

SHAPING SUSTAINABLE EMPLOYMENT RELATIONSHIPS IN THE AGE OF DIGITALISATION: ANALYSING POLICY MEASURES IN AN AGENT-BASED FRAMEWORK

WORKING PAPER

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ABSTRACT

In this paper, we argue that the degree of potential benefits derived from the process of digitalisation depends on the institutional environment implemented in the digital sphere. The digital field offers entirely new perspectives and possibilities that might have the power to alleviate many processes especially with regard to labour and to restructure existing employment relationships.

We argue that political action of unionisation and compromising requires some degree of trust and reciprocity between actors to be established in the digital sphere. This is necessary in order to establish and strengthen a model of social partnership in the digital sphere, that has proven to be a successful tool in negotiating adequate employment relationships and working conditions. The aim of this paper is to shed some light on the interconnectedness of individual behavioral traits, social norms and the degree of contractable information in a path-dependent evolutionary process in an agent-based framework. Building on an evolutionary game theoretical model by Bowles (2004) we show how different social norms of trust and reciprocity emerge in the context of complete and incomplete information and vice versa. The model features both firms (employers) and workers (employees) and focuses on their interaction on the labor market. It is used to analyze how (1) social norms change and which behavioral traits emerge when the prevailing type of contract is changed. Furthermore, (2) different policy alternatives including union action and government intervention will be analyzed.

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1 Introduction

When a sphere that has not been part of the economic sphere is about to be subordinated by the latter, this always comes with great new opportunities on the one and new risks on the other hand. Digitalisation is an example for such a transformative process — the digital sphere is nowadays frequently used to enable economic interaction and negotiation processes. The possible advantages of this development are manifold, so are, however, its potential risks. In this paper, we study the process of digitalisation as a transformative process, that augments the spectrum of governance modes for transactions and contracting, leading to an "evolution of capitalist institutions itself" (Davidson et al., 2018, p. 653). We further argue that the actual potentials exploited of this transformation, strongly depend on the institutional structure implemented in the digital sphere. This is illustrated by taking the labour market and employment relationships as an example of contracting in which social norms of trust are a crucial component. It seems unlikely that a transition of employment relations to the digital sphere will turn out to be more efficient and beneficial to society simply by transferring economic ties and positions to this new sphere. Rather, in order to prevent uncontrolled and unwished for shifts of power, it is crucial to actively shape and re-shape the process of ongoing digitalisation. This is especially true when it comes to the labour market, where tendencies of a structural re-organization have become especially clear. A shift of working space is strongly related to constructing a (new) working environment and therefore subject to managerial control (Heiland, 2021). On the other hand, the digital field offers entirely new perspectives that might have the power to alleviate many processes especially with regard to labour and to restructure existing employment relationships. This however will only be possible if (1) this is regarded as such and if (2) power shifts toward employers are averted. In order to prevent developments that go to the disadvantage of the employee, vigorous political action is necessary.

In the following contribution, we argue that such action — whatever form it might specifically take — requires some degree of trust and reciprocity to be established in the digital sphere. Only then will it be possible for workers to unionize and to find compromises that can include discriminated groups instead of being subordinated to decisions of the currently dominating parties. This is necessary in order to establish and strengthen a model of social partnership in the digital sphere, that has proven to be a successful tool in negotiating adequate employment relationships and cooperative working conditions in a non-digital work environment (e.g. Behrens and Helfen, 2016; Bélanger and Edwards, 2007). An institutional structure that fosters cooperation within the production process furthermore establishes a fair and reciprocal relationship between employers and employees (e.g. Carpenter et al., 2009). The aim of this paper is therefore to shed some light on the interconnectedness of individuals behavioural traits, social norms and the degree of information in employment contracts in a path-dependent evolutionary process. Building on a model by Bowles (2004), we aim to show how different social norms emerge in the context of complete (sales) and incomplete (employment) contracts and vice versa. As shown by Gräbner et al. (2018), agent-based modelling can provide some useful insights into the functional mechanism of institutions of trust and (social) control (*ibid.*). Therefore, we build on an agent-based model in order to describe the relationship of both firms (employers) and workers (employees) and focuses on their interaction on the labour market. Its purpose is to analyze how social norms change and evolve when the prevailing contract and the degree of contractual information therein changes: How will the degree of trust in a society be impacted by a change in the contractual arrangement and the degree of information contained therein? What implications can be derived for the bargaining power of workers and the model of social partnership in the digital sphere?

We proceed as follows: Section 2 provides a short literature overview about the status quo of research on digital labour market and sustainable employment relationships. Section 3 deals with the institutional and behavioural effects of different governance structures and the interconnectedness of (complete) information and trust. Section 4 introduces the model and Section 5 provides some discussion of first results. In Section 6 we conclude and present some policy recommendations derived from the model analysis.

2 Digitalisation and Employment

The term ‘Digitalisation’ is broadly applied in the literature and often defined in various ways (see e.g. Reis et al., 2018). Following from this, a broad spectrum of possible implications for the labour market has been discussed with regard to the increasing tendency to organise work by means of technology. However, the existing literature agrees to a vast extent about the increasing importance of mechanisms of Automatisations and the use of Big Data to describe the process of ongoing Digitalisation (Degryse, 2016).

For the purpose of this paper, we will apply a broad definition of ‘Digitalisation’ as a socio-technical transformation that augments the spectrum of governance modes for transactions through increasing collection and processing of information by the continuous improvement of Information and Communication Technology (ICT). Within this process, employment relationships undergo a significant change, which cannot be reduced to shifts of job creation and job losses, but furthermore imply a qualitative change of work and the labour market (Freddi, 2018). For example, the Digitalisation of labour processes often results in direct peer-to-peer transactions and contracts on single, fragmented assignments. These micro-tasks are often standardized and precisely specified in the associated contracts, which enables monitoring through the use of algorithmic control (e.g. Mengay, 2020; Wood et al., 2019). Furthermore, these qualitative shifts have brought about new business forms and a re-organisation of firms as intermediaries on the labour market (e.g. Srnicek, 2017). In this paper, we argue that the potential increase in contractable information reshapes the very nature of employment contracts and has furthermore major implications for social norms of trust and cooperation within society. The traditional role of firms as intermediaries in providing trust in situations of uncertainty is challenged by the ever-changing environment of new technological achievements. Our focus is therefore not limited to, but especially applies to the environment of the rapidly growing field of Gig and Platform Economy (e.g. Schwellnus et al., 2019).

New forms of digital employment relationships are characterised by rapid increase in the collection, storage, processing of data and information. This again shapes the nature of the contract applied and the degree of (complete) information and standardization therein (e.g. Mengay, 2020). Proponents of fully-specified contracts have promoted the ability of technological solutions to easily define such contracts by lowering transaction costs and therefore increasing efficiency (e.g. Catalini and Gans, 2020; Nurvala, 2015) as well as flexibility for both, workers and employers (Mulcahy, 2016). However, reduced cost efficiency due to a reduction in transaction costs on an individual micro-level of single transactions do not take into account asymmetric distributional effects, nor broader implications of reducing trust and therefore cooperation on a firm or societal level. If not implemented right, the reduction in costs might therefore be one-sided and only be realized by a shift of risk from employers to employees. Furthermore, anticipations that technologies such as blockchains are even able to completely replace intermediaries and therefore, trust between agents, have recently been put into perspective (De Filippi et al., 2020). Contrarily, several papers argue for potential asymmetric shifts of power in the course of Digitalisation: For example, the increasing application of new forms of digital technologies provide potentials for organizational control and monitoring for employers (e.g. Heiland, 2021; Levy, 2015). On the other hand, platform workers are usually faced with greater economic insecurity (Cirillo et al., 2021). Similarly, the specific nature of digital working environment caused an increase in sales contracts with precisely defined tasks and compensation. This again resulted in an increase in self employment (Eichhorst et al., 2017) and ‘independent contracts’ (Friedman, 2014) but intensified the commodification of labour (power) (e.g. Ferschli, 2017; Gandini, 2019; Goods et al., 2019; Moore et al., 2018) with far-reaching consequences on workers’ bargaining power and therefore workers’ agency on a political level. Mengay (2020) summarizes two main effects from digitalisation, that is a re-Taylorisation and dequalification of work as well as a degradation of remaining autonomy for workers in the labour process. Following a Marxian perspective, he describes this loss of autonomy as part of an increasing individual and political alienation process (*ibid.*).

2.1 Cooperation and Social Partnership in a Digital Sphere

These findings seem to support the presumption that a reconstruction of labour contracts in the course of a shift to the digital sphere implies not only individual, but far-reaching societal and political consequences. Several implications have been broadly discussed in the literature, from a theoretical perspective, as well as on empirical grounds. It results in a broad consensus about the need for some regulation and new policies to (1) protect workers rights in the digital sphere and (2) exploit and enable the potential of cooperation on digital platforms (e.g. Scholz, 2017). The former includes proposals such as to strengthen workers position on platforms by aligning the legal status of third-party workers with traditional employees and thus ensuring them the same social protection and legal claims (e.g. Cherry and Aloisi, 2018; De Stefano and Aloisi, 2019). Additionally, with respect to the latter, there's a broad literature strand on Sharing or Collaborative Economies (see e.g. Gruszka, 2017; Petropoulos, 2017), that are supported by technological infrastructure. Still, also in this context of collaboration, several authors emphasise the potential of negative consequences on working conditions, as well as asymmetric power relations on and between platforms (Gruszka, 2017; Langley and Leyshon, 2017). This is to say, that even Digitalisation theoretically provides the technical solutions to improve communication and collaboration between unknown actors, the actual potential exploited depends on the institutional structuring of the digital labour market. In addition, Digitalisation and ICTs might enable communication and therefore unionisation of different actors around the globe³, but long-term cooperation and social partnerships require trust in order to establish a sustainable, productive and appreciative employment relationship (e.g. Barroso-Méndez et al., 2016; Palmatier et al., 2007).

Whereas the traditional form of employment contracts with high degrees of uncertainty about e.g. the task to be executed provide the possibility of a trustful relationship, labour contracts in the digital sphere, however tend to be closer to complete sales contracts that do not require that the involved parties have any trust at all. The degree of cooperation and trust is interwoven with the existing institutional structure of the employment environment, that is the contractual relationship. Therefore, an increase in contractual information potentially changes social norms within society to a specific set of behavioural traits that make trust redundant (Bowles, 2004). Furthermore, these external changes in the degree of information have the potential of major implications for the stability of existing institutions within society. As shown by Cordes et al. (2021), the emergence and collapse of institutions portrays an asymmetric character. Therefore, existing social norms of cooperation and trust might be further applied in a changing environment, even beyond the point where they are still appropriate (*ibid.*). However, the resulting collapse might then be all the more sudden and non-reversible for a long time period (*ibid.*). A collapse of social norms of cooperation has important implications for both, employers and employees. The former would benefit from the additional benefits generated in cooperative firm developments (e.g. Bowles, 2004; Cordes et al., 2008). For the latter, a cooperative environment would reduce the threat of authority abuse (Simon, 1951). Furthermore both would benefit from an environment suitable for compromise and strong social partnership. This model has shown to be capable to achieve and maintain adequate working conditions (e.g. Behrens and Helfen, 2016; Palmatier et al., 2007). Therefore, the loss of trust between contracting parties would have more far-reaching effects on compromising and therefore the democratisation of work.⁴

From a Polanyian perspective, the evaluation of the potential of digital organisation structures is placed between two opposing poles. On the one hand, some authors take a positive stance towards the potential of Digitalisation to enable a so-called Sharing or Collaborative Economy and along with this a re-embedding of in the economy into social relations. On the other hand, the very same process is described to constitute a manifestation of an ongoing commodification of labour in the digital infrastructure (e.g. Heiland, 2018; Montalban et al., 2019). The aim of this paper is therefore, to provide an additional in-depth explanation of these seemingly contradictory findings of

³See e.g. 'Dynamo' at Amazon Mechanical Turk as an example of a platform for communication for workers to organize and unionize.

⁴The increase of communication and networking abilities due to digitalisation might also soften or reverse this effect as it enables unionisation and therefore strengthens the workers bargaining position. This point is not further elaborated here, but might be implemented to the model at a later stage of research.

collaborative approaches that often result in deterioration of workers rights and social regression. The model offers a mechanism of trust and complete information in order to explain why digital labour relationships are not necessarily cooperative and which institutional structures might help to improve cooperative behaviour on platform environments. We argue, that a change in the degree of available information, and therefore the degree of complete contracts deteriorates social norms of trust and cooperation and therefore the foundation of social partnership. This might further result in a long-term, irreversible restructuring of labour-capital-relations. Finally, we extend the model with an analysis of different additional policy measures to test their implications in order to contribute to the appeal for an adaption of policies applied in the digital sphere (see e.g. Stewart and Stanford, 2017).

3 Governance, (In)complete Information and Trust

The presence of trust is most relevant in situations of missing information, i.e. incomplete or asymmetric information about some aspects of the good to be traded (such as quality in the market of lemons; (Akerlof, 1978), bounded rationality (Simon, 1990; Williamson, 1979) or other circumstances regarding the transaction such as ex ante uncertainty (Knight Frank, 1921) about the future state of the world to be realized. Conversely, mainstream economics often postulates complete information in order to derive a unique equilibrium state, in which individuals are able to bargain over the pareto-optimal allocation without the need of governance or third-party intermediaries (Coase, 1960). Assuming the complete information assumption holds and the set of individual preferences is given the problem of allocation is solved by pure rational logic in a self-organizing manner (Hayek, 1945).

However, in the broad discussion of institutional governance the markets vs. central planner continuum is not sufficient to explain the wide variety of organizational forms (e.g. Powell, 1990). The price mechanism active in competitive markets is only one example of a decentral mechanism of governance, trust and network-based cooperation being another. One distinctive aspect of networks compared to pure market allocation is the role of trust: whereby complete and symmetric information is a precondition for efficient market allocations, incomplete information is a necessary condition for a situation of cooperation and trust (Bowles, 2004). A trustful, network-based environment further helps to promote the voluntarily sharing of information within a network. This inter-relational aspect of institutions and individual behavioral traits has been further developed by Bowles (*ibid.*), who shows that the lack of complete information gives rise to endogenous enforcement strategies. This further implies that actors' preferences are not given but are interrelated to the actor's environment as well as the actions of others. This way, coordination failures are prevented as the parties in a network agree to forego their own interest for the sake of the mutual beneficial outcome (Bowles, 2004; Powell Walter, 1990). This was first pointed out by Axelrod and Hamilton (1981) who showed that a social norm of trust and reciprocity achieves the pareto-optimal outcome in prisoner's dilemma situation by favouring cooperation. Based on the assumption of long-term interactions and repeated play, cooperative individual behaviour is promoted as well as punishing those who refuse to cooperate. Therefore, the emerge of a social norm of reciprocity and trust within a network (following a tit-for-that strategy) promotes cooperation and mutual learning, thus favours the voluntary exchange and use of information and enables mutual beneficial outcomes. Therefore, long-term employment relationships of reciprocity and trust outperform market mechanisms and yields the most efficient solution to coordination failures, not by incentivizing individual behavior but by decreasing the conflict of interests (Bowles, 2004). Furthermore, fundamental uncertainty about the future increases the overall advantages of (incomplete) employment contracts against (complete) sales contracts due to establishing a long-term relationship, but simultaneously increases the potential abuse of authority by the employer (Simon, 1951). Therefore, the degree of information specified in contracts crucially shapes the employment relationship between employer and employee on two different levels: (1) within a firm or network, where the degree of information in contracts decides upon trust or monitoring, and (2) on a socio-political level, where mutual trust and cooperation represents the foundation of social partnership and coordination of interest. The degree of completion of contractual information possible depends inter alia on the ability of technical components to measure and verify real world data and transfer it to the digital sphere. Therefore, the

	reciprocators	defectors
incomplete information	$\frac{\pi^H}{2}; \frac{\pi^H}{2} - \delta$	$\frac{\pi^L}{2}; \frac{\pi^L}{2}$
complete information	$\pi^L; -\delta$	$\pi^L; 0$

Table 1: Payoffs in the Prisoners Dilemma Game of Information and Trust (Bowles, 2004, p. 262)

process of Digitalisation reshapes employment relationships via the channel of completion of contractual information and following from this, the establishment of a trustful, cooperative environment.

3.1 Coevolution of Preferences and Institutions

The behavioural traits in a population as well as completeness in contracting are both subject to one underlying mechanism that connects the required level of trust to a specific set of preferences (Bowles, 2004). A completion of contractual content in the course of digitalisation might thus jeopardize these existing institutional environment of employment relationships.

To illustrate this mechanism of interconnectedness of the degree of contractual information and the distribution of behavioural traits, we build on and modified a game-theoretical model by Bowles (*ibid.*), which is constructed as follows: Consider a population that consists of employers and employees that are randomly paired for a single interaction. They trade over a good (the labour effort) of high (H) or low (L) quality, with the level of quality (H or L) chosen by the employee, and costly to verify for the employer (with detection costs δ). The employer makes the first move to offer either a complete or incomplete contract. Employees on the other hand can be reciprocators, adjusting their behavioural strategy to the contract offered, or can be (unconditional) defectors by choosing the minimal effort, irrespectively of the contract offered. If the employer offers a complete contract, the employee receives some fixed compensation that is just enough to compensate her for providing the low quality task. The reciprocal employee reacts to the complete contract by providing a low quality task and pays costs of detection δ . In the incomplete contract the employer bears the costs of the low quality task plus half of the profit resulting from the exchange. Payoffs for this prisoners dilemma game are given in Table 1.

There is also some experimental evidence supporting the claim of interrelation of social norms and contractual design. Schmidt et al. (2012) show, that different forms of contracts (incomplete, complete) provoke different forms of behaviour. In their experiment, people were ask to choose between complete sales contract (with ex ante fixed and clearly specified tasks) and incomplete employment contracts (that specified a principal agent relationship over some period, but no specific task to be executed by the agent). They find that incompleteness in employment contracts gives rise to long-term employment relationships and reciprocity. These personal relationships yielded wages and effort levels in the experiment exceeding equilibria levels predicted by rational choice theory in settings of complete contracts *ibid.* Based on this empirical evidence we seek to built an agent-based model with heterogeneous agents, to replicate these interrelated aspects on the labour market. When is trust maintained in employment relationship? Which institutional conditions maintain trust and therefore cooperation and which policy are adequate in supporting the establishment of cooperation and social partnership in the digital sphere? Which conditions are required to promote the expansion of trust and cooperation?

4 Model Description

In order to analyse these links and formal relations we set up an agent-based modelling framework that features firms and workers who interact with each other. Firms can either offer a complete or incomplete contract. Workers, in return,

can choose between two behaviour styles: they can act selfishly and can put in as little effort as possible or they can act as reciprocators, meaning that they put in some more effort than necessary into their work. The model is analyzed using Monte Carlo Simulations, thereby iterating through the model runs (each containing 400 time steps).

The timeline of events in each time step is as follows:

1. Workers and firms meet in the labour market where jobs and revenues are assigned.
2. Firms and workers, respectively, evaluate whether they have been successful in the current period.
3. Firms and workers, respectively, evaluate and rank the workers/firms that they worked with in the current period.
4. Based on past experience, firms decide on what contract to offer in the next period. Workers decide on whether or not to change their work behaviour.

4.1 The labour market

In the beginning of each period, workers and firms meet on the labour market, where jobs are assigned. First, firms offer jobs to workers that they have made good experiences with in the past. This is to give firms and workers the possibility to build long-term working relationships. The worker who is offered a job is, in turn, willing to take it if they have made good experience with the offering firm. In a next step, all workers who did not get a job during this process (either because they were not wanted by any firm or because they wanted to change their employer) will apply for a job at their highest ranked firm – which they will be granted as long as the respective firm’s labour demand has not been satisfied. After all jobs have been assigned, work starts – which (1) gives workers information on the firm’s working conditions, i.e. the contract style offered and which (2) lets the firms know how much effort their employees put into their work. This will determine each agent’s payoffs in the current period, which, in a baseline-scenario are computed as above in Table 1 in section 3 such that the original conditions of the prisoner’s dilemma are maintained.

Note that the modelling framework also features the possibility for globally available worker ratings (which will be elaborated on in further detail in Section 4.3). That is, if, due to an increased feasibility in communication technology, firms have the chance to rate workers publicly. In this case, the highest ranked worker gets to choose which firm to work with first.

4.2 Evaluation of firm and worker success

Each firm f considers its performance in the current period as successful if its payoff per worker are equal to or higher than the aggregate average payoff per worker.

$$success_{f,t} = \begin{cases} \text{True} & \text{if } (\frac{y}{n_w})_{f,t} \geq (\frac{\bar{y}}{n_w})_t^F \\ \text{False} & \text{otherwise} \end{cases} \quad (1)$$

Where $(\frac{y}{n_w})_{f,t}$ denotes the income y per hired worker of firm f in period t and $(\frac{\bar{y}}{n_w})_t^F$ is the average income per worker of all firms F in period t .

Each worker w , on the other hand, considers the period to be successful if their payoff exceeds or is equal to the average worker payoff.

$$success_{w,t} = \begin{cases} \text{True} & \text{if } y_{w,t} \geq \bar{y}_t^W \\ \text{False} & \text{otherwise} \end{cases} \quad (2)$$

	reciprocators	defectors
incomplete information	4*; 4*	1*; 3*
complete information	3*; 1*	2*, 2*

Table 2: Rating of the interaction partner

Where, analogously, $y_{w,t}$ denotes the income of worker w in period t and \bar{y}_t^W is the average income of all workers W in period t .

4.3 Rating of interaction partners

After each agent has determined whether they were successful in the current period, they rate their interaction partner(s) as shown in Table 2. That is, each firm f will give each worker w that they worked with in period t a rating of one to four stars, depending both on the worker behaviour and the offered contract style. If the worker acted as a reciprocator, they will be rated with three or four stars, depending on whether the firm offered a complete or incomplete contract. If, however, the worker defected, they will be rated with only one or two stars, again, depending on the firm's offered contract style. Workers rate the firm they worked with in period t analogously – a firm that offered an incomplete contract will receive a three or four star rating. Otherwise, the firm will be rated with one or two stars.

As already indicated in Section 4.1, the rating of an agent will influence the willingness of past interaction partners to enter a work relationship in the future. This goes as follows. In the baseline scenario of the model, each firm only has information on the workers that have been employed there in the past. All workers, that have not worked for the firm yet are ranked neutrally with 2.5 stars. Therefore, in the beginning of each model run, a worker who acts as a reciprocator will be ranked higher than the firm's average worker ranking. In the next period, these workers will be asked to work at the firm again. All other workers will try to find a position with another firm.

Note that, in this baseline scenario, the firms have no information on how other firms have evaluated their workers. The model framework, however, also features the possibility for a global rating system, where workers are rated publicly. In this scenario, every firm would like to work with the highest rated worker, who, as a result, *de facto* gets to choose which firm to work with.

4.4 Strategy decision

In the end of each time step, each agent updates their strategy. To this end, the firm computes which of the two contract styles have been successful more often in the past. This will be pronounced the firm's personal best strategy. Firms are assumed to be able to guess the globally best strategy for firms with probability ϕ_F . That is, with probability ϕ_F , each firm will change its strategy to the globally best strategy. Otherwise, it will stick with its personal best strategy. If, however, a firm was unsuccessful for the ten past periods, it will change its strategy to the opposite of their personal best strategy.

The same is, analogously, true for workers. With probability ϕ_W , each worker will adapt their behaviour to the most successful behaviour among all workers. Unless they have been unsuccessful for ten consecutive periods, they will pick their personal best strategy.

5 Discussion of Results

In order to study our research question, the baseline model is initialized with a starting value of 70% of incomplete contracts as suggested in the experiment conducted by Schmidt et al. (2012). Empirical work on what share of workers

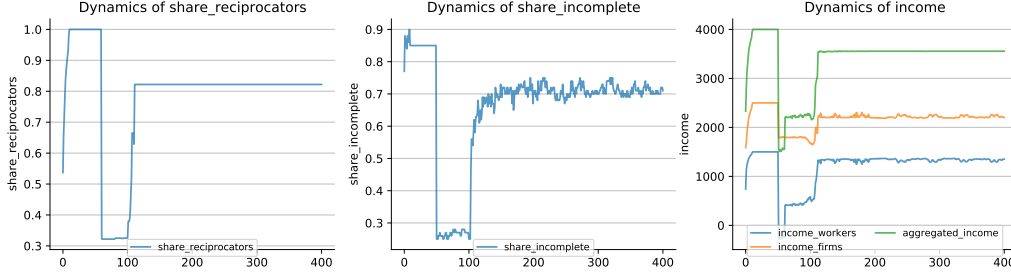


Figure 1: Model dynamics for the baseline scenario. The first plot shows the mean share of reciprocators. Similarly, the second plot shows the mean share of firms who offer an incomplete contract. The third plot shows the mean of aggregate payoffs of firms and workers, respectively.

	reciprocators	defectors
incomplete information	$\frac{\pi^H}{2}; \frac{\pi^H}{2} - \delta$	$\frac{\pi^L}{2}; \frac{\pi^L}{2}$
complete information	$\frac{\pi^L}{2}; \frac{\pi^L}{2} - \delta$	$\frac{\pi^L}{2}; \frac{\pi^L}{2}$

Table 3: Payoffs in the Prisoners Dilemma Game: Minimum Wage Scenario

will show a cooperative behaviour in an institutional context is scarce. Cordes et al. (2008, 2021), however, convincingly argue that humans can show a tendency towards cooperative behaviour and there is no reason to assume that all workers act as defectors in the beginning (as would be suggested by *homo oeconomicus* assumptions). This is why we, for now, assume a share of 50% of reciprocators among workers in at the start.

To study the impact of Digitalisation and how a sudden change in the number of complete contracts will affect the willingness of workers to act as reciprocators, in period 50 an exogenous shock occurs to the model which causes a high share (in our case, for now, 80%) of firms to offer a complete contract.

Figure 1 shows the results for the baseline setting. Here, in the beginning, workers quickly adapt to reciprocator-behaviour. However, after the shock in period 50, the share of reciprocators drops drastically. Although both the share of reciprocators as well as the share of incomplete contracts do eventually increase again, they never attain their pre-shock level.

Minimum wage. In order to analyse how policy measures can help avoid the permanent drop in collaboration, we first implement minimum wages. To this end, we change the payoff matrix as seen in Table 3, such that the firm has to always share its payoffs with the worker – even in a complete contract scenario.

As can be seen in Figure 2, this has a major effect on the model dynamics. First, in this scenario, firms instantly bounce back to offering incomplete contracts. Although also in this scenario, the share of incomplete contracts never reaches its pre-shock level, it does yield a higher share than the baseline. However, the drop in incomplete contracts seems to be so brief that worker do not react to it at all – here, we see a constant willingness to reciprocate. Second, this scenario yields higher aggregate payoffs than the baseline scenario. This is due to the higher willingness to cooperate on either side and is not affected by the fact that firms are faced with overall lower payoffs in this scenario.

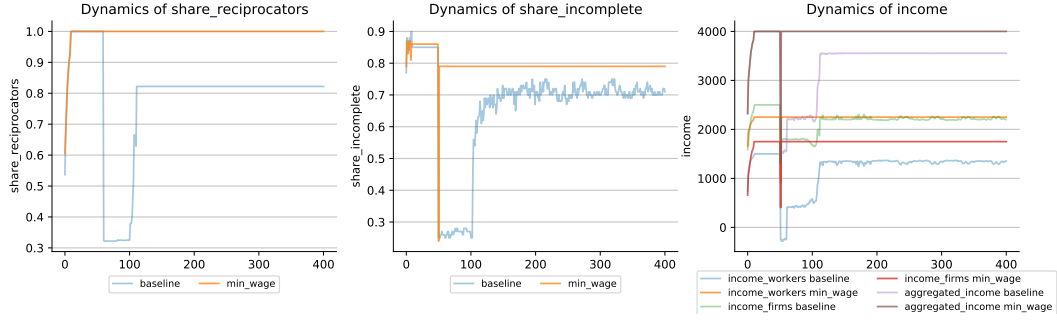


Figure 2: Model dynamics for the minimum-wage scenario. The first plot shows the mean share of reciprocators (orange line) as compared to the baseline scenario (blue line). Similarly, the second plot shows the mean share of firms who offer an incomplete contract. The third plot shows the mean of aggregate payoffs of firms and workers, respectively.

	reciprocators	defectors
incomplete information	$\frac{\pi^H}{2} ; \frac{\pi^H}{2} - \delta$	$\frac{\pi^L}{2} ; \frac{\pi^L}{2}$
complete information	$\pi^L - c ; -\delta$	$\pi^L - c ; 0$

Table 4: Payoffs in the Prisoners Dilemma Game: Contract Costs Scenario

Contract costs. A second policy tested in our model is the introduction of contract costs. In this scenario, firms who offer complete contracts are faced with some additional costs c that manifest in their payoffs, as shown in Table 4. Workers behaviour does not change in this setting, but the general level of incomplete contracts after the shock is lower than in scenario with minimum wages and closer to the baseline scenario.

Contract share. Another policy tested in our modelling framework is the possibility to legally regulate the share of contracts offered. This model scenario refers to the equal legal treatment of traditional employment contracts and platform workers as proposed in the literature (e.g. Cherry and Aloisi, 2018; De Stefano and Aloisi, 2019). This regulation is thought to confine the overall number of complete contracts to not exceed a share $\theta\%$. In the model, this policy also helps to preserve cooperation. Here, the shock is not as severe, due to the regulation. Interestingly, the firms’ bounce-back will, in this scenario, lead to a higher number of incomplete contracts relative to the pre-shock scenario (see Figure 4).

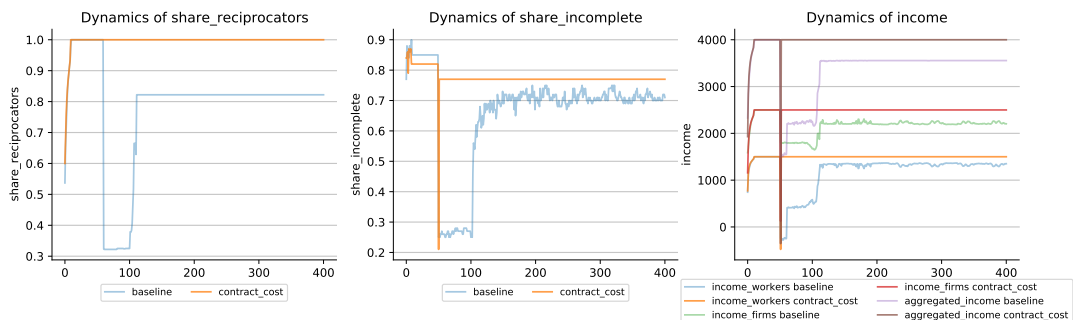


Figure 3: Model dynamics for the contract cost scenario. The first plot shows the mean share of reciprocators (orange line) as compared to the baseline scenario (blue line). Similarly, the second plot shows the mean share of firms who offer an incomplete contract. The third plot shows the mean of aggregate payoffs of firms and workers, respectively.

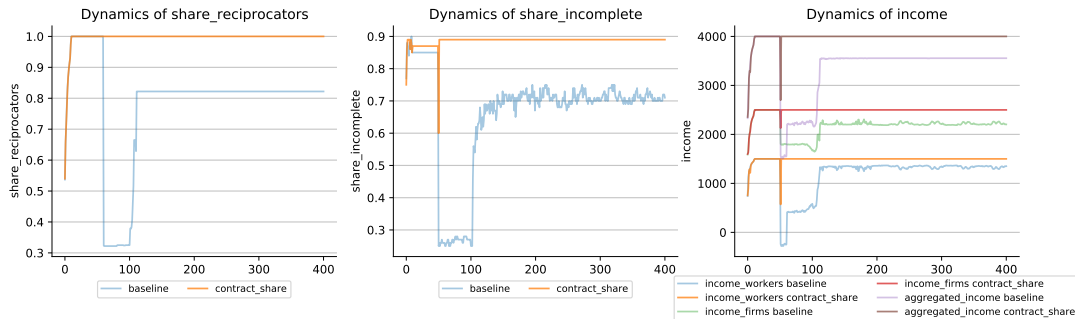


Figure 4: Model dynamics for the contract share scenario. The first plot shows the mean share of reciprocators (orange line) , as compared to the baseline scenario (blue line). Similarly, the second plot shows the mean share of firms who offer an incomplete contract. The third plot shows the mean of aggregate payoffs of firms and workers, respectively.

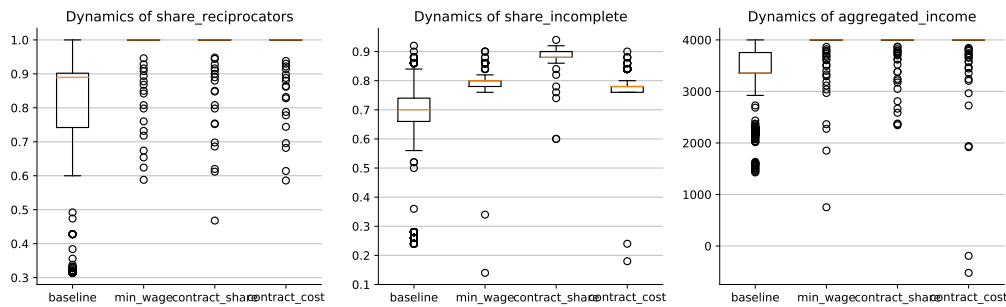


Figure 5: Boxplots that compare the model outcome in period 400 in different scenarios.

Comparing the scenarios. The boxplot shows us that all policies are better than the baseline scenario, with regard to the share of reciprocators, the share of incomplete contracts and the aggregated payoffs. Although these results have to be treated with caution due to the simplicity of the model, the absence of many characteristics on traditional as well as on digital labour markets and the many assumptions to be challenged, the model outcome suggest that union action is desperately needed and helps to promote trust and cooperation and therefore sustainable employment relationships in the long run.

6 Conclusion and Policy Recommendations

In this paper, we studied the impact of a Digitalisation of labour markets with the example of different forms of contracts offered and the degree of information contained therein. We set up an agent-based-model of firms and workers who interact on a labour market to analyse how a sudden drop in the share of incomplete, traditional employment contracts impacts the social norms of trust and cooperation within society. In doing so, we analyse the impact of an increasing share of (digital) complete contracts of single micro-tasks that operate on a technological infrastructure on existing employment relationships and social partnership. In general, we find that the exogenous shock of a fall in the share of incomplete contracts deteriorate the share of reciprocators and therefore jeopardize existing social norms of trust and cooperation. This has major implications on both the cooperative environment within firms and organisations as well as on the potential of social partnership on a broader, societal scale.

Furthermore, we applied several scenarios with different labour market policies and compared them to the baseline scenario without any government intervention. The boxplots of different policies show, that any of the policies proposed helps the maintenance of trust and cooperation in employment relations. In all scenarios with policy measures tested, the share of reciprocators, the share of incomplete contracts and the aggregate payoffs are higher than the

baseline scenario. All policies promote reciprocity and cooperation, and the share of reciprocators as well as the share of incomplete contracts do eventually increase after the exogenous drop in incomplete contracts. However, they never attain their pre-shock level. The highest post-shock level is achieved in the minimum-wage-scenario, that offers workers some economic security and an equal share of the profits exploited. We therefore conclude that Digitalisation is in urgent need to actively shape and re-shape this transformative process in order establish long-run sustainable employment relationship and to maintain trust and cooperation on the digital, as well as the traditional labour market.

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