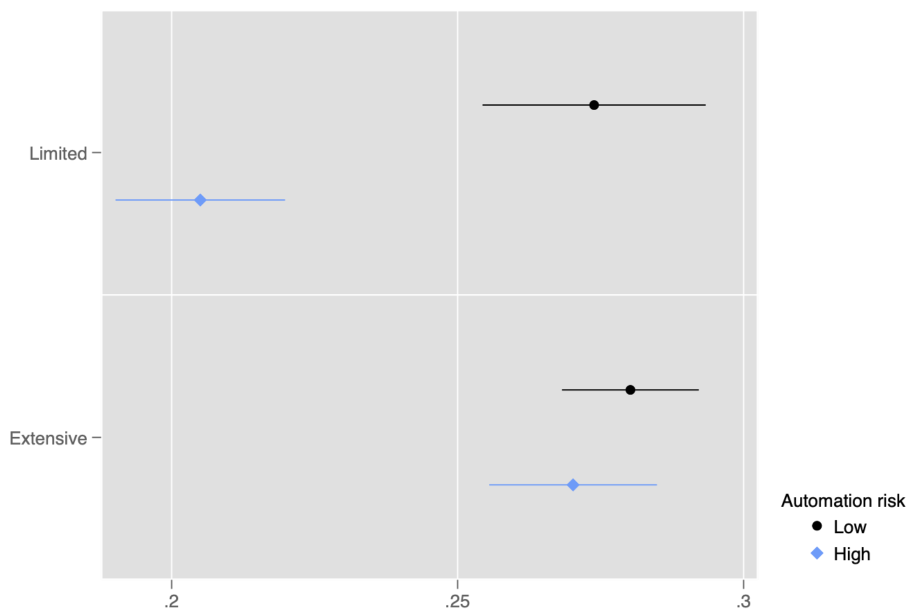

Figure 4.4 Interaction effect between automation risk and education on incumbent support

4.5.3 Further Results

Figures 4.5 and 4.6 offer slightly more schematic insights into the interaction of automation risk and voters' labour market resources in the broadest sense. Firstly, Figure 4.5 shows predicted incumbent support among voters with high automation risk for different levels of aggregated labour market resources (i.e. high is minimal 2, medium is 1 and low is the absence of resources). The observed, and significant, decline in predicted government support as the level of resources falls quite nicely encapsulates the idea that automation risk and broader labour market position interact when it comes to voting behaviour. Again, this is not necessarily a traditional labour market story about voters in 'bad' jobs. Automation threatens jobs on either end of the occupational ladder and is in fact most strongly correlated with middle-skilled jobs. What these findings do pick up on is the increased anxiety among so-called 'sitting ducks' in the labour market to absorb that risk. Put together with the previous findings, this again gives us a strong indication that workers think about automation risk in a differentiated way and can reasonably approximate their own overall risk status.

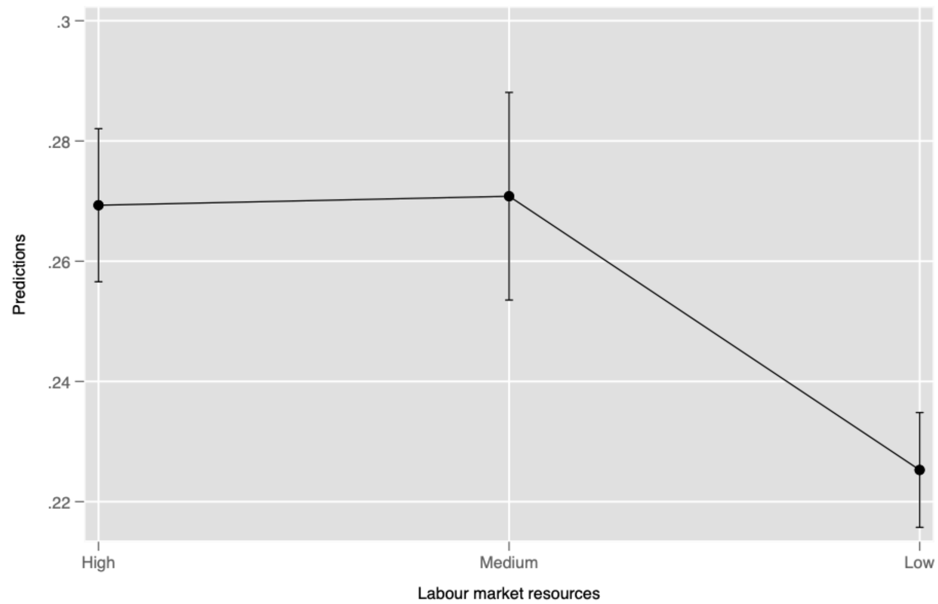

Figure 4.5 Predicted margins of support for the government among voters with high automation exposure by levels of labour market resources

Borrowing from comparative capitalism literature (Hall and Soskice 2001), Figure 4.6 elaborates on this by classifying high automation risk voters by the 'model' they live in. The findings intuitively corroborate the insight that labour market protections *and* chances matter to the broader story of automation risk and voting. Theoretically at-risk workers in so-called coordinated or Scandinavian settings are much more likely to support the government than their peers in any of the other models. All else being equal, countries such as Germany, Austria and Sweden boast some of the most robust welfare states, strong worker protection, high levels of co-determination as well as robust growth and relatively fluid labour markets. Compared to other growth regimes, this means at-risk workers are relatively better protected from lay-offs (particularly vis-à-vis the liberal system) while also benefiting from more plentiful opportunities for labour market re-entry compared to countries such as Italy or Greece. While there are certainly differences in the underlying occupational structures between different models, I do not think they are at all strong enough to explain this variation. These findings, therefore, confirm previous work done by Battisti *et al.* (2017) who show that many German workers are relatively protected from direct adverse effects originating from technological and organisational changes in the firm. They also indicate to what extent institutional differences play an important role in this story.

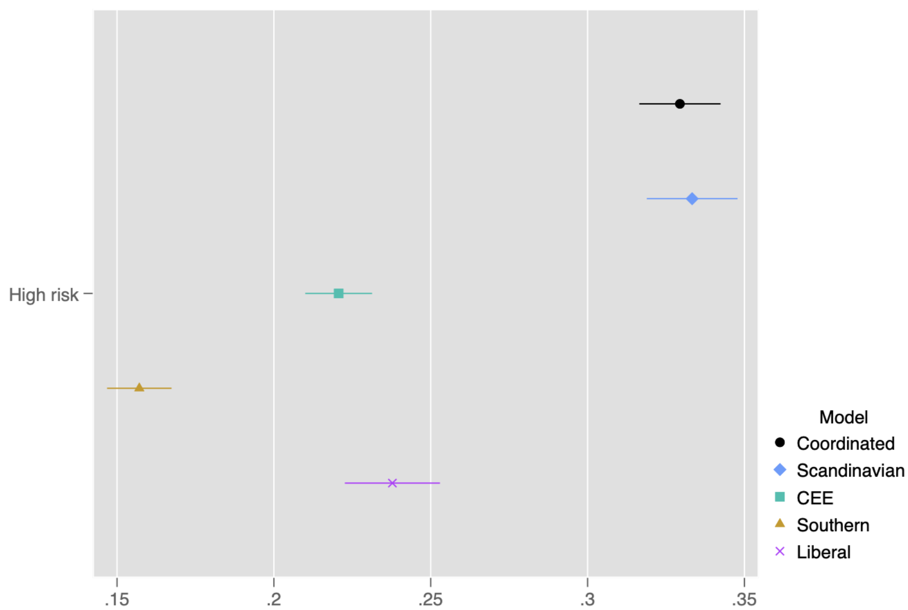

Figure 4.6 Predicted margins of support for the government among high automation risk works by growth model

Table 4.3 Testing the importance of the far-right as part of anti-incumbent voting

	(1) Baseline	(2) Far-Right Presence	(3) Excl. Far-Right Supp.
F&0	-0.138***	-0.136***	-0.117**
	(0.0368)	(0.0391)	(0.0406)
Education	0.0193***	0.0266***	0.0242***
	(0.00363)	(0.00391)	(0.00407)
Income	0.103***	0.112***	0.118***
	(0.00497)	(0.00531)	(0.00554)
Age	0.0168***	0.0163***	0.0176***
	(0.000965)	(0.00102)	(0.00106)
Gender	-0.00128	0.0160	0.0544*
	(0.0233)	(0.0245)	(0.0256)
Urban	-0.126***	-0.108***	-0.150***
	(0.0254)	(0.0267)	(0.0280)
Religiosity	0.0269***	0.0254***	0.0268***
	(0.00399)	(0.00422)	(0.00439)
Constant	-3.370***	-3.577***	-3.495***
	(0.470)	(0.473)	(0.476)
Wave FE	Yes	Yes	Yes
Election FE	Yes	Yes	Yes
Region FE	Yes	Yes	Yes
N	48,514	41,660	36,796

Robust standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Finally, there remains the question to what extent this story of anti-incumbent voting is different from previous findings surrounding far-right support (Anelli *et al.* 2019; Im *et al.* 2019; Kurer 2020). It is at least plausible that anti-incumbent voting, observed here, is to a large extent driven by votes for far-right parties that tend not to be in government. Table 4.3 gets at the heart of this question in two steps. Firstly, it compares estimates of the baseline model for the whole sample (1) compared to a sub-sample of elections featuring far-right challengers (2). What we see is that the absence or presence of the far-right does not significantly influence the results. Column 3, then, takes this one step further by also excluding all observations in which respondents claim to have cast a vote *for* the far-right. Doing so sets up a *least likely* case in which far-right voting and anti-incumbent support would be different. Indeed, if these two phenomena perfectly overlapped, the results ought to come out flat here. We can, however, plainly see that far-right voting is only a part of the anti-incumbent tendencies among at-risk workers, accounting for roughly 15% of the story and slightly influencing significance. In short, we can conclude that workers who face significant automation risk are less likely to support incumbents than other employees. This particular type of voting behaviour *can* manifest itself as votes for far-right challenges when they are present, but is likely far from limited to that specific type of party support.

4.6 Conclusion

Technological change and automation are here to stay. As we have seen in the past, this almost inevitably means significant adaption in labour markets and product markets as well as the creation of 'losers' and 'winners'. And as recent sweeping contributions by Frey (2019), Iversen and Soskice (2019) and Boix (2019) suggest, these technical changes could therefore well be a key driver of changes in the political landscape as well as prove crucial in determining the stability of governments in industrial democracies.

This paper, therefore, analysed the link between occupational automation anxiety, incumbent support and individuals' capacity to adapt to technical change in

Europe. Looking at the impact of this occupational risk on voters' support for the government in 20 European countries, a clear pattern emerged. Workers facing the danger of seeing their job automated were significantly more likely to cast votes *against* the incumbent. While this tells us little about party support in the positive sense, it is a striking result nonetheless since automation risk cuts across many sectoral, religious, cultural and even socioeconomic lines. Clerical workers, cashiers and accountants are all roughly equally exposed to this trend.

Crucially, however, my results indicate that this automation anxiety does not stand on its own. That is to say, automation risk is only one part of broader labour market risks that voters might channel into anti-incumbent sentiments. This means that at-risk workers lacking permanent contracts, significant co-determination and/or a strong education to fall back on form a constituency that is particularly likely to reject incumbents. However, when those same voters are equipped with the tools to adapt to the technological challenge, this antipathy seems to largely dissipate. Luddism, it seems, is as much about the lack of resources to absorb risks and the capacity to adapt to technological change as it is about these technologies themselves.

This paper, therefore, makes three key contributions to the existing literature. Firstly, it highlights the interplay between automation risk and broader risks workers face in the labour market (Rueda 2007; Burgoon and Dekker 2010; Pahontu 2021). It specifically demonstrates how anti-incumbent votes driven by automation risk are particularly dominant among those workers facing the most pressing *material* risks, so-called sitting ducks. That is to say, those workers lacking sufficient labour market resources and who are therefore not equipped to adapt to technical changes. Conversely, voters with more resilient careers did not seem to flinch in the face of automation risk.

Secondly, my results also help us understand the mechanisms behind automation risk and voting behaviour better. Whereas previous work demonstrated automation risk led voters to the far-right, this paper emphasises that type of voting might well be part of a broader anti-incumbent position in Europe. This finding, I think, lies in line with the idea that ideological and strategic ambiguities surrounding the topic of automation in the political arena make it hard for voters to correctly identify allies in the political arena. However, while voters might have a hard time articulating their anxieties into positive support for a certain agenda, they do not seem to be blind to the risks automation poses to them as some versions of the misattribution story propose. The very fact that these sitting ducks display systematically lower support for incumbents compared to workers in resilient careers, signals that they are clear-eyed about the risks they face. For governments, then, this means automation is not a problem of technology but one of policies and power-resources.

Finally, this paper widens up the empirical scope regarding the relation between automation anxiety and incumbent support by looking at more than 20 European countries. In doing so, this paper shows this trend is widespread. That is to say, observable across Europe and not specific to majoritarian electoral systems all the while transcending the far-right voting discussed in the current literature (Baccini and Weymouth 2021; Gallego *et al.* 2022).

While this paper suggests automation anxiety is mostly concentrated among voters facing the highest level of *material* risk, it is worth noting I do not altogether want to reject socio-cultural interpretations. Work *is* a strong source of self-identification. It is therefore quite safe to assume challenges to that self-image do incite some sense of status anxiety. What is more, my results also seem to suggest that far-right support is a very significant part of anti-incumbent voting.

However, the main thrust of my argument is that the immediate danger of material precarity ought to be a stronger driver of voting behaviour than the more subtle sense of status loss. Indeed, the idea that well-entrenched workers have more to lose in terms of status than others who might fail to provide for their basic needs seems counterintuitive.

This also points to another element worth addressing regarding the 'supply-side' politics at play. To conduct as broad an analysis of the political implications of automation as possible, this study zooms in on voters, thereby putting to the side any questions of party competition, ideology, campaign promises or even government policies. This undoubtedly represents a potential shortcoming. As stated before, there is good reason to believe radical right parties have been particularly successful at activating resentment among challenged workers (Im *et al.* 2019; Anelli *et al.* 2021), while Jane Gingrich (2019) has convincingly shown that policy can go some way to alleviate automation anxiety. Much work, nevertheless, remains to be done in this domain and future research into the party politics of automation, particularly regarding manifesto promises, is definitely warranted. Put together with the insights into valid concerns held by certain groups within the electorate, demonstrated in this paper, this could help us map the political problem of automation with even greater clarity.

So, where does this leave us? There is, I believe, cause to be cautiously optimistic. If political dissatisfaction among workers facing occupational automation risk is primarily driven by workers who presently cannot "run alongside machines" (Brynjolfsson and McAfee 2011), then the list of possible solutions to this problem is plentiful. A wide range of policies, from strengthening unions and social dialogue to better contracts, retraining opportunities and generous unemployment support, could go towards diminishing the anxiety experienced by some workers.

While there is some evidence to suggest a critical mass of voters would support such policy interventions (Balduini *et al.* 2022), this does of course not mean incumbents will consider it in their best interest to implement such ideas, let one that the implementation of these ideas would be altogether easy. However, it does suggest (in line with Frey 2019) that technological change does not necessitate discontentment or political upheaval as long as the political system can negotiate its worst short-term effects.

5

Conclusion

Bringing it all together – Summary of Key Findings –
Contributions to the Automation Debate –
Broader Contributions – Limitations & Further Research –
Final Conclusions

5.1 Bringing it All Together

Over the past centuries, labour-saving innovations, ranging from the spinning jenny to automated railway points and AI, have freed us from many backbreaking and tedious tasks. In doing so, they have allowed large parts of the labour market to engage in more stimulating and productive work, paving the way for a growing economy that provides ever greater benefits to far more people than before. There is little doubt that most European societies, from the very bottom to the top, are better off than they were before the industrial revolution because of this innovation. The fact that automation has played such a crucial role in easing people's lives, providing new jobs and raising the general standard of living over the last centuries, means it is no exaggeration to say it is therefore one of the cornerstones that have helped capitalist democracy tick.

Yet, all that glitters is not gold. At its core, automation is a highly distributive process that swings fortunes from one occupational category to another. Since the start of the industrial revolution, we have witnessed shifting demand for skills, going from skilled artisans to semi-skilled industrial workers all the way to highly educated professionals. In recent decades this last shift seems to have gone hand in hand with a decline in demand for middle-skilled workers, creating a polarised labour market in many advanced capitalist democracies. What is more, automation has seemingly heightened the distributive tension between workers and capital owners in many places. As capital has replaced labour in many tasks, economists have argued the share of total income going to workers has decreased in recent decades. For many citizens of these countries, this has led to heightened anxiety. Anxiety both about their ability to end up and stay on the right side (both figuratively and literally) of an increasingly squeezed labour market as well as about what technological change has in store for us next.

In this thesis, I have argued that the ways in which capitalist democracies deal with the confluence of these two key characteristics of automation (i.e. that is both central to long-term growth in ACDs and yet politically difficult to square with democracy in the short-term) helps to account for the uneven development of this kind of technological change in time and space. Automation is not simply a process that is exogenous to the political process. Since capitalist democracies are a type political economic system that primarily distributes income through work, automation tends to be a politicised process that operates within the institutional confines the political economy, which set out how we produce growth and how the fruits of that growth are to be distributed. In short, labour-saving technological change is deeply political and understanding its distribution and social effects throughout the advanced capitalist world requires us to think about politics and institutions.

Having demonstrated this political economy view of automation over the course of three papers, in this final chapter I will first summarise the findings and contributions of these individual papers. I will then discuss how I think these findings fit together, what their place is within the broader debate on automation and how they speak to other important questions within social sciences today. I will, finally, conclude with some recommendations for future research.

5.2 Summary of Key Findings

The first paper of this thesis was motivated by a puzzle. If automation is in fact causally determined by occupational task content, as is proposed in the seminal literature (Autor and Acemoglu 2011; Acemoglu and Restrepo 2018ab), why is it that the introduction of credit scoring influenced the similarly non-routine jobs of British and German bank branch managers so differently? I conducted a comparative case study, relying on archival work, balance sheet analysis and elite interviews, to argue that we can only understand the shifting fortunes of these branch managers and their branches by looking at the institutional conditions underpinning the financial systems in which they operated.

More specifically, I argue that the different adoption strategies German and British banks pursued reflected the (changing) role of banks within the political economy rather than that of pure technological determinism. British banks during the eighties were confronted with a rapidly liberalising environment in which previously existing financial oligopolies were eroding. This changing financial environment had two immediate consequences. On the one hand, increased competition put pressure on their revenues. On the other hand, however, Thatcher-era liberalisation opened up the possibility to increase lending to customers, to subsequently securitise these loans and borrow from international markets. These twin forces of challenge and opportunity changed the position of British banks in their domestic market, away from one of traditional intermediary towards one of market-led banking. For branch managers this meant their comparative advantage in issuing sound credit became devalued in a context of increased competition and declining costs for bad credit.

While this led to British bank managers to be largely *replaced* by credit scoring, their German counterparts remained largely unaffected by this transition. In fact, German banks at the time decided to use credit scoring only to *complement* decision making at the branch level. I argue that this initial divergence is explained by Germany's bank-led financial system anchored around relational banking and strong public and cooperative banking pillars in which the skills of branch managers to issue sound loans that would mature on banks' balance sheets remained crucial. It was only during the late 1990s, when the Schröder reforms pushed the German financial system, and in it first the commercial banks, towards a model of market-led banking that banks' strategies surrounding credit scoring slowly converged on the British model.

I see three key contributions for this paper. First, this paper highlights the limitations of the popular task-based arguments. Not only does this case show how technology chipped away at the highly non-routine and interpersonal job of branch managers but more importantly, it offered an example of what is intuitively obvious to most of us: there is no single way to introduce any given technology. The importance of these points should not be understated as they suggest that the relationship between tasks and automation is more complex than proposed by the RBTC paradigm. Of course, automation *does* substitute labour for capital in discrete tasks in the production process, and the literature has also been right to point out how routine-intense occupations will, all else being equal, be most vulnerable to this process. However, the precise causal relationship envisaged by RBTC does not seem to hold up. Not only did the sudden demise of branch managers in the UK demonstrate how non-routine jobs can also be automated through job re-engineering and routinisation (also see Braverman 1974), but the initial divergence with Germany also exemplifies the way businesses can implement the same technology into the same field and still make different automation decisions. Routine intensity, then, might be neither a sufficient nor even necessary condition for automation.

Having questioned the causal role of the tasks-structure within automation, the second contribution of this paper is therefore to place institutions at the heart of my explanation of labour-saving technological change. Rather than being an intervening variable within a broader task-framework, this paper shows how financial market regulation was in fact the primary *causal* factor determining the labour-saving use of credit scoring in the UK, and later Germany.

Finally, this paper also makes a methodological contribution to the literature. Existing work on automation had, to date, relied almost uniquely on quantitative research design. The qualitative case study design at the heart of this paper, therefore, offers a good example of the benefits of a detailed analysis of a single technology and its adoption in a specific industry.

Whereas the first paper in this Ph.D. examined the functionally *different paths* taken by firms adopting the same technology at a similar rate, the second paper looked into *differences in the rate* of adoption of automation across countries.

This paper, therefore, takes the analysis one step further by arguing that diverging levels of automation adoption, and more specifically industrial robotisation, in the OECD can be usefully explained by institutional differences.

This paper specifically examined the relationship between cooperative institutions and industrial robotisation to challenge Leontieff's suggestion that workers would do anything to hold back the tide of automation if they had the power. To do so, I compiled an original index of cooperative institutions in the OECD to proxy the degree of institutionalisation in the productive sector across different countries. I paired this institutional index with sectoral robot density levels in a panel analysis that spans 25 countries and 24 years, showing that higher degrees of cooperative institutions are not only associated with *more* robotisation but also predict more equitable outcomes at the sectoral level in terms of the labour share and overall working hours. Here again, we see the importance of institutions in guiding the process of automation. What is more, by zooming deeper into the relationship between institutions, automation and recessions, I show that the relation between robotisation and institutionalised cooperation tends to reverse during recessions.

In doing so, this paper offers a number of key contributions to existing scholarship. Firstly, it offers an institutionally driven explanation of the puzzling divergences in industrial robotisation across the OECD. Whereas existing theory would point to relative factor costs, industrial composition and/or demographic factors (Autor and Acemoglu 2011; Acemoglu and Restrepo 2018) to account for these differences, I argue these divergences are likely more politically driven than often assumed. Secondly, the findings in this paper challenge the existing work on the consequences of automation on the labour share and working hours (Karabarbounis and Neiman 2013; Autor et al. 2017a; Acemoglu and Restrepo 2018a; Kehrig and Vincent 2018). Whereas previous contributions emphasised the importance of new technologies in either lowering the bargaining power of workers and the competitive pressure they put on the lower end of the labour market, my findings suggest these consequences are likely as much driven by political and institutional differences as they are the result of technological change itself. While my data does not allow me to discuss the effects of robot adoption on the economy as a whole, the results at the very least give us a glimpse into the first order-effects by showing that within-sector labour shares tend to remain stable (and indeed even rise) in cooperative settings.

As such these findings echo a recent contribution by Parolin (2020) who also finds organised labour softens the impact of automation on labour income. The insight that robotisation in highly cooperative settings coincides with stable (or even rising) labour shares but slowly declining working hours similarly corroborates conclusions by Dauth *et al.* (2021) who find that automation in Germany generally speaking favours incumbents who tend to take over new tasks in plants while coming at the costs of new entrants.

Finally, this paper contextualises the story of 'jobless recoveries' (Jaimovich and Siu 2012) by showing how the uptick in automation during recessions is specifically a feature of liberal economies. Automation in cooperative settings, meanwhile, seems to be a more long-term and deliberative process. Businesses in these countries seem to be happy to let a good crisis go to waste. Interestingly, this finding probably offers us part of the explanation as to why labour shares tend to decline when robots come into liberal economies. Negotiated and hence more inclusive automation seems to stop benefits from accruing disproportionally in the form of non-wage income. The conclusion that automation goes hand in hand with more equitable social outcomes for incumbents, therefore, seems to directly discount the competing argument that automation is a tool used to disorganise labour (Presidente 2020).

The first two papers of this thesis established the importance of politics and institutions in determining how technologies are adopted, the rate at which they are adopted, as well as the social consequences of that adoption. For the final paper, I, therefore, looked at a different part of, what I believe is, an interdependent causal chain. That is to say, instead of analysing the causal effect of political processes on automation, my final chapter contributes to the nascent debate on the effects of automation on political behaviour. Using pooled cross-sectional survey data, I show that automation risk is strongly tied to anti-incumbent voting but that this automation anxiety should be understood as part of broader labour market insecurities faced by workers.

More specifically, I leveraged the last four waves of the European Social Survey across 20 EU countries to test the effects of occupational automation risk (as computed by Frey and Osborne 2017) on incumbent support. Controlling for most relevant confounders, I estimate that the anxiety of being in a highly automatable occupation vis-à-vis holding in a non-automatable job amounts to around a 13% decrease in the likelihood of supporting the incumbent. This is clearly a striking finding as it suggests voters are strongly expressing the risk to their livelihoods when to go to the ballot box.

However, further analysis showed that the political consequences of automation anxiety are about more than merely holding down an automatable job. In fact, by estimating a series of interaction effects between the occupational automation measure and individual-level labour market resources (i.e. human capital, co-determination and/or contracts) I show that this rejection of government is predominantly concentrated among voters in automatable jobs who lack the resources to adapt to this technical change; sitting ducks if you will. Conversely, those workers with stable contracts, strong co-determination and/or high levels of human capital were not found to vote very differently from their peers in non-automatable positions.

Put together this offers, at least, two key contributions to the literature on technological change and voting behaviour (Im *et al.* 2019; Anelli *et al.* 2019; Sacchi *et al.* 2020; Kurer 2020; Gallego *et al.* 2021; Gallego and Kurer 2022). First of all, my paper provides the most sweeping account of the political consequences of labour-saving technological change to date. Whereas previous studies have generally been limited to a handful of countries, or even a single election, the wide scope of my analysis (20 countries over 8 years) provides some good evidence about the generalisability of this trend. Studies on the link between technological change and incumbent support, particularly, had previously been limited to single country analyses (Kurer *et al.* 2020; Baccini and Weymouth 2021).

Secondly, and most importantly, my paper challenges the emphasis on technological change within the literature. Existing accounts have indeed put a lot of explanatory importance on technological risk, only controlling for rather than seeking to understand its interaction with other key parameters. By combining the use of an occupation-based automation indicator (FO) with individual-level parameters (similar to a new approach recently proposed by Pohontu 2021) my paper suggests that *occupational* automation risk is, paradoxically, only a necessary but not a sufficient condition for automation anxiety among voters.

These findings ought to shift the focus in the debate away from questions regarding what technologies pose the most significant 'risk' and how best to measure this, onto questions about how labour markets and welfare states set workers up to deal with those risks. In that sense, the conclusions corroborate more recent findings in economic history that suggest the link between early agricultural mechanisation and protest was strongly intermediated by external labour market options for farmers (Caprettini and Voth 2020). That conclusion, of course, also resonates very well with the previous findings in this thesis since it neatly demonstrates how the same cooperative institutions, by distributing more widely the benefits of automation and softening its most socially regressive elements, directly intermediate the link between automation and democratic instability.

5.3 Contributions to the Automation Debate

Before jumping into the broader argument and conclusions I draw from these papers for the broader debate on automation, it is worthwhile offering a short refresher of the main theories of automation; neoclassical, Marxist and institutionalist thinking.

If we can recall, the notion of routine-biased technological change proposed automation filters out routine tasks of the economy on a cost-efficiency basis, arguing this process, in turn, leads to productivity and demand effects that reinstate new tasks down the line. Marxist interpretations of automation on the other hand, reject the idea that automation is an efficiency-led process with potential for political consequences, instead arguing automation itself is a political tool by capital to control workers and their skills as well as to disorganise labour within the permanent class struggle. Existing institutionalist accounts, finally, agree with the Marxist premise that automation is endogenous to politics. Hpwever, rather than fully subscribing to the Marxist argument these, often historical, accounts focus on the political and institutional levers behind the technological change by embedding it within the broader picture of coalitional politics required to bypass the opposition of labour. Put together, these theories all paint a relatively deterministic picture of automation that suggests this type of technical change is either completely exogenous to the political process or, in the best-case scenario, a zero-sum game with equally predictable outcomes.

This thesis offered some systematic evidence to suggest that reality is more complicated. My first paper strongly demonstrated how routineness is neither a sufficient nor a necessary condition for automation, while also showing how the exact implementation of credit scoring was tied to the broader growth strategy envisaged by financial market institutions, as opposed to any predictable form of class antagonism. While my second paper brought the notion of class and industrial relations back in, the conclusions were orthogonal to what purely antagonistic zero-sum arguments would expect. Not only did I find that highly institutionalised settings automated *more*, but that innovation was not found to be detrimental to the conditions of workers at the sector level. Finally, in the sphere of political behaviour, my third paper demonstrated how workers are themselves not necessarily politically activated by labour-saving technical changes, as long as they can adapt to these innovations.

Building on the contributions made in each individual paper, the overarching argument of this dissertation is that automation, both in terms of its causes and effects, is endogenous to politics and the institutional settlement that is made in each polity over the question of how growth will be pursued and distributed. This conclusion, carries with it a number of key insights for the debate. Firstly, it signals that automation is first and foremost a political process, conditioned by power and institutions rather than tasks and costs. Indeed, from specific questions regarding the type of innovation funded by the state, over worker involvement in firm-level decision-making and labour-market institutions conditioning the costs to lay off workers to broader questions of how we conceive of economic growth, it should be clear we cannot start to think about automation and its effects without reflecting on the institutions and politics undergirding the system in which it unfolds (or indeed fails to do so!). As Piore and Sabel (1984, 5) once put it: "Machines are as much a mirror as the motor of social development."

The emphasis on power and politics in this thesis, of course, borrows from existing institutional accounts (Mokyr 1990; Allen 2009; Frey 2019). However, in contrast to these arguments, which (sometimes to their own admission, see Frey 2019) provide an institutional addendum to the dominant task paradigm, I propose a more differentiated and open-ended understanding of the relationship between institutions, industrial power relations and automation. More specifically, my final two papers bring out the importance of the political game between capital and labour to the broader political economy.

Squaring their conclusions about automation rates, social outcomes and political behaviour with previous insights by Frey (2019) and Boix (2019) regarding the respective absence of automation prior to modern capitalism and its deep impact on social stability during the early industrial revolution, this suggests capital and labour face a political time inconsistency problem, particularly within democratic capitalism. While both parties benefit from the long-term growth automation provides, they harbour opposing ideal short-term preferences that are equally problematic for reaching the long-term goal of growth since automation fundamentally alters the balance of power in the bargaining game between capital and labour. Whereas both Marxist and institutionalist accounts would have us expect convergence towards a single equilibrium, approaching automation as a *game* clearly suggests we can expect multiple different outcomes, ranging from the low-growth/no automation equilibrium described by Frey (2019) to notably a *positive sum* scenario where the sharing of automation's short-term negative externalities between capital and labour leads to high automation, high growth and high equality equilibrium.

We know from decades of political economy that reaching such a cooperative equilibrium is far more likely in high trust (Putnam 1993) and deeply institutionalised settings (Olson 1983; Hall and Soskice 2001) where cooperation is strongly embedded (Axelrod 1984) and this seems to be exactly the direction taken by coordinated market economies where unions and employer organisations lobby governments for co-investment into innovation *and* training; sectoral organisations funded by the government successfully disseminate information about automation to SMEs; and labour market insiders are actively participating in automation by obtaining relevant, and often firm-specific, skills while cooperating with management regarding shopfloor innovation.

This is not to say, institutionalised cooperation is a prerequisite to automation by any means. Mechanisation during the first and second industrial revolution, as well as in the US Midwest in recent decades, did not closely rely on cooperation or negotiation and therefore definitely did not heed potential social consequences. However, as Boix (2019) and Frey *et al.* (2017) both pointed out, this model of automation risks upsetting the socio-political fabric of society. We could also interpret the relative ease with which bank managers were pushed aside in the UK from this angle. The sacrifice of this group of workers was relatively painless, democratically speaking, since they only represented a very small group of workers that, for the most part, had excellent employment opportunities, which eased the transition. Ultimately, the challenge of automation for capitalist democracies, as always, is not simply to find a political settlement that is conducive to automation-led productivity growth but to make sure that the capitalist hunger for growth does not inadvertently pave the way for political instability. The good news, in this regard, is that recent work suggests the electorate in most countries is in favour of some interventions that could redistribute these costs (Balduini *et al.* 2022).

I would also suggest that the precise mechanism through which this political game is played, is institutionally determined. To use Schattschneider (1960, 71): "Some issues are organised into (electoral) politics while others are organized out." In this case, countries with neocorporatist traditions seem to feed the politics of automation into a densely institutionalised system of producer politics, made up of works councils, sectoral organisations and tripartite negotiations. Elsewhere that same distributive question seems to largely play out in the sphere of electoral politics. This, I think, is very important. As in any repeated game with long-term stakes, settlements depend on credible commitments which neocorporatist institutions have traditionally been very good at fostering (Hall and Soskice 2001). Electoral politics, meanwhile, is known to be much more myopic (Barro and Gordon 1983) and prone to policy swings. This potentially heightens the uncertainty, and therefore myopia, for at-risk groups.

This shift towards a more malleable appreciation of labour-saving technical change, conditioned by the broader parameters of growth in the political economy, also allows us to step away from a deterministic vision of technology. In this thesis, I presented one seemingly puzzling example of how one specific technology was implemented very differently across countries, but it should be clear that there is no preordained way in which any innovation should be adopted - let alone what should be their socioeconomic effects. Instead, thinking about automation as being a politically contested phenomenon that is part of the broader institutional growth settlement in the political economy forces us to consider how diverging adoption strategies could be complementary to these settlements. To be clear, I am not proposing to replace neoclassical determinism with a slightly more differentiated version of it, based on a finite set of economic models. However, as institutions set out the incentive structure in the economy, I believe they co-determine the likelihood of different adoption strategies.

Finally, it is interesting to note that a theory of automation based on politics and institutions might not only be better at explaining past technology adoption but, crucially, it is also more future-proof than prominent routine-based arguments. While I do not wish to oversell the potential of AI and Machine Learning (see Woolridge (2021) for a level-headed history of these technologies), it is clear that one of the main selling points of these innovations lies in their ability to automate *non-routine* tasks (Brynjolfsson and McAfee 2014). AI's ability to shake up complex activities (think of industries like finance, law and accounting) therefore points to the potential historical and technological limitations inherent in the RBTC paradigm (Susskind 2020).

5.4 Broader Contributions

Aside from the key contributions this thesis makes to the study of automation in social sciences, I also believe it holds some lessons for other debates. In particular, I want to briefly discuss the relevance of my findings for literature on comparative political economy, globalisation, and finally the nascent debate on market power.

First and foremost, my thesis clearly speaks to the broader discipline of comparative political economy (CPE). Here I see three particular points of interest for the debate. Firstly, I hope this thesis helps to reshape political economists' relationship with technological change. In considering innovation, the focus in

CPE has generally been on *product* innovation (i.e. the development of brand new products and services) (Hall and Soskice 2001), as opposed to *process* innovation (i.e. changes in the way we produce existing goods and services). From my analysis, it should be clear that this latter form of innovation is not only central to growth in advanced capitalist democracies, but that is a significant political issue that equally determines the parameters of distribution within the political economy.

Secondly, one of the central arguments presented here is that capitalist diversity is very much alive. Far from being either immutable or having converged towards a single model, my findings demonstrate how production and redistribution in capitalist democracy still take many different forms today. Even in the case of credit scoring, where extensive convergence has happened, we can still observe the different application of technology across the diverse German banking landscape. In contrast to what some scholars have argued in recent years (Baccaro and Pontussen 2016) this means that the systematic analysis of differences in the supply-side of economies is far from a fruitless endeavour, particularly to understand the rise of new technologies (see Thelen (2018) for an excellent example).

Finally, I believe my research can cautiously speak to the age-old debate on the relation between capitalism and democracy, which has sparked up again in recent years (see Hacker and Pierson 2011; Streeck 2016; Iversen and Soskice 2019; Boix 2019; Piketty 2019; Hall 2021). My work offers some support to a nuanced interpretation of this relation, where capitalism and democracy are neither functionally complementary pieces of to same puzzle nor irreconcilable opposites. Looking at the evolution of automation suggests these two models *can* work together but that their respective logic of efficiency and equity are always at odds. A ruthless pursuit of mechanised efficiency could very well upend democratic stability in the same way that a tyranny of the majority, protecting job stability and equity, could stifle innovation and capitalist drive. My work would suggest the only way to guarantee a stable co-existence of these two models is through institutionalising mechanisms that seek to negotiate structural shifts like automation. While establishing and maintaining such arrangements is often costly and difficult, the good news seems to be that equity-enhancing cooperation could well lead to more efficiency as well.

This brings us to the conclusions my thesis has for that other set big distributive challenges for capitalist democracy: globalisation. Based on the economic approach to automation as a phenomenon driven by tasks and factor costs, there is a widespread idea of automation and offshoring as being functionally similar but competing challenges to Western labour markets. That is to say, firms looking to boost their competitiveness have the option to either substitute labour for capital domestically or exploit opportunities for international labour market arbitrage and organise production elsewhere (Sabel 1982; Baldwin 2019; Eeckhout 2021). While this argument intuitively makes sense, if we approach automation and globalisation from the perspective of a bargaining game over the parameters of production and distribution in the political economy, it becomes clear that these challenges are in fact quite distinct. In a world of increasingly footloose MNEs, offshoring production essentially means the political game gets transported as well, leaving labour with few political tools to assert its power. While automation and offshoring may *a priori* look quite similar, the political and institutional game they engender could not be more different.

This, finally, brings us to the link between my research and the nascent debate on market power which has asserted that there is a link between technological change, market concentration, and consequently rents captured by superstar firms, and many of the socioeconomic problems seen in many western democracies today. As I see it, there are roughly two versions of this story. The first is best captured by Autor *et al.* (2017) who assert that the rise of a new type of economy which is heavily reliant on intangible capital (Haskel and Westlake 2017) and network effects are leading to a skew in the adoption of cutting-edge productivity-enhancing technologies towards a so-called 'super-star' firms such as Google and Facebook. According to this argument, the winner-takes-all nature of the digital world has nudged us towards increased market concentration, in part based on uneven adoption of technology. In this version of events, we are witnessing increasing inequities mostly just as a result of a new type of highly capital intensive firms.

The second account, as presented by industrial organisation scholars like Phillipon (2017), De Loecker (2021) and Eeckhout (2021), on the other hand, proposes the central issue is not technology but the absence of serious supervision and competition enforcement. The resulting market concentration, even in traditional industries, is seen driving down the labour share, through the increased monopsony and monopoly power of dominant firms allowing them to accumulate the demand and productivity effects of automation as rents, as opposed to letting these gains accrue in the form of wage-income. The obvious implication of both arguments is that the key distributive tensions we are witnessing with regards to automation and technological change more broadly does not resolve around capital and labour as much as it does around a tiny subset of capital-owners and everyone else.

I want to preface my contributions to this debate by saying I think this is an extremely valuable and stimulating line of research, and that the data I used in my work does not fully allow me to directly engage with the arguments laid out by this literature. That being said, my research would suggest that the truth is somewhere in the middle of both sets of claims, in the sense that technology does too much of the heavy lifting in Autor's *et al.* (2017) analysis and too little for Eeckhout (2021). Let us start with Autor *et al.*. Clearly, the very technological structure of the knowledge economy presents capitalist democracy with some novel challenges, but recalling paper one forces us to consider not just how new technologies change market dynamics but also how concrete institutional factors such as corporate tax structures, data protection legislation and patent laws pave the way for these technologies to generate winner-takes-all markets in the first place. After all, it is likely *not* a coincidence we talk about 'Silicon Valley' and not the 'Silizium Tal'.

At the same time, arguments that focus on the importance of anti-trust enforcement probably put too much belief in the ability of competitive markets to produce Pareto-optimal outcomes with regards to automation. It is perfectly reasonable to assume more competitive markets could, among other things, lead to better (re)training, more easily turn structural technological unemployment into frictional unemployment, and promote a more normal distribution of income across firms. However, it is worth remembering that, as Frey (2019) so eloquently put it, even short-run adjustment costs can represent a lifetime for some workers. As a result, even below the veneer of macro-economic stability during the Golden Age of capitalism, relatively competitive markets still fostered tremendous anxiety about automation (just consider Lyndon B. Johnson's Commission on Technology, Automation, and Economic Progress).

This leads me to think that the relation between technology and market concentration is more nuanced than suggested by either part of the literature. Market concentration, as a development, is likely only tangentially related to automation - interacting but not enough to explain it, let alone fully explained by it. I would rather suggest we should consider market concentration, like automation, as a function of broader political-institutional settlements made over production and redistribution within the political economy. Doing so forces us to consider the impact, and complimentary, of a much wider range of institutions and the overall growth strategy they are calibrated for.

5.5 Limitations & Further Research

The conclusions of this thesis are subject to some caveats and limitations. In what follows I will discuss what might seem as some internal contradictions between the different papers, outline the remaining limits to this research and outline avenues for future work.

As with any project that tackles such a wide range of questions, there is some risk that the assumptions and implicit arguments in each of the papers might seem, at first sight, contradictory. Firstly, seeing how my first paper emphasised the different ways one technology was implemented might raise a fair concern regarding the second paper in this thesis, which only looks at adoption rates. The first point I want to make about this is a methodological one. These two papers rely on different methodologies which necessarily implies they have different strengths and drawbacks. While I cannot guarantee robots are used in the same way across different industries and countries, the goal of this paper was to provide an insight into adoption with a high level of external validity. This, almost necessarily, means foregoing some level of detail and nuance. However, there are reasons to think the question of different adoption strategies is perhaps less pressing for this paper. Robots, in contrast to credit scoring, are arguably a technology with a very well-defined use. The ISO (ISO 8373) definition specifically defines a robot as a "automatically controlled (...) manipulator (...) for use in industrial automation applications". While we can conceive of robots being used in ways other than automation, they are a technology specifically designed to automate discrete tasks in production in contrast to credit scoring which is more open-ended in nature.

A second, ostensible, contradiction emerges between the first and the third paper. The final paper in this Ph.D. applies a task-based logic as a strategy to identify workers in automatable occupations. This, seemingly, clashes with the conclusions of the first paper in this thesis which strongly argued routine tasks are neither a sufficient nor even a necessary condition for automation. How, then, is the application of this task-based identification strategy justifiable? I think there are two points to make here. First of all, while my findings suggest automation is not predicated on routineness, it nevertheless is an excellent proxy for predicting the risks associated with labour-saving technical change. Routine tasks simply are more *easily* automated on a technical level while workers in highly routine occupations also tend to have fewer power-resources to 'fight back'.

Secondly, and most importantly, the validity of the results on electoral behaviour in the third paper hinges on *perceptions of automation risk* as opposed to *objective automation risk*. This is a very important distinction. Since we have to assume voters are only activated by issues they perceive as salient, what matters most is the degree to which they *believe* their jobs are at risk as opposed to potentially material risks that remain below the waterline. I, therefore, think the approach in the final paper is justifiable since we know from prior research (Dekker *et al.* 2017; Heinrich and Witko 2021) that task-based measures correlate very highly with workers' perceptions of automation risk to their jobs.

While I believe my arguments to be internally cohesive, there are nevertheless some important limitations to the argument presented here (on top of the ones already identified in each paper). First of all, this thesis has examined automation in a specific type of political economy; advanced capitalist democracies (ACDs). While this focus is largely warranted considering the relative concentration of advanced automation within ACDs, it should be clear that labour-saving technological changes also take place within non-democratic and non-capitalist polities. This means that there is likely some limitations to the generalisability of my argument, particularly in as far as that it relies on the interplay between capitalism and democracy. That being said, there are good reasons to believe that the broad contours of a politically driven understanding of automation likely transcend ACDs. In fact, we should expect politics, (informal) institutions and well-considered growth strategies to be a particularly important driver of the adoption of technologies in non-market societies, which almost by definition tend not to allocate resources based on efficiency. We just have to recall the famous anecdote of Milton Friedman (ironically) advising the Chinese government that digging canals using spoons would expand the need for labour, upon being told of their unwillingness to use machinery, in order to imagine how this might play out.

Secondly, within the universe of ACDs this thesis has had a further focus on (Western) European societies. As a result my research, therefore, did not examine notably highly automated ACDs such as Japan and South Korea. This, again, limits the external validity of my findings. However, as in the case of non-ACDs there is some reason to be optimistic. Just consider the case of Japan which has some of the highest automation rates in the world. Here, manufacturing, retail and even personal services have been automated to a significant extent. While it is undoubtedly true that most of the activities that were subject to this transition were routine in nature, one of the key reasons labour-saving technical change has advanced to such a great extent in Japan is the confluence of a rapidly ageing population with a strong political resistance to the import foreign labour. The Japanese government has therefore provided massive support for R&D in robotisation in an attempt to stabilise output in the face of a declining working-age population. This not only means automation in Japan is driven by a broader politically driven growth strategy, underpinned by the labour market and innovation institutions, but also that automation has a relatively limited short-term impact on workers.

This brings us neatly onto some avenues for further research. One obvious issue that has received little attention in this thesis is the role of governments. The politics of production and distribution in capitalist democracies takes place in the sphere of producer group politics on the one hand and electoral/governmental politics on the other (Downs 1957; Schattschneider 1960; Hall 2021). Both the first and the final paper of this thesis shed light on aspects of this second dimension, but no systematic analysis was done investigating the role of government action. This undoubtedly is an untapped area that could further help to shed light on some of the conclusions of this thesis. Further research on the effects of government intervention, but also the economic and electoral preconditions of such action, on automation in ACDs would therefore be a logical next step. What would be particularly interesting is further qualitative research examining the interaction between governments and industrial relations institutions.

Similarly, another potentially fruitful line of research could examine the role of political parties in the process of labour-saving technological change. As should be evident from the final piece of this thesis, there has been plenty of research focused on the electoral consequences of automation. Yet, the supply-side politics of this story on the other hand has so far not been subject to the same amount of attention. It remains somewhat unclear if, when and how parties pick up these issues to put them on the political agenda. Future research could therefore combine in-depth case studies with newly available text-as-data methods to study party manifestos and parliamentary records to get at these open questions.

Finally, the COVID-19 epidemic has made extensive field research in firms, unions and other industrial relations institutions impossible. This means that the high-level findings in the second paper have predominantly relied on existing empirical and theoretical contributions to derive their substantive conclusions. Future research could therefore focus on in-depth analyses of shopfloor politics surrounding automation, skill attainment, job security as well as their interaction with labour market institutions. These remain salient topics that, especially with the advent of Industry 4.0., merit further research.

5.6 Final Conclusions

The question of how we produce and distribute wealth is central to the operation of the political economy. For capitalist democracies, the principle that guides this nexus is that resources should be allocated efficiently, but also in such a way as to benefit the majority of the population. It goes without saying that these two ideas are often at odds with each other, leading to conflict and political strife.

While some of these areas of conflict may be trivial to the existence of the system, capitalist democracy simply cannot afford to get others wrong. Automation, I think, falls into this latter category. Labour-saving technological change, on the one hand, is crucial because it is a key lever of productivity growth that, over the course of the last centuries, has paved the way to a more robust economy that, all else being equal, provides better and more fulfilling work and higher standard of living for its citizens. There is little reason to believe we should not expect this to continue in the future. Automation, however, is also contentious. The benefits it provides over the long-run, when left unregulated, tend to go hand-in-hand with short-term Pareto-inefficiency as some are forced out of work, or find their skills severely devalued with the advent of new technologies.

In this thesis, I analysed automation from a comparative point of view by examining how this process of labour-saving technological change unfolds across different countries and interacts with national institutional contexts and electoral behaviour. Doing so allowed me to hold existing accounts on automation up to the light. Far from being a process that follows a deterministic pattern, I found that automation is driven by institutional and political factors and therefore highly context-specific. Automation it turns out, presents itself as a problem of time inconsistency to capitalist democracies. As a result, its development is part of the broader institutional settlement on questions of production and distribution.

Labour-saving technological change, from this point of view, is not just a question of innovation and production but also one of redistribution. This means our collective future welfare does not simply hinge on the technologies we can come up with, but also on the political environment in which they will operate. As governments across Europe drool over the possibilities of, the much-touted, Industry 4.0, it is therefore worth remembering productivity and prosperity in ACDs is likely to depend as much on the political settlement surrounding any transition as it will on the imagination of engineers and the brute force of innovations they can conjure up.

Appendix A

This Appendix provides supporting information for paper 1: *(De)Regulating automation: the rise of credit scoring and market-led banking in the UK and Germany.*

A.1 Descriptives

A.1.1 List of interviewees

Interviewee	*Function*	*Date*	*Type*
Interviewee 1	Corporate Historian Barclays Bank	25/01/2019	In person
Interviewee 2	Head of Archive and Museums Lloyds bank	08/03/2019	In person
Interviewee 3	Former employee Deutsche Bank and Dresdner Bank	18/11/2019	Telephone
Interviewee 4	Former branch manager UK	5/12/2019	Telephone
Interviewee 5	Former senior employee Barclays bank	10/12/2019	Telephone
Interviewee 6	Senior official Landesbanken consortium and former branch manager	15/12/2019	In person

Appendix B

This Appendix provides supporting information for paper 2: *Conflict or Cooperation? Exploring the Relation Between Cooperative Institutions and Robotisation in the OECD.*

B.1 Descriptives

Table B.1.1 Summary statistics

Variable	*Obs.*	*Mean*	*Std. Dev.*	*Min*	*Max*	*Source*
Robot Density (log)	3122	3.06	1.87	-3.77	7.26	IFR + OECD STAN
Cooperative Index	4906	0.47	0.22	0.04	0.80	Own calculations
Regular Involvement	4915	1.10	0.65	0	2	ICWTSS
Wage Coordination	4915	2.62	1.36	1	5	ICWTSS
Bargaining Coverage	4915	61.57	29.73	7.7	100	ICWTSS
Sectoral Institutions	4915	1.22	0.80	0	2	ICWTSS
Works Councils	4906	1.37	0.76	0	2	ICWTSS
Price of labour (log)	4134	2.79	0.82	-1.10	4.30	OECD STAN
Price of capital (log)	4915	-0.82	1.51	-6.68	.92	Penn Tables
Output (log)	4854	9.70	1.98	1.98	3.94	OECD STAN
Value added (%)	4854	0.32	0.07	0.11	0.66	OECD STAN
Share of 15-64 (%)	4915	67.00	1.78	62.59	72.41	OECD STAN
Growth rate (%)	4906	2.49	3.21	-14.81	25.16	OECD STAN
Social expenditure (%)	4805	21.59	4.72	0	34.1	OECD
EPL	4914	0.34	0.128	0	0.64	OECD
MDMH	4914	15.86	29.30	0.90	150	Beck et al. 2001
Labour share (%)	4915	0.57	0.05	0.33	0.72	OECD STAN
Hours worked (log)	4134	5.37	1.60	1.37	10.55	OECD STAN

Table B.1.2 Classification of sectors based on ISIC Rev. 4 and robot density

Sector	*ISIC Code*	*Robot density*
Food, beverages and tobacco	10-12	51.8
Textiles, wearing apparel, leather and related	13-15	19.6
Wood, paper products and printing	16-18	24.3
Chemical, rubber, plastics, fuel-products mineral products and other non-metallic	19-23	109.5
Basic metals and fabricated metal products, including machinery and equipment	24-25+28	51.8
Electric, electronic and optical equipment	26-27	67.6
Transport equipment	29-30	468.5
Furniture, other manufacturing	31	21.8

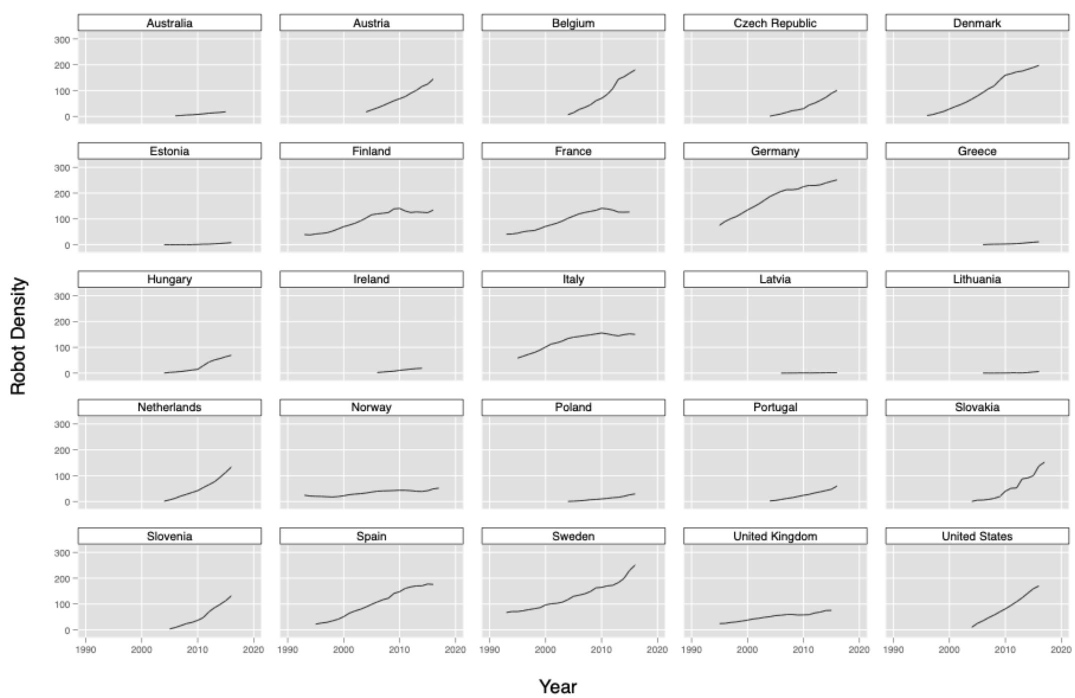

Figure B.1.1 Evolution of robot density (log) by country
Source: Author's own calculations based on International Federation for Robotics and OECD

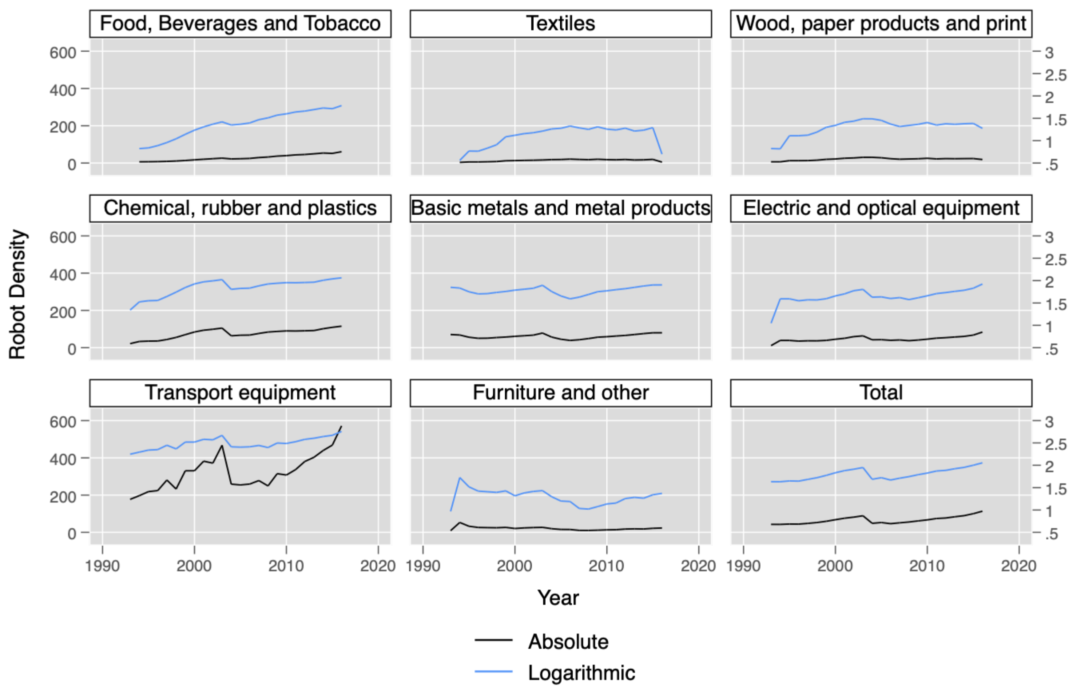

Figure B.1.2 Evolution of robot density by sector
Source: Author's own calculations based on International Federation for Robotics and OECD

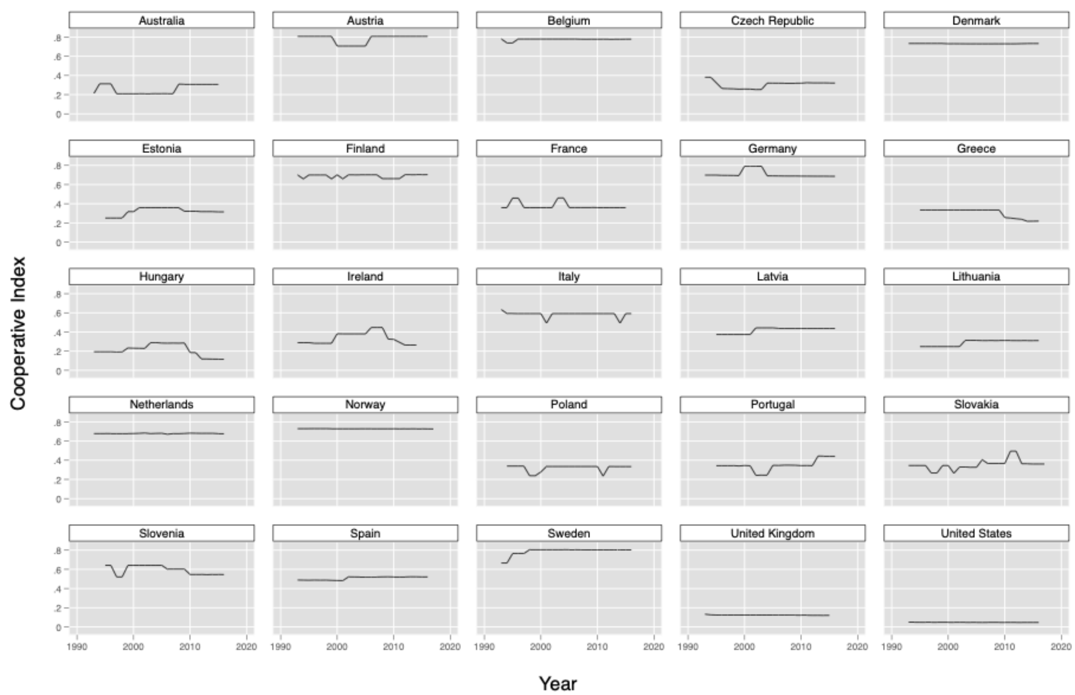

Figure B.1.3 Evolution of the Cooperative Index by country
Source: Author's own calculations based on ICTWSS

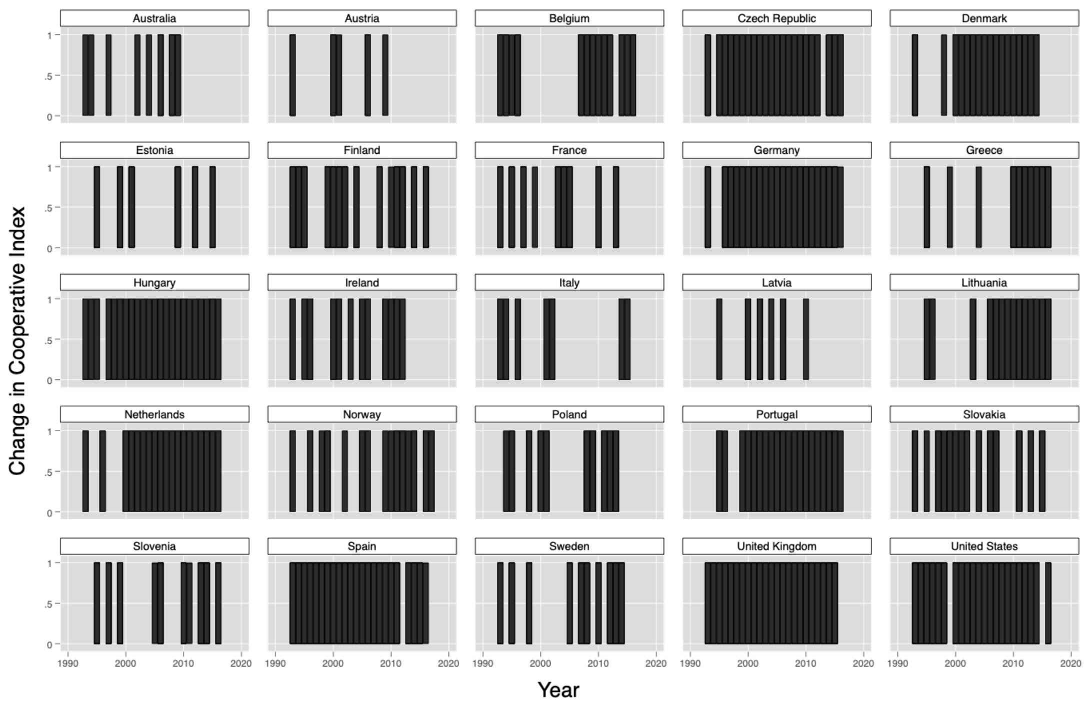

Figure B.1.4 Incidence of change in the Cooperative Index by country
Source: Author's own calculations based on ICTWSS

B.2 Diagnostics

B.2.1 Chronbach's Alpha for the cooperative index elements

Item	*Obs.*	*Sign*	*Item-test corr.*	*Item-rest corr.*	*Average interim corr.*	*Alpha*
Wage coordination	4915	+	0.7153	0.5515	0.5790	0.8462
Bargaining coverage	4915	+	0.8024	0.6771	0.5215	0.8134
Regular involvement	4915	+	0.7721	0.6324	0.5414	0.8252
Sectoral institutions	4915	+	0.8570	0.7606	0.4855	0.7906
Works councils	4915	+	0.8025	0.6770	0.5216	0.8135
Test scale					0.5298	0.8493

Table B.2.2 Variance inflation factors baseline model

Variable	*VIF*
Cooperative index	3.51
Price of labour (log)	4.32
Price of capital (log)	1.28
Output (log)	1.90
Value added (log)	1.28
Share of 15 to 64 (%)	2.52
Social expenditure (%)	2.48
EPL	2.18
MDMH	1.48
Mean VIF	1.47

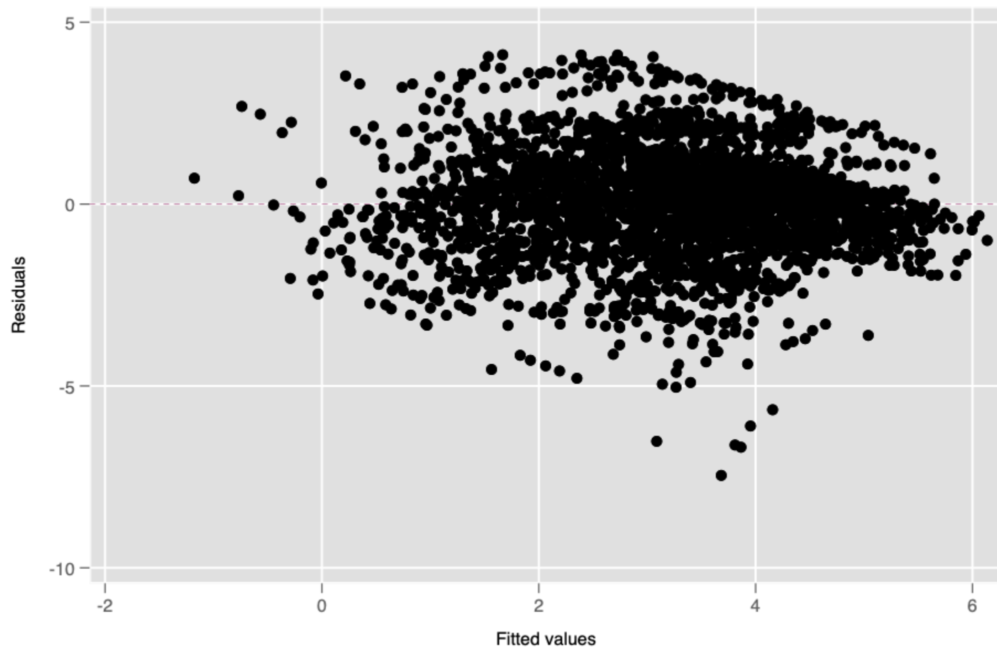

Figure B.2.1 Residuals of the baseline model versus fitted valued

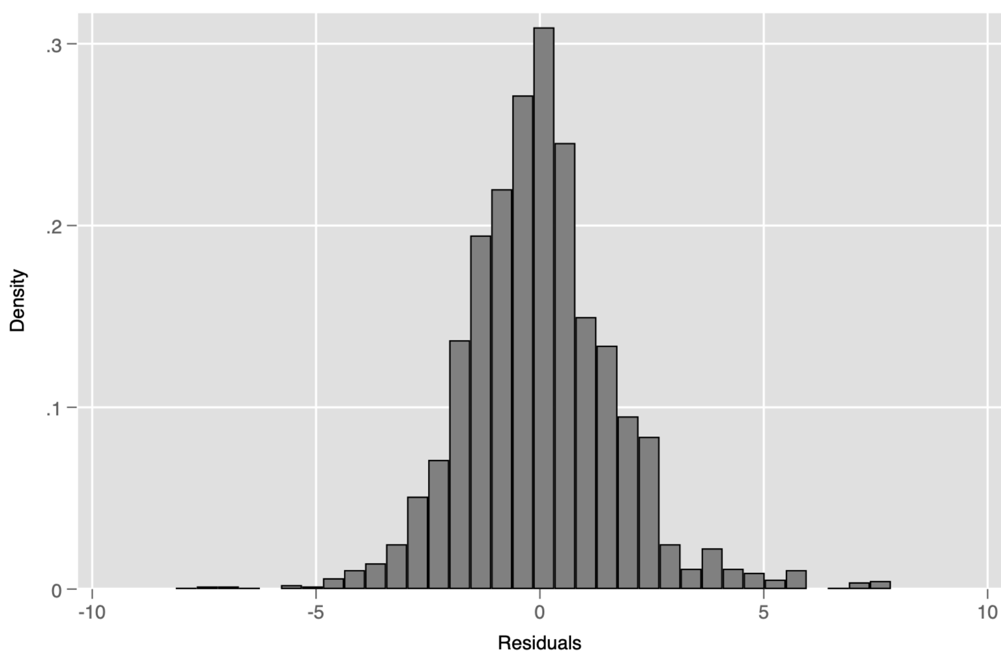

Figure B.2.2 Histogram of residuals for the baseline model

B.3 Robustness tests

Table B.3.1 Robustness tests

	(1) Alt. IV	(2) Alt. DV	(3) Exc. Auto.	(4) L +1	(5) L +3	(6) Jackn.	(7) Bootstr.	(8) Mixed-Eff.
Jahn	0.369*							
	(0.149)							
Cooperative index		1.797**	2.080**	1.531*	1.750*	1.765*	1.765**	1.835*
		(0.651)	(0.687)	(0.690)	(0.678)	(0.679)	(0.657)	(0.887)
Constant	0.394	-0.509	-0.255	4.857	-2.873	1.415	1.415	0.296
	(5.285)	(5.374)	(5.414)	(5.087)	(5.260)	(5.601)	(5.599)	(9.393)
Var(Country)								-0.263
								(0.497)
Var(Sector)								0.221***
								(0.0663)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
N	2,762	2,773	2,446	2,845	2,687	2,773	2,773	2,773
Country-Sector	199	199	176	199	199	199	199	199
R2	0.51	0.52	0.51	0.52	0.51	0.51	0.51	0.61

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

B.4 Full estimations

Table B.4.1 Estimations for individual institutions

	(1) No Controls	(2) Controls	(3) Country FE
Regular involvement	-0.0490	0.311**	0.689***
	(0.179)	(0.136)	(0.143)
Wage coordination	-0.238	-0.423*	-0.445
	(0.282)	(0.255)	(0.315)
Bargaining coverage	-0.0468	-0.712***	-1.346***
	(0.304)	(0.254)	(0.354)
Sectoral institutions	1.920***	1.421***	1.380*
	(0.314)	(0.237)	(0.759)
Work councils	1.096***	1.020***	1.092***
	(0.290)	(0.205)	(0.258)
Constant	0.537	-3.470	-0.165
	(0.416)	(3.563)	(5.071)
Year FE	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes
Country FE	No	No	Yes
Controls	No	Yes	Yes
N	3012	2773	2773

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table B.4.2 Estimations for normal times vs recessions

	(1) Normal times	(2) Recession
Cooperative Index	2.444***	-2.128**
	(0.621)	(0.828)
Price of labour	0.803**	0.132
	(0.361)	(0.322)
Price of capital	0.172	-0.913***
	(0.271)	(0.304)
Output	0.361**	0.0930
	(0.151)	(0.112)
Value-Added (%)	1.195	-0.231
	(1.218)	(0.814)
Share 15-64 (%)	-0.121*	-0.117*
	(0.0675)	(0.0706)
Growth rate (%)	-0.0587***	-0.00360
	(0.0144)	(0.00881)
Social expenditure (%)	0.0358	-0.0695**
	(0.0262)	(0.0278)
EPL	-0.948	-2.716***
	(0.965)	(0.563)
Constant	1.718	1.128
	(5.144)	(2.145)
Year FE	Yes	Yes
Sector FE	Yes	Yes
Country FE	Yes	Yes
Country-Sector Clusters	196	177
N	2,070	703

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

B.5 Marginal effects

This paper contends that automation follows institutional lines in the advanced capitalist world. If that is the case, we might also expect the effects of key indicators (like wages and labour supply) to have differing effects on automation according to the institutional system they are in. To further gauge how sensitive robotisation is to relative changes in market conditions in these different institutional settings, a series of interaction effects was therefore computed. Plotting the average marginal effects of these estimations gives us some indication to what extent robotisation is a 'market-led' process depending on the level of cooperation in the economy. While these results are not all statistically significant, it is worthwhile noting that the marginal effects of our key factor cost variables (prices of labour and capital) are highest in more liberal settings. This not only means that the expected effect of a one-unit change in factor costs is conditional on the institutional setting, but also that robot density is expected to react more strongly to that change in liberal settings. What is more, robotisation also seems to be more sensitive to changes in the labour supply in those countries. These results add credibility to our previous findings as they suggest robotisation is a far more 'marketised' process, reacting more straightforwardly to price-signals, in liberal economies than it is in cooperative settings.

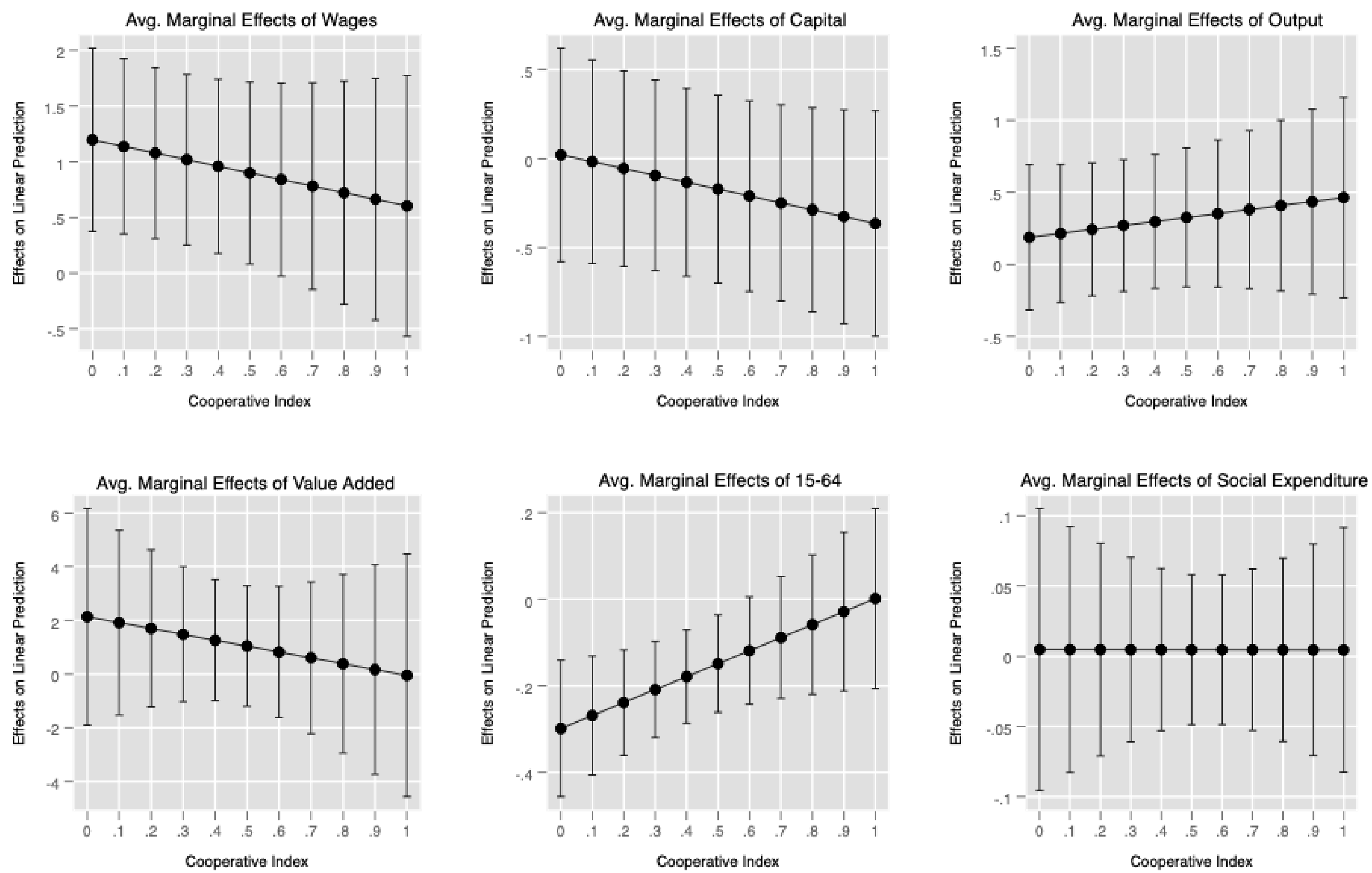

Figure B.5.1 Average marginal effect of key indicators by level of institutionalised cooperation

Appendix C

This Appendix provides supporting information for paper 3: *It's the robots, stupid? Automation risk, labour market security and incumbent support in Europe.*

C.1 Descriptives

Table C.1.1 Summary statistics

Variable	*Mean*	*Std. Dev.*	*Min.*	*Max.*	*N*	*Source*
Incumbent support	0.133	0.339	0	1	273221	ESS
Frey & Osborne	0.561	0.337	0.004	0.99	203780	Frey and Osborne (2017)
Years of education	12.807	4.206	0	25	273276	ESS
Income decile	5.414	2.76	1	10	146436	ESS
Age	49.556	17.557	14	123	271800	ESS
male	0.483	0.5	0	1	272489	ESS
Urban	0.635	0.481	0	1	272141	ESS
Religiosity	4.521	3.037	0	10	270647	ESS
Type of contract	0.761	0.427	0	1	232758	ESS
Co-determination	4.129	3.628	0	10	239389	ESS
Robot exposure	1.459	1.926	0.002	28.532	143304	IFR and OECD
Real growth (%)	0.01	0.144	-0.708	2.355	96998	ESS Context
Net migration (%)	2.645	4.053	-26.1	24.1	141964	ESS Context
Unempl. rate 15-74 (%)	8.268	4.969	1.3	37	143126	ESS Context
Arntz-index	0.127	0.134	0	0.574	44143	Arntz *et al.* (2017)
Father's occupation	5.821	2.428	1	9	157803	ESS
Attitude to migration	4.874	2.43	0	10	262868	ESS
Goverenment Deficit	-3.12	4.47	-32.2	4.2	183056	Eurostat
$\Delta Debt-to-GDP$	1.75	5.91	-27.5	27.7	152581	Eurostat
Ofshoring index	23.59719	31.57347	0	100	269902	Rommel and Walter (2017)

Table C.1.2 List of governments

Country	*Government*	*ESS Wave*
Austria	SPÖ/FPÖ	6,7,8
Austria	FPÖ/ÖVP	9
Belgium	CD&V/CDH/VLD/MR/PS	6
Belgium	CD&V/CDH/VLD/MR/PS/SPA	7,8,9
Czech Republic	ODS/TOP/VV	6,7
Czech Republic	CSSD/KDU/CSL	8
Czech Republic	CSSD/KDU/CSL/ANO	9
Denmark	Venstre/C	6
Denmark	SD/RV	7
Estonia	PP-RP/SD	6
Estonia	Reform/PP-RP/SD	7
Finland	NC/GL/SP/C	6
Finland	SD/LA/GL/CD/NC/SP	7
Finland	SD/NC/GL/CD/SP	8
Finland	SD/GL/LA/C/SP	9
France	UMP	6,7
France	PS	8,9
Germany	CDU-CSU/SPD	6
Germany	CDU-CSU/FPD	7,8
Germany	CDU-CSU/SDP	9
Hungary	MSZP	6,7
Hungary	Fidesz/KDNP	8,9
Ireland	FF/PD/Green	6,7
Ireland	FG/Lab	8
Ireland	FG/Ind	9
Italy	PDL/PD/UDC/FLI/ApL	6,8
Italy	PD/NCD-AP/CPE	9
Netherlands	CDA/CU/PvdA	6
Netherlands	VVD/CDA	7
Netherlands	VVD/PVDA	8,9
Poland	CP/PP	6,7,8,9
Portugal	SP	6,7
Portugal	CDS/SD	8,9
Slovakia	SDKU-DS, SaS, KDH, Most-HiD	6
Slovakia	SMER-SD	9
Slovenia	SDS/NSI/DESUS/SLS/DL	6
Slovenia	DESUS/SD/PS/ZAAB/DL	7,8
Slovenia	SMC/SD/DESUS/Ind	9
Spain	PSOE	6,7
Spain	PP	8,9
Sweden	M/C/L/CD	6,7,8
Sweden	G/SD	9
UK	Lab	6
UK	Cons/LDem	7
UK	Cons	8,9

Source: Based on own research

C.2 Diagnostics

Table C.2.1 Collinearity Diagnostics

	VIF	SQRT VIF	Tolerance
Automation	1.22	1.10	0.821
Income	1.26	1.12	0.793
Education	1.14	1.07	0.879
Age	1.03	1.01	0.972
Gender	1.02	1.01	0.976
Urban	1.02	1.01	0.981
Religiosity	1.03	1.01	0.973

Table C.2.2 Model fit and specification diagnostics

	Linktest
Hat	.9990993***
	(.0351941)
Hat-SQ	-.0004498
	(.0154466)

Linktest and Fittest both test the model specification. Linktest test the idea that if the regression equation is correctly specified, no additional independent variables should be significant above chance. The test specifically looks of link errors where the dependent variable needs to be tranformed to accurately relate to the independent variable. The fact that Hat is significant but Hat-squared is not suggests the model is well-specified in this instance.

C.3 Robustness test and other results

Table C.3.1 Main interaction results

	(1) Incumbent	(2) Incumbent	(3) Incumbent
F&O	-0.673***	-0.251**	-0.129*
	(0.150)	(0.0953)	(0.0651)
Education	0.00352	0.0234***	0.0166***
	(0.00552)	(0.00398)	(0.00365)
Education*F&O	0.0367***		
	(0.00992)		
Contracttype		0.172**	
		(0.0626)	
Contracttype*F&O		0.140	
		(0.102)	
Co-determination			0.0362***
			(0.00621)
Co-determination*F&O			0.0135
			(0.0102)
Constant	-3.121***	-3.346***	-3.488***
	(0.474)	(0.507)	(0.480)
Wave FE	Yes	Yes	Yes
Election FE	Yes	Yes	Yes
Region FE	Yes	Yes	Yes
N	42034	48054	48309

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table C.3.2 Robustness tests

	(1) Arntz *et al.*	(2) Occupational FE	(3) Sector FE	(4) Fiscal	(5) Fiscal	(6) Offshoring	(7) Migration Att.	(8) Soc. Background	(9) W-EU
Arntz	-0.843***								
	(0.161)								
F&O		-0.149**	-0.138***	-0.138***	-0.133***	-0.151***	-0.130***	-0.106**	-0.105*
		(0.0504)	(0.0368)	(0.0368)	(0.0371)	(0.0368)	(0.0371)	(0.0386)	(0.0422)
Gov. Deficit				0.772*					
				(0.321)					
Debt %gdp					0.0125				
					(0.0115)				
Offshoring						0.00147***			
						(0.000357)			
Immigr. Attitudes							0.0207***		
							(0.00521)		
Occupation Father								-0.00968	
								(0.00548)	
Constant	-2.071***	-2.783***	-3.370***	-1.602***	-2.277***	-3.366***	-3.442***	-2.871***	-3.239***
	(0.210)	(0.476)	(0.470)	(0.332)	(0.155)	(0.469)	(0.472)	(0.484)	(0.470)
Wave FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Election FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Occupation FE	No	Yes	No	No	No	No	No	No	No
Sector FE	No	No	Yes	No	No	No	No	No	No
N	19032	48309	48309	48309	47712	48309	47541	42872	35371

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table C.3.3 Regional automation risk estimations

	(1) incumbent	(2) incumbent	(3) incumbent	(4) incumbent
F&O	-0.180***	-0.125*	-0.291***	-0.107*
	(0.0469)	(0.0500)	(0.0694)	(0.0477)
Robot Exposure	-0.00454			
	(0.0105)			
F&O*Robot Exposure	0.0142			
	(0.0153)			
Migration Rate		0.00993		
		(0.00593)		
F&O*Migration Rate		-0.00832		
		(0.00862)		
Unemployment Rate			-0.000407	
			(0.00650)	
F&O*Unemployment Rate			0.0181*	
			(0.00783)	
Growth Rate				0.113
				(0.183)
F&O*Growth Rate				-0.590*
				(0.285)
Constant	-3.119***	-3.225***	-3.165***	-2.695***
	(0.440)	(0.444)	(0.447)	(0.465)
Wave FE	Yes	Yes	Yes	Yes
Election FE	Yes	Yes	Yes	Yes
Region FE	No	No	No	No
N	42,958	42,354	42,865	28,986

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

C.4 Automation risk

The Frey and Osborne (2017) index (F&O) used here relies on three steps to measure the automation risk faced by individual occupations. Firstly, Machine Learning researchers at the Oxford University Engineering Sciences Department were asked to assess the automatability of a range of tasks. Using 2010 task data in the O*Net dataset researchers where asked to indicate whether discrete tasks can be "sufficiently specified, conditional on the availability of big data, to be performed by state of the art computer-controlled equipment." Secondly, Frey and Osborne identify 9 engineering bottlenecks: 1. finger dexterity 2. fine arts 3. cramped work space and awkward positions 4. fine arts 5. originality 6. social perceptiveness 7. persuasion 8. assistant and caring for others. The same O*Net data about occupational task-contents as well as measures of the approximate complexitity of those tasks, is used to fully determine the automatability of 70 occupations within the 2010 Standard Occupational Classification System (SOC). The automatability of remaining occupations is based on the features of these original 70 occupations.

The F&O, however, is not perfect. Arntz *et al* (2016) argue that there are two key problems with this indicator (see also Im *et al.* (2019) for a good discussion). The first issue is that the indicator assumes task structures are universal within occupations. The second drawback is that it assumes similarity of task structures across countries. Related to this, I think there is a third potential issue. Frey and Osborne use U.S. data to infer automatability, while it is not *a priori* obvious global tasks contents overlap perfectly with O*Net findings. While the Arntz *et al.* indicator tries to overcome some of these drawbacks using Autor and Handel's (2013) insight that task structures are different within occupations, I nevertheless decide to use the F&O. Firstly, as pointed out before, the Arntz *et al.* indicator has inferior case coverage. This is an inherent problem for the any comparative work since it limits external validity (which is the main point of attraction for cross-country analysis). See Figures C.4.1 and C.4.2 for an idea of the overall distribution of automation risk in the ESS according to the F&O. Finally, there is a potential other issue with this approach to measuring automation anxiety: stress can come from more than occupational task-structure. Voters might be anxious about their labour market position as a result of both the task content of their job *or* the prevalence of automation in their direct surroundings.

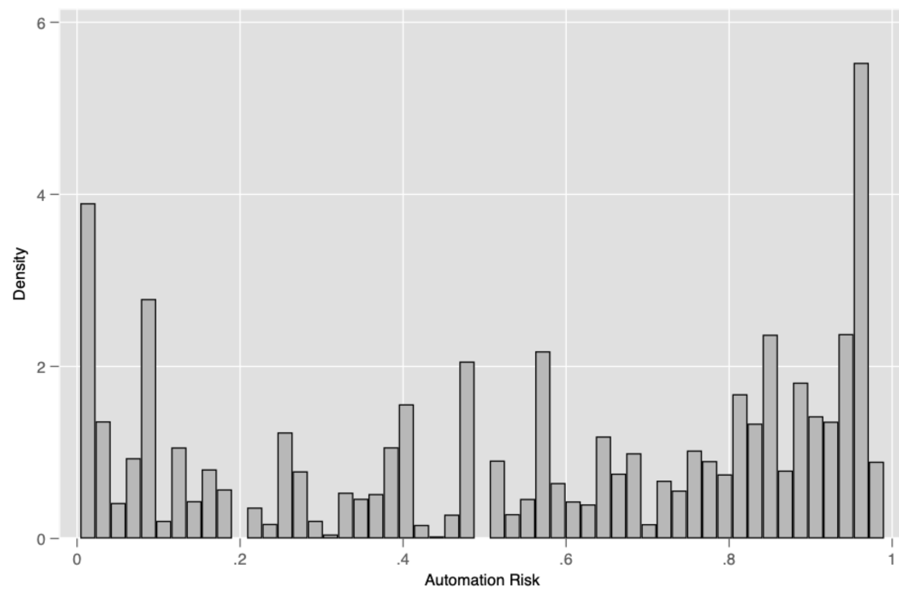

Figure C.4.1 Aggregate distribution of occupational automation risk in the ESS
Source: Author's own calculations based on Frey and Osborne (2017)

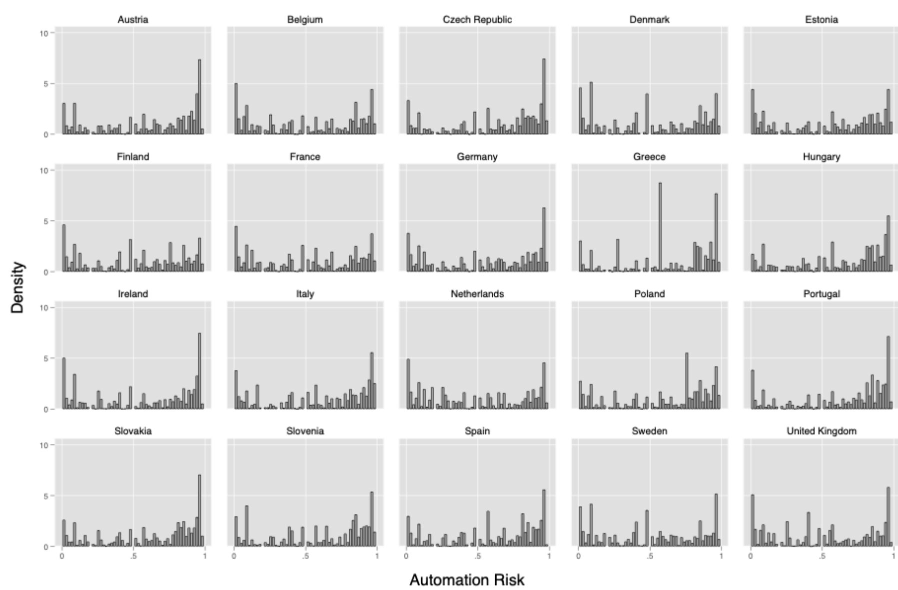

Figure C.4.2 Distribution of occupational automation riks in the ESS by country
Source: Author's own calculations based on Frey and Osborne (2017)

Being aware of the possible limitations of the F&O and the approach as a whole, I therefore conducted further robustness tests (as outlined previously). Firstly, I test my baseline model on a more limited sample using the competing Arntz *et al.* (2016) index. Secondly, in line with Acemoglu and Restrepo (2018) as well as Anelli *et al.* (2022), I compile a robot exposure indicator which I run alongside my baseline models. This measure is compiled using International Federation for Robotics (IFR) data on the number of operational robots in country-sectors for each year and OECD data on regional demography and sectoral employment. Formally this indicator looks like:

$$RobotExposure_{crt} = \sum_{j} \frac{L_{crjt}}{L_{crt}} * \frac{R_{cjt}}{L_{cjt}} \tag{1}$$

Where the penetration of robotisation in country C, region R and year T is a function of the mean of the number of robots R for each sector S in that country-year over the number of workers employed in that sector, normalised by the proportion of the working population of region R employed in sector S. Conceptually, this measure captures the regional level (at NUTS2) penetration of robots in the economy by capturing sector level robot density (i.e. robots per worker) and the importance of automated sectors for overall regional employment. The methodological aim of this construct is twofold. Firstly, it primary use is to parcel out different sources of politically salient automation risk. Robustness test including this measure therefore check for this potentially important dimension. Secondly, however, this regional measure is useful to complement the lack of cross-country variation inherent in the F&O. See Figure C.4.3 to get in idea of the distribution of this measure at the country-level.

It is also worth re-emphasising that the use of automatability measures, and the F&O in particular, restricts the historical scope of this inquiry. As I already indicated, the F&O is based on the most recent international classification of occupations scheme (ISCO 08), meaning transposing it onto waves employing older versions (even with correspondences) is likely to lead to some empirical slippage. However, there is a potentially even more important reason to be cautious about using the F&O for historical data having to do with the underlying methodology. That is to say, since the F&O is based on expert judgement and the determination of technical bottlenecks (both of which are *future* oriented assessments of risk) it is likely strongly over-estimate occupational risk for prior periods as they are based on *current* and therefore more advanced technical capabilities than would be present in the past.

Assuming the approach in this paper usefully measures automation risk, there could still remain some questions regarding to 'what' kind of jobs it is categorising as high risk. More concretely, there might be some worry that the F&O measure is actually just another way of measuring 'bad jobs'. I believe there is some reason to think this is not an issue. Firstly, at a theoretical level, we know that much of the impact of automation has firmly been concentrated in the middle of the labour market. In fact, literature on the link between labour market polarisation and automation has pointed out labour-replacing technical change likely has *contributed* to precarity of lower skilled jobs as middle-skilled workers were forced to descend the occupational ladder in search for new jobs (Goos and Manning 2009; Autor and Dorn 2011). At the same time, data within the ESS can give us some confidence that the relation between overall job quality and job-automatability is not so pronounced. Figure C.4.4 plots respondents mean satisfaction with job, work-life balance and salary by occupation. While we see some negative correlation between job and worklife satisfaction with automation, this plot gives us some confidence that the relation is not very pronounced. To the extent that it might give cause for concern, the inclusion of controls for education and income (as well as the inclusion of the interaction effects for labour market resources) should account for this dimension.

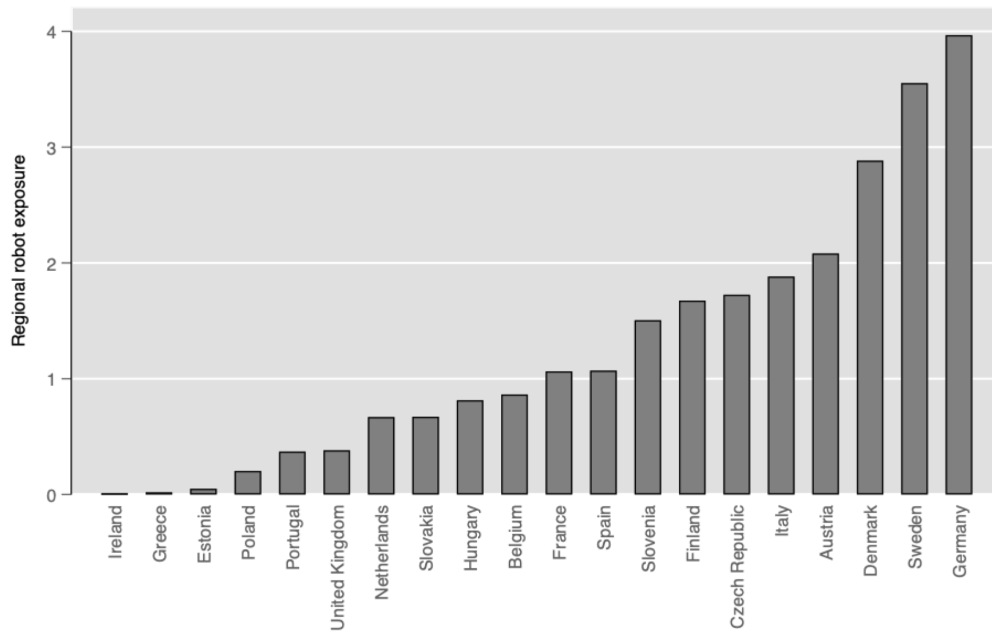

Figure C.4.3 Aggregate robot exposure by country
Source: Author's own calculations based on Anelli *et al.* 2022

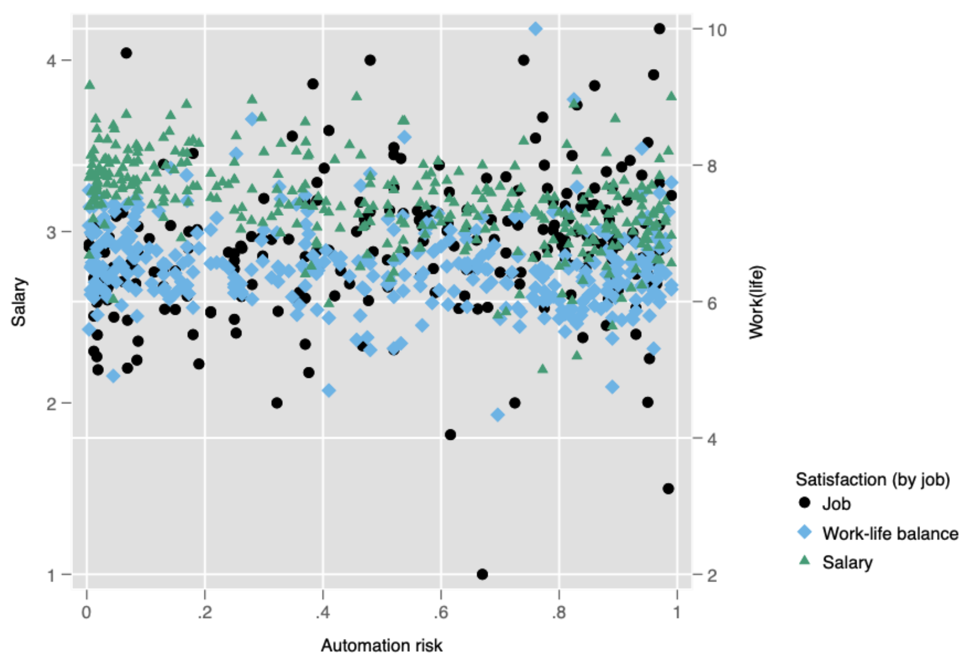

Figure C.4.4 Scatterplot of mean satisfaction with job, work-life balance and salary by job category and automation risk
Source: Author's own calculations

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