Why isn't Uber a worker cooperative? On the (im)possibility of self-management in the platform economy

Filippo Belloc
Department of Economic Studies
University "G. d'Annunzio"
Viale Pindaro 42, 65127
Pescara, Italy

f.belloc@unich.it

Abstract

We develop a simple model of a worker-managed (WM) via-app labour platform firm, through which a homogenous service is provided to customers on-demand, with the costs of organizing and monitoring the workers being constant across different sizes of the business. We show that WM platforms may be viable when the initial cost of the platform and the cost of external capital for financially constrained workers are lower and in environments characterized by high revenues and positive network externalities. Moreover, when capital-managed (CM) platform owners retain an overhead commission below a certain critical threshold, workers are better off as employees in a CM firm. These findings are shown to fit available anecdotal evidence revealing that WM platforms are confined to activities related to on-line trade of ethical goods and artistic products, where demand bunching effects matter significantly. On the other side, where network effects are milder and overhead commissions are set strategically by CM firms, as in the peer-to-peer transportation sector, WM via-app platforms are virtually absent.

Keywords: Labour platforms, via-app work, worker-managed firms.

JEL classification: J54, L22, P13

1 Introduction

The last decade has seen the organization of work changing dramatically. An increasing amount of non-standard types of work has emerged, commonly referred to as the "platform economy", including various forms of crowdwork and work-on-demand via-apps. Estimates of the number of individuals who work in the platform economy come to touch upon dozens of millions worldwide and report exponential growth rates (Smith and Leberstein, 2015; Harris and Krueger, 2015; Katz and Krueger, 2016; Abraham *et al.*, 2017). Sectors of activity cover (and are not limited to) delivery, home services and transportation. Well-known companies operating through labour platforms are *Uber*, *Lyft*, *TaskRabbit*, *Care.com*, *Amazon Mechanical Turk*, *Crowdflower*, *Crowdsource*, *Clickworker*, *Foodora*, *Deliveroo*, among many others.

While the legal notion of a via-platform labour relationship is vague, from an economic perspective there is a key ingredient that makes a platform-based firm different from traditional forms of organization. Thanks to algorithmic management and the via-app organization of work, the platform technology provides various solutions for fast and relatively precise monitoring of individual performance and for coordinating thousands or even hundreds of thousands of workers, allowing them to meet with as many different customers through standardized and largely homogenous interactions (Cramer and Krueger, 2016). This makes the organizational functions of managers relatively less important and the traditional hierarchical direction by a chain of controllers virtually unnecessary. Moreover, platform activities, generally, do not require significant external funds. Human effort is the most relevant input in platform-based service provision and each worker is often required to contribute with his own asset (e.g. a car, for *Uber*'s drivers). As a result, unlike conventional firms, labour platforms exibit very low marginal costs and are able to show dramatic increases in their workforce in very short periods of time. For instance, in the United States, *Uber* has grown from a base of near zero active drivers in mid-2012, to 100.000 in mid-2014 and to over 400.000 a year later (Uber Newsroom, 2015).

Despite their diffusion and the very high number of workers that they employ, digital labour platforms are often criticised by workers for their employment and job organization policies. Platform workers are largely seen to express distrust of via-app systems of labour organization and report that work opportunities are scarce or fragmented (Huet, 2014; Rogers, 2017). Workers' complains refer to the information asymmetries between the workforce and the management of the platform (usually platform workers can make inquiries and receive template responses, but they are not empowered to negotiate the terms of their work by communicating to a representative of higher management) and to the ratings and surveillance models (algorithms of performance monitoring are left intentionally undisclosed, but also have a strong impact on employment opportunities; see Rosenblat and Stark, (2016)).

In the light of this, it seems somewhat surprising that workers crowd into capital-managed (CM) platform-based businesses, while worker-managed (WM) organizations, which would better account for workers' preferences, are virtually absent in the platform economy. This is puzzling, because the characteristics of platform-based activities suggest that WM platforms should be, at least, as efficient as CM platforms: the strong homogeneity of the workforce and the centrality of the working effort with respect to the physical capital in platform-based activities reflect some of the standard arguments proposed by economic theory (in particular, Grossman and Hart (1986), Hart and Moore (1990) and Hansmann (1996)) to explain the viability of WM economic organizations. Empirical evidences show that worker cooperatives, in fact, tend to employ workers-members with similar skills and competencies (Burdín, 2016) and are likely to cluster in labour-intensive and low capital investment activities (Podivinsky and Stewart, 2007).

With this paper we try to address this puzzle, by providing a simple and intuitive formal analysis – the first, to the best of our knowledge – of a WM digital labour platform organization.

We model the via-app platform as a digital infrastructure through which a homogenous service is provided to customers on-demand. Due to the technological characteristics of labour platforms, the fixed costs of providing the service and those of organizing workers can be assumed not to vary with the size of the workforce. Digital algorithmic monitoring also reduces possible advantages or disadvantages of WM versus CM forms of economic organization, and monitoring costs can be assumed to be constant across diverse ownership structures. Consequently, for both CM and WM platforms, profits and per-capita earnings, respectively, are increasing in the size of the business until an equilibrium level of demand is reached. Hence, under an initial assumption that WM organizations maximize only per-capita earnings, the optimal size of CM and WM platform is shown to be the same, in the presence of a competitive market for membership. In extensions of the basic model, we consider user-side network effects and introduce some additional essential differences between WM and CM platforms, including employment concerns in WM firms, coalition costs that make the establishment of a WM platform relatively more costly, and the presence of positive externalities among workers-members (worker-side network effects).

Against this background, we study the viability of WM labour platforms, concentrating on the short-run implications of the model. In particular, we model the relative payoff of the workers across WM and

CM platforms ownership structures as depending, all else being equal, on the overhead commission that the workers must pay to the platform owner if they work as employees in a CM firm. We show that the maximum level of the overhead making CM firms more attractive for workers increases with both the initial cost of the platform and the cost of external capital for financially constrained workers and decreases when network effects matter significantly. The intuition behind this finding is simple. When a CM firm does not pay fix wages but retains an overhead on the revenues raised by the employees, an increase in the revenues, due to network externalities, accrues to workers only partly, while, in a WM platform, it is entirely captured by the workers. As a result, the overhead applied by capitalist owners being equal, WM platforms are more convenient for workers when network externalities are stronger. Some reported anecdotal evidence on platform cooperativism in the on-line market of ethical goods and artistic products (where demand aggregation effects are particuarly important) appears consistent with this conclusion.

The paper contributes both to the debate on the platform economy and to the literature on worker-managed firms. On the one side, there is an increasing attention by policy-makers and, to a larger extent, the public opinion on how better wages and improved working conditions on the job may be sustained for platform workers (Smith and Leberstein, 2015). While the extension of standard employment protection institutions, such as statutory rights to minimum wage and unemployment insurance, has been shown to be difficult to implement (Harris and Krueger, 2015; Krueger, 2018), we discuss the rationale for a market-based solution, based on an endogenous reallocation of ownership rights.

In doing this, on the other hand, we contribute to the long-standing literature on worker-managed firms (see Bonin *et al.* (1993) and Dow (2003) for a survey), which has never addressed the issue of via-app forms of worker-managed labour organizations, so far. The main point that differentiates our model of a self-managed labour platform from extant stylisations of worker cooperatives is that we assume the monitoring costs to be the same for CM and WM firms and constant in the size of the workforce (so that capital-related marginal costs are equal to zero). The issue of whether cooperatives face higher costs for monitoring their workers with respect to capital-owned firms is controversial. While Alchian and Demsetz (1972) maintain that monitoring in cooperative organizations is less efficient because the benefits of monitoring are diluted among workers-members (similarly, Hueth and Marcoul (2015) assume that monitoring by producers is costly relative to monitoring by specialists), the literature on worker cooperatives show that workers-members may have incentives to monitor their peers in a more efficient way than in traditional firms (Putterman, 1984; Kandel and Lazear, 1992) and that this may be one of the efficiency advantages of WM firms (Bai and

Xu, 2001; Bowles and Gintis, 2008). Under the context-specific assumption that the monitoring costs are equal across different ownership structures and that such costs as well as organizational costs are constant in the size of the firm, our model introduces some possible explanations for the rarity of WM firms in the platform economy and points to which environments, instead, may make them viable and relatively attractive for workers. In particular, we unveil the role played by network effects as a possible factor facilitating the viability of WM organizations, which may explain the existence of worker cooperatives also in other more traditional sectors outside the platform economy and which has been generally overlooked by related literature (e.g., Dow and Putterman (2000), Belloc (2017)). Moreover, we consider the wage paid by CM firms (i.e. the outside option of WM firms' workers) to be endogenous, being it modeled as a function of the final service unit price. This generates some additional relevant differences between our framework and standard comparative analyses of worker cooperatives (see Dow (2018) for a technical survey).

The paper is organized as follows. In Section 2, we present our basic framework, where WM platforms maximize per-capita earnings, and an array of extensions, dealing with employment level concerns, network externalities and coalition costs. In Section 3, we provide comparative statics, discuss the main implications of our model about the viability of WM platforms, and report some available anecdotal evidence. Concluding remarks are in Section 4.

2 The model

2.1 Baseline framework

Consider two possible ownership structures – organized, respectively, as capital-managed (CM) and worker-managed (WM) – of a via-app labour platform, through which a homogenous service may be provided to customers on-demand. The platform can be thought of as a digital infrastructure that allows organizing via-app the division of labour across (possibly many) workers (also on a time or geographical basis), to meet customers, and to monitor the quality of the service provided by each worker. The platform is costly. While capitalist entrepreneurs do have enough liquidity to buy the platform from an external programmer, the workers are financially constrained and need to raise funds on the capital market to afford the price of the platform. Let us denote with I the initial sunk investment for the platform provision (equal for both workers and capitalist entrepreneurs) and with i the interest rate for the workers who decide to buy their own platform to start a WM firm.[1] Organizing the workers and monitoring the quality of service provision through the platform cost m, which, due to algorithmic techniques, is constant across different numbers of workers employed in the firm and across ownership types. Assuming that a given via-app labour platform is suited for providing a given homogenous service through a given organization of work, the platform can be stylised as a combination of I, m and r, with $r > 0$ denoting the revenues per unit of service. We assume that the unit price r is given (it can be thought of as a competitive price to the extent that workers - be they employees in a CM firm or members-owners in a WM firm - compete in the final market as independent contractors).[2] Price r clears the market at $\bar{c}$, with c being the supplied number of units of service (we assume that each unit of service corresponds to one customer). We also assume that workers' performance can be perfectly monitored through the via-app platform and that the workers have similar abilities.[3] The possibility that heterogenous workers sort endogenously among types of firm is thus excluded in this model. Finally, we denote with n the number of workers and with $(1-\alpha)r$ the amount that, in a CM firm, employers pay to an employee for each unit of service provided (with $\alpha \in [0,1]$ being an overhead commission parameter and αr the total commission that the employee must pay to the platform owner). Let us assume that, given α, $(1-\alpha)r$ is equal to the reservation wage of the workers, so that they refuse joining both WM and CM platforms for lower payoffs, and that profit or per-capita income maximization is obtained by the firm by adjusting employment. To keep things simple, we also normalize the units of service supplied by one worker to 1, so that $n = c \ \forall n \in [0, \bar{c}]$, while, for $n > \bar{c}$, additional workers will not find corresponding additional customers. Let us also normalize the disutility of effort to 0, so as to measure with $(1-\alpha)r$ the net payoff of employees in a CM firm, and assume (as a participation constraint) that there is an interval $[\underline{n}, \overline{n}]$, with $\underline{n} < \bar{c} < \overline{n}$, for which the total revenues (rc) are larger than the total costs of both the WM and CM firm (i.e., respectively, $I(1+i)+m$ and $I+m+n(1-\alpha)r$). For simplicity, we consider these variables as normalized at a one-period production level, so that the costs I and m denote the fraction of the total fixed costs (for, respectively, buying the platform and monitoring workers) relative to each period and c and n the number of customers and workers who are, respectively, served and employed in each period.

[1] The assumption that capitalist entrepreneurs do not raise external capital may seem restrictive. However, it can be relaxed, without affecting our model set-up, by simply normalizing the cost of external capital for capitalist entrepreneurs to zero and assuming that workers pay an extra cost of capital equal to iI.

[2] In most of the existing CM labour platforms, workers are not standard employees and interact with the platform owners through non-standard forms of employment (often, platform workers are independent contractors). Nonetheless, to reduce distractions in the text, we will refer to CM platform workers as employees.

[3] Both these assumptions are reasonable for platform-based services.

In a CM labour platform structure, we assume to have only one owner. His profits are:

$$\pi_{CM} = \begin{cases} rc - [I + m + n(1-\alpha)r] & \text{if} \quad n \leq \bar{c}, \quad \text{with} \quad c = n \\ r\bar{c} - [I + m + n(1-\alpha)r] & \text{if} \quad n > \bar{c} \end{cases} \tag{1}$$

In a WM labour platform structure, we have possibly many workers-owners. Per-capita earnings in a WM organization are:

$$\pi_{WM} = \begin{cases} \frac{rc}{n} - \frac{I(1+i)+m}{n} & \text{if} \quad n \leq \bar{c}, \quad \text{with} \quad c = n \\ \frac{r\bar{c}}{n} - \frac{I(1+i)+m}{n} & \text{if} \quad n > \bar{c} \end{cases} \tag{2}$$

From Equation (1), it is straightforward to observe that $\pi_{CM} < 0$ when $rc < I + m + n(1-\alpha)r$ and $\pi_{CM} \geq 0$ when $rc \geq I + m + n(1-\alpha)r$. In particular, $\partial\pi_{CM}/\partial n > 0$ if $n < \bar{c}$, while $\partial\pi_{CM}/\partial n < 0$ if $n > \bar{c}$. From Equation [2], we observe that $\pi_{WM} < 0$ when $rc < I(1+i)+m$ and $\pi_{CM} \geq 0$ when $rc \geq I(1+i)+m$, and that, again, $\partial\pi_{WM}/\partial n > 0$ if $n < \bar{c}$, while $\partial\pi_{WM}/\partial n < 0$ if $n > \bar{c}$ (with $\lim_{n\to\infty} \pi_{WM} = 0$). All in all, the key difference between a CM and a WM organization, in this baseline setting, is due to the payoff policy, i.e. WM firms redistribute net revenues equally to all workers-members, whilst, in CM firms, the capitalist owner retains all the residual profits after the workers are paid a wage, which is a function of the unit revenues. We are not assuming that workers inherently value democratic participation in a WM organization.

With this very simplified framework, we can study the possible emergence of via-app WM labour platforms, under the assumption that the workers choose whether to work as employees in a CM structure or to organize themselves in a WM structure only depending on the relative monetary per-capita payoff they will be able to get from the two alternative employment (i.e., ownership) solutions. In doing this, we implicitly assume that employment outside options in CM platforms are always available to workers. We also assume that workers-members of a WM organization have equal shares. For now, we do not consider the possibility that workers are concerned also with employment levels and job or income stability. We consider, finally, workers and capitalists as equally able to have an initial entrepreneurial idea and to commission a job platform to an external programmer.

Depending on the number of workers involved and taking all else as given, we have possible alternative scenarios (also represented in Figure (1)), as follows.

[insert Figure (1) about here]

- If $n < \frac{I+m}{\alpha r}$, then $\pi_{WM} < 0$ and $\pi_{CM} < 0$, and both WM and CM labour platform structures are not profitable.
- If $\frac{I+m}{\alpha r} < n < \frac{I(1+i)+m}{r}$, then $\pi_{WM} < 0$ and $\pi_{CM} > 0$. Only the CM labour platform is viable.[4]
- If $\frac{I(1+i)+m}{r} < n < \frac{I(1+i)+m}{\alpha r}$, then $\pi_{WM} > 0$ and $\pi_{CM} > 0$. While both the CM and WM labour platforms are viable, the payoff $(1-\alpha)r$ that workers can get from being employees in a CM platform is higher than what they can get from organizing themselves through a WM platform, i.e. $0 < \pi_{WM} < (1-\alpha)r$. Thus, workers will prefer to offer their work as employees rather than as members of a WM organization.
- If $\frac{I(1+i)+m}{\alpha r} < n < \frac{1}{1-\alpha}(\overline{c} - \frac{I(1+i)+m}{r})$, then $\pi_{CM} > 0$ and $\pi_{WM} > (1-\alpha)r > 0$. For the workers, to run a WM platform, rather than being employees in a CM organization, is more convenient.
- Finally, if $n > \frac{1}{1-\alpha}(\overline{c} - \frac{I(1+i)+m}{r})$, $\pi_{CM} > 0$ and $0 < \pi_{WM} < (1-\alpha)r$. In this case, the workers are better off, again, as employees in a CM organization.

We can now define the survival size of a WM platform, denoted with s_{WM}.

Definition 1. *Define s_{WM} as $min\{n : \pi_{WM} > (1-\alpha)r\}$ with $(1-\alpha)r > 0$, i.e. the minimum size at which a WM platform becomes attractive for workers, by making non-negative profits and paying average earnings higher than a capitalist salary.*

For an income maximizing WM platform, the survival size is:

$$s_{WM} = \frac{I(1+i)+m}{\alpha r} \tag{3}$$

From Equation (2), it is also straightforward to obtain that the income maximizing size of the organization is the same in a CM and in a WM platform, as follows:

$$n^*_{WM} = n^*_{CM} = \overline{c} \tag{4}$$

[4] $\frac{I+m}{\alpha r} < \frac{I+m+i}{r}$ will hold when $\alpha > \frac{I+m}{I(1+i)+m}$. Hence, when $\alpha < \frac{I+m}{I(1+i)+m}$ we may have that $\frac{I(1+i)+m}{r} < n < \frac{I+m}{\alpha r}$: in this case, $\pi_{WM} > 0$ and $\pi_{CM} < 0$, i.e. only WM platforms are viable, but self-managed workers obtain a payoff that is lower than what they would get as employees in a CM firm, which however is not viable. This case is ruled out by the fact that $(1-\alpha)r$ is equal to the reservation wage of the workers, so that they refuse joining both WM and CM platforms for lower payoffs.

Equation (4) equals to say that a per-capita income maximizer WM platform will choose employment levels, in practice, as a conventional profit maximizing firm. The reason is easy to see. If the final market is competitive, workers-members appropriate the entire surplus of the firm, with each worker receiving an equal fraction of the total surplus. Thus, an income maximizing WM firm will pursue maximization of total profits in order to expand per-capita earnings (Dow, 2018, Chapter 2). To keep things simple, throughout the paper we will refer to a stylised WM firm in the platform economy as an income maximizing firm, even if its employment behaviour is equivalent to that of a profit maximizing firm (in the next Section, we will show that an income maximizing WM platform may deviate from profit maximization in the direction of employment maximization, when its welfare function places some weight also in employment levels).

While it is intuitive that a WM platform, if established, will expand to $n^*_{WM} = \overline{c}$, because at this size it will maximize per-capita earnings, $n^*_{WM} = \overline{c}$ it is also shown to be an equilibrium in the presence of a perfect (i.e. competitive) market for membership, where insider members would be willing to accept new members above n^*_{WM} upon payment of some price for membership.

Proposition 1. *If CM platforms pay positive wages (i.e., $\alpha < 1$) and the WM platform is income per-worker maximizing, in the presence of a competitive membership market, then $n^*_{WM} = \overline{c}$ is an equilibrium.*

Proof. Suppose not and that new members above n^*_{WM} are accepted by insiders upon payment. Insiders will be willing to accept new members if the reduction in their per-capita earnings is, at least, compensated by the revenues obtained by selling new membership shares. On the other side, outsiders will be willing to pay, at most, the difference between the per-capita earnings they will get as workers-members in a WM platform and the wage offered by a CM platform. Denoting with Δc the amount of new members, the following inequality holds:

$$\underbrace{\left[\frac{r\overline{c}}{\overline{c}+\Delta c} - \frac{I(1+i)+m}{\overline{c}+\Delta c} - (1-\alpha)r\right]\Delta c}_{\text{Willingness to pay of outsiders}} \geq \underbrace{\left[\left(\frac{r\overline{c}}{\overline{c}} - \frac{I(1+i)+m}{\overline{c}}\right) - \left(\frac{r\overline{c}}{\overline{c}+\Delta c} - \frac{I(1+i)+m}{\overline{c}+\Delta c}\right)\right]\overline{c}}_{\text{Loss of insiders}} \quad (5)$$

Some algebra shows that Equation (5) holds if:

$$\alpha \geq 1, \quad (6)$$

which contradicts Proposition 1. Hence, if $\alpha < 1$, $n^*_{WM} = \overline{c}$ is an equilibrium. ■

An implication of Proposition 1 is that, under the assumption that workers are concerned only with per-capita earnings, expansion of a WM platform above size $\overline{c}$ is possible only if competing CM platforms retain all of the revenues raised by their employees, which equals to say that CM platforms pay zero wages. This paradoxical result is actually unsurprising. Theory of membership markets shows that expansion is desirable for per-capita income maximizing WM firms only if the value of the new members' marginal product exceeds the outside wage (see, e.g., Sertel (1987) and Dow (1996)). Here, new members who enter a WM platform of a size $\overline{c}$ do not find corresponding customers and, in fact, do not contribute to raise additional revenues. Hence, the new members' marginal product is zero, and so as to be the outside wage in a CM firm for condition (5) to hold.

Related to this, it is interesting to observe that, given a labour platform (and, therefore, given I, m, r and $\overline{c}$, and taking i as exogenous), for each possible number n of workers involved, the relative payoff of the workers across the two platform ownership structures depends on the overhead parameter α. As α increases, the size interval for which a WM organization is more convenient for the workers, i.e. $\left[\frac{I(1+i)+m}{\alpha r}, \frac{1}{1-\alpha}(\overline{c} - \frac{I(1+i)+m}{r})\right]$, becomes larger, on both the right- and the left-hand sides. As α decreases, this interval becomes smaller.

Definition 2. *Define α_E as $max\{\alpha : (1-\alpha)r > \pi_{WM}\ \forall n \in [0, \infty]\}$, i.e. the level of α under which WM platforms are never convenient for the workers.*

For an income maximizing WM platform of size $n = \overline{c}$, by using Equation (2) into Definition 2, we obtain that the level of α under which WM platforms are never convenient for the workers is:

$$\alpha_E = \frac{I(1+i)+m}{\overline{c}r} \tag{7}$$

where $\frac{I(1+i)+m}{\overline{c}r} < 1$, due to the participation constraint (i.e., $I(1+i)+m < \overline{c}r$). When $\alpha < \alpha_E$, workers will join only CM firms.

2.2 Extensions

2.2.1 Employment level concerns

The hypothesis that WM firms maximize only net income per-unit of labour dates back to the first formal model of workers cooperative provided by Ward (1958). Although the per-capita income maximization assumption has been extensively used in the self-management literature, it has been also showed not entirely plausible in theory (Dow, 2003) and its empirical support has been proved to be modest (Craig and Pencavel, 1992, 1993). Thus, we next relax this assumption and extend our baseline framework to possible employment concerns in WM platforms.

If WM organizations are concerned also with employment levels, they will maximize a more general welfare function than Equation (2), which can be written as follows:

$$W_{WM} = \begin{cases} \beta \left[\frac{rc}{n} - \frac{I(1+i)+m}{n} \right] + (1-\beta)n & \text{if} \quad n \leq \overline{c}, \quad \text{with} \quad c = n \\ \beta \left[\frac{r\overline{c}}{n} - \frac{I(1+i)+m}{n} \right] + (1-\beta)n & \text{if} \quad n > \overline{c} \end{cases} \tag{8}$$

where both earnings per-member and total employment enter as inputs and where β (with $0 < \beta < 1$) is the weight that a WM organization places on earnings per-member. When $\beta = 1$, then Equation (8) reduces to Equation (2), i.e. $W_{WM} = \pi_{WM}$.

Maximizing Equation (8) with respect to n and recalling from Equation (4) that the income maximizing number of customers is $\overline{c}$, we obtain the following first order condition:

$$\beta \frac{[I(1+i)+m] - r\overline{c}}{n^2} + (1-\beta) = 0 \tag{9}$$

from which we can obtain the optimal size of a WM organization concerned with both income per-worker and employment, i.e.:

$$n^{**}_{WM} = \sqrt{\frac{\beta}{1-\beta}[r\overline{c} - (I(1+i)+m)]} \tag{10}$$

Recall that $\frac{1}{1-\alpha}\left[\left(\overline{c} - \frac{I(1+i)+m}{r}\right)\right]$ is the size of a WM platform for which $\pi_{WM} = (1-\alpha)r$. Thus, if the optimal size is such that

$$n^{**}_{WM} > \frac{1}{1-\alpha}\left[\overline{c} - \frac{I(1+i)+m}{r}\right], \tag{11}$$

then Equation (8) is maximized with $\pi_{WM} < (1-\alpha)r$. Manipulating Equation (11), we can obtain the threshold level of β, below which the workers maximize their welfare by running a (relatively large) WM platform even at the price of collecting per-capita earnings lower than the monetary payoff they would get as employees in a CM organization, i.e.:

$$\overline{\beta} = \frac{r\overline{c} - [I(1+i)+m]}{r\overline{c} - [I(1+i)+m] + (1-\alpha)^2 r^2} \tag{12}$$

The survival size of an employment-concerned WM platform is the one where the following condition holds:

$$\beta(1-\alpha)r + (1-\beta)n = \beta\left[\frac{rc}{n} - \frac{I(1+i)+m}{n}\right] + (1-\beta)n \tag{13}$$

Equation (13) simplifies to $n = s_{WM} = \frac{I(1+i)+m}{\alpha r}$ (i.e., the survival size of an employment-concerned WM platform is the same as for an income maximizing WM platform). Indeed, while the ownership of the platform influences the monetary payoff of the workers, a given employment level has the same value ($(1-\beta)n$) across WM and CM organizations. Thus, the size at which being members of a WM platform is more convenient than being employees in a CM firm depends only on the income per-worker. For the same reason, we also have that the threshold level of α making WM platforms never convenient for workers is again $\alpha_E = \frac{I(1+i)+m}{\overline{c}r}$.

Moreover, from Equation (10), we can see that, for a WM organization concerned also with employment levels, an exogenous negative shock in the demand for the service translates into lower reductions of employment levels, at the price of accepting also some reduction of per-capita incomes. That self-managed firms are more inclined to adjust pay than employment in response to market changes is consistent with previous empirical evidence (Craig and Pencavel, 1992). In particular, in our model, one-unit reduction of $\overline{c}$ induces a reduction of n^{**}_{WM} by $\sqrt{\frac{\beta}{1-\beta}}r$.

In the rest of the paper, we will generally keep focusing on s_{WM} and α_E. Given that they are equal for both an income maximizing WM platform and a WM platform concerned also with employment, we will continue referring to an income maximizing stylised WM firm. This is to avoid unnecessary notation and to keep mathematics simple, not to exclude that WM firms may also maximize a convex combination of employment and dividends.

2.2.2 User-side network effects

For platform services, it is commonly the case that the more users participate to the platform, the more useful it becomes for all users. This translates into an increasing willingness to pay of customers, as the number of customers increases. Here, we take into account this possibility, by assuming that, for both WM and CM platforms, total revenues grow in the number of customers according to

$$rc^{\delta}, \tag{14}$$

with $\delta > 1$ (and reasonably close to 1) being a user-side network effect parameter.[5] Unit revenues will be rc^{δ}/c. Hence, the payoff of the workers in a CM platform will be:

$$(1-\alpha)rc^{\delta-1} \tag{15}$$

while the payoff in a WM income maximizing platform will be:

$$\pi_{WM} = \begin{cases} \frac{rc^{\delta}}{n} - \frac{I(1+i)+m}{n} & \text{if} \quad n \leq \overline{c}, \quad \text{with} \quad c = n \\ \frac{r\overline{c}^{\delta}}{n} - \frac{I(1+i)+m}{n} & \text{if} \quad n > \overline{c} \end{cases} \tag{16}$$

It is straightforward to obtain that the survival size of a WM platform (be it concerned about employment or only income maximizing), in the presence of network effects, is:

$$s_{WM} = \sqrt[\delta]{\frac{I(1+i)+m}{\alpha r}} \tag{17}$$

while the threshold level of α making WM platforms never convenient is:

$$\alpha_E = \frac{I(1+i)+m}{\overline{c}^{\delta} r} \tag{18}$$

[5] Newtork externalities may also be on the worker-side, when the number of workers is positively associated with a firm's better ability to improve the quality of the service, due to information sharing among workers and peer-effects. We consider this latter case in Appendix A, where we show that, notwithstanding a different nature of the network effects across the user-side and the worker-side cases, the main results of the model do not change substantially.

Finally, the optimal (income maximizing) size is again:

$$n_{WM}^{***} = \bar{c} \tag{19}$$

2.2.3 Coalition failure and the platform as a club good

The main results of our framework do not change substantially if we remove an implicit assumption that we have made so far. We have considered self-managed workers and capital owners as having the same capability to develop an initial entrepreneurial idea. Hence, both workers-members and capitalist entrepreneurs would only need to bear the initial investment I (i.e., the cost of the platform) for starting the business. Related to this, the tacit assumption was that there are no other costs involved in rolling-out the activity.

This is actually very rare for cooperative organizations. In fact, while the assumption of zero roll-out costs may be reasonable for CM firms, where the capital owner only needs buying the platform and posting job vacancies to hire workers, the same is less true for WM organizations, where the workers need to assemble a team of workers and to make initial collective decision-making (including that related to the interaction with programmers and creditors) before buying the platform. These coalition costs can be considered as increasing in the number of workers-members involved. Let us denote total coalition costs with $K(n)$ and define them as:

$$K(n) = kn \tag{20}$$

In the presence of positive coalition costs, standard economic intuition would predict that a free-riding problem affects the initial stage of organizing a WM firm. The benefits from forming a WM platform may be seen as a public good: the investment borne by an individual for building a via-app platform organization and for finding the workforce generates benefits that accrue to all the workers-members. Hence, none of the potential members will be willing to take over the initial stage of a platform development. In particular, a coalition failure will be more likely to arise when many workers have to coordinate simultaneously for the roll-out of a self-managed activity, as in the platform economy. This is a straightforward consequence of standard models of public goods production, which finds support both in the traditional cooperative economics literature (Staatz, 1983) and in the related experimental research (e.g., Andreoni *et al.*, 2003) and that does not need to be formally discussed.

This problem may be addressed by a WM platform by requiring members to pay a price p for membership as for a standard club good. If K is divided equally across members, the price for membership is $p = k$. As a result, per-capita earnings in an income maximizing WM organization will change with respect to our initial formulation (2) only slightly:

$$\pi_{WM} = \begin{cases} \frac{rc}{n} - \frac{I(1+i)+m}{n} - p & \text{if} \quad n \leq \overline{c}, \quad \text{with} \quad c = n \\ \frac{r\overline{c}}{n} - \frac{I(1+i)+m}{n} - p & \text{if} \quad n > \overline{c} \end{cases} \tag{21}$$

Given per-capita earnings as specified in (2), we can obtain that the survival size of a WM platform becomes:

$$s_{WM} = \frac{I(1+i)+m}{p - r\alpha} \tag{22}$$

which is obviously higher than that obtained without coalition costs, and that the threshold level of α making WM platforms never convenient is now:

$$\alpha_E = \frac{1}{r}\left(\frac{I(1+i)+m}{\overline{c}} + p\right) \tag{23}$$

3 Comparative statics and anecdotal evidence

In this Section, we perform some comparative statics to highlight how the viability of WM platforms changes in response to variations of our model's variables.

An intuitive way to investigate under which conditions a WM platform is able to improve workers' utility comparatively to a CM firm is the analysis of the pattern of s_{WM}, i.e. the minimum size at which WM platforms become attractive for workers, and α_E, i.e. the maximum level of the overhead parameter of a CM firm making WM platforms never convenient. Recall that, at a size lower than s_{WM}, WM platforms are not viable, because workers are better off as employees in a CM firm, and that, when a capitalist owner applies an overhead lower than α_E, workers obtain a relatively higher utility as employees in a CM platform at any size of the business, while the opposite holds when $\alpha > \alpha_E$.

In Figure (2), we show how the variables considered in the model influence the survival size s_{WM} of WM platforms. In particular, the model versions with network effects, with coalition costs and without both of them are disentangled (the latter is our basic model version). As discussed in the previous Section, s_{WM} does not change depending on whether the WM platform is income-maximizing or also concerned with employment, all else being equal.

[insert Figure (2) about here]

The survival size is shown to increase with I, m and i, particularly for WM firms bearing some coalition costs. In the presence of coalition costs, s_{WM} increases also with r and, to a larger extent, with α, while, when coalition costs are absent, s_{WM} is strongly reduced by higher levels of r and α. With positive network effects, moreover, the survival size of WM platforms is lower than when network effects are zero.

How α_E thresholds change across different levels of our main variables is shown in Figure (3). Again, the model versions with network effects, with coalition costs and without both of them are disentangled. As for s_{WM}, α_E does not change depending on whether the WM platform is income-maximizing or also concerned with employment, all else being equal.

[insert Figure (3) about here]

As one can notice, the maximum level of the overhead granting CM firms survival increases with I, m and i, i.e. CM firms are better able at providing improved workers' conditions when the initial investment, monitoring and organizational costs and the cost of the external capital for WM firms are high. It is worth specifying that the higher convenience of being employees at higher levels of m does not depend on a higher monitoring efficiency of CM platforms, but it is due to the fact that, in a WM firm, monitoring and organizational costs influence directly workers-members' incomes, while, in a CM firm, they rest on the employer. Interestingly enough, α_E decreases in the unit revenues (r), the equilibrium level of customers ($\overline{c}$) and the network effects parameter (δ). These results are intuitive and specific of the platform economy. When a CM firm does not pay fix wages but retains an overhead on the revenues raised by the employees, an increase in the revenues - being it due to higher unit prices and higher demand, or to network externalities - accrues to workers only partly. On the other side, in a WM platform, a unit increase in the revenues is entirely captured by the workers. Therefore, for CM firms to be attractive to workers, as the revenues increase, the overhead must decrease. That very small revenues relative to the fixed costs make WM firms' remuneration fall below the members' reservation income, thereby increasing the ability of CM firms to extract higher rents, is compatible with standard theory (Brewer and Browing, 1982; Miyazaki and Neary, 1983). More in general, the overhead applied by capitalist owners being equal, WM platforms should be more convenient for workers in higher value added activities and larger markets and when network externalities are stronger.

In addition, we also observe that, in all the panels represented in Figure (3), α_E is lower in the presence of network effects with respect to when network externalities are absent, for any value of all the other variables.

Finally, in Figure (4), we also plot the kernel density distributions of α_E and s_{WM} generated from random values of our models' variables, after 1000 iterations. Although the two sets of distributions, so obtained, present a rather low kurtosis, they are also useful to give a sense of scale of a realistic range of α_E and s_{WM}. According to our simulations, both α_E and s_{WM} might touch quite extreme values, however the probability mass of α_E is concentrated mostly between 0.2 and 0.5 (with lower values in the presence of network externalities and higher values in the presence of coalition costs), while a typical survival size may be between 2000 and 4000 workers-members (with higher numbers when both coalition costs and network effects are absent).

[insert Figure (4) about here]

Our results, specific to the platform economy, differ from previous theoretical research on worker cooperatives in at least two main ways (see Pencavel *et al.* (2006) as a representative reference).

First, we show that income maximizing WM platforms do not tend to employ a lower number of workers than their CM counterparts. Standard theory predicts that capitalist firms set employment at the level where the marginal product of labour equals the given wage, while worker cooperatives set employment at a lower level, where the marginal product of labour equals income per-worker: because the maximized value of per-worker net revenues is no less than the wage, then employment in CM firms is not less that in WM ones. In our framework, both WM income maximizing and CM profit maximizing platforms choose to employ $n = \bar{c}$ workers, as at $n = \bar{c}$ they maximize per-capita earnings and profits, respectively. In particular, this theoretical result and our simulations taken togheter, it seems unlikely that a typical WM platform would employ less than 2000 workers-members.

Second, the relationship between the optimal level of employment $n^*_{WM} = \bar{c}$ of an income maximizing WM platform and r is different from usual theory of worker cooperatives. In our model, an increase in r (due, for instance, to a positive demand shock) causes an increase in $\bar{c}$ and thereby in n^*_{WM}. We also find that n^*_{WM} is not affected by variations in I and m. Instead, standard theory would predict that employment is higher when fixed costs are greater and that, if labour is the only input, increases in unit prices of the output reduce employment (this is the so-called "perverse supply response"; see, e.g., Steinherr and Thisse (1979)).[6] Related to this, we do find, however, that increases in unit revenues and fixed costs, respectively, reduce and increase the survival size s_{WM}, with the effect of r being strong in magnitude, according to our static simulations.

Anecdotal evidence

While the comparative statics follows straight from the model previously presented and holds under the assumptions made there, it seems to be also consistent with available anecdotal evidence, though scarce.

Let us consider, first, the case of *Uber*, which is the best known CM labour platform in the private peer-to-peer transportation sector. *Uber* passes the payment of each ride on to drivers after deducting an overhead commission generally ranging between 20% and 30% (Rosenblat and Stark, 2016). Given that, in the transportation sector, network externalities are relatively low and confined to the benefits of multiple rating (apart from this, the value of a ride for the final user does not increase significantly with the number of riders), an overhead parameter between 20% and 30% is presumably lower than the α_E threshold corresponding to the fixed and operating costs, market size and average unit prices specific to the sector. And, in fact, *Uber*-like private peer-to-peer transportation activities are not based on a WM platform. They would have been probably so, if the overhead commissions applied by capitalist owners in the sector were higher and, more precisely, above 40% or 50%, according to our static simulations. This is coherent with recent descriptive statistics reported by Hall and Krueger (2017), where *Uber*'s drivers in the US are shown to receive higher earnings per hour than their driver counterparts, organized in traditional (not via-app) workers cooperatives in many US cities. Specifically, the average earnings per-hour of *Uber*'s drivers range from \$16.20 in Chicago to \$30.35 in New York, while hourly wages of taxi drivers are \$11.87 and \$15.17 respectively. *Uber*'s drivers are not reimbursed for driving expenses, such as gasoline, depreciation, or

[6] Refinements of standard theory show that the downward sloping perversity of the supply curve happens only in a low price range, where the short-run fixed cost burden becomes severe due to low revenues (Miyazaki and Neary, 1983). Others have related the output supply elasticity of WM firms to the worker-partnership market (originally, this is due to Sertel (1987)) and showed that imperfect appropriation of current members from outsiders over the surplus generated by the firm yelds employment contraction in response to an increase in output price (see Dow (2018, Chapter 9) for an overview).

insurance (though they may be able to partially deduct work-related expenses from their income for tax), while taxi drivers may not have to cover those costs. Nonetheless, the data suggest that unless their after-tax costs average more than \$6 per hour, the net hourly earnings of *Uber*'s drivers exceed the hourly wage of taxi drivers, on average, and that *Uber*'s overhead commissions are set just below the critical threshold.

Despite the popularity of CM platforms, like *Uber*, in many other sectors, there are also some notable WM exceptions that prove the rule set out in our theoretical framework.

In particular, a few WM platforms seem to be successful precisely in those activities where network effects bite the most. This is the case, among others, of *Loconomics*, which is a platform-based cooperative based in San Francisco and designed to manage short-term freelance jobs in areas like home care and child care, providing an alternative to investor-owned platforms such as *TaskRabbit* (gig work) and *Handy* (home cleaning). In this area, fiduciary issues throughout the network of users and demand aggregation effects play a significant role and generate relevant positive externalities. Related to *Loconomics*, it is also worth mentioning that financial stability of the platform was expected to be achieved with a relatively large number of workers-members, namely 2.000 member service professionals (Coca, 2017), what is consistent with our model predictions, where it is shown that the breakeven size is reached by WM platforms at a relatively high size, especially in the presence of low unit revenues. 2.000 members is, in fact, a large number if compared with the average size of worker cooperatives in more traditional sectors, which ranges from 200 to 300 workers according to available statistics for Italy (Pencavel *et al.*, 2006) and the US (Craig and Pencavel, 1992) and reduces below 100 workers for Uruguay (Burdín and Dean, 2009) and France (Pérotin, 2016).

Another experience again consistent with our theoretical conclusions is that of *Fairmondo* – a member-owned digital cooperative, launched in 2013 in Germany through crowdfunding with the aim of competing with on-line markets such as *Ebay*, that enables people to sell ethical products. Also in this area, network effects are likely to be strong. While it is difficult for separate sites of single sellers to become sufficiently visible in mainstream consumer markets, by working together through a cooperative platform many individual sellers can aggregate the demand for ethical goods and so acquire larger visibility.

Network effects of the sort referred to in our model are also strong in the photography and artist sector, where we find what is probably the most successful WM platform, *Stocksy United*, apparently unthreatened by any competing CM platform – to the best of our knowledge. *Stocksy United* is a platform-based cooperative, publicly launched in 2013 in Canada, providing a collection of royalty-free stock photography and video footage, with about 1.000 contributing members (what is, again, compatible with our static simulations).

In this area, network externalities are very powerful, as the number of customers has a significant impact on the value of the service and demand bunching dynamics may increases dramatically the perceived quality of the product and its price. Perhaps due to this, a cooperative form of platform ownership has proved in fact to be viable.

4 Conclusions

Our simple model shows that the income levels provided by a WM via-app labour platform may be better for workers-members comparatively to CM platforms. Moreover, WM platforms may adjust their size depending on workers' employment level concerns, while CM firms do not. So, why aren't usually labour platforms worker cooperatives?

With our framework, we have argued that this may be the result of a mix of causes. In particular, WM platforms are shown to be better viable when the initial cost of the platform and the cost of external capital for financially constrained workers are lower and in environments characterized by high revenues and positive network externalities. Moreover, all else being equal, when CM platform owners retain an overhead commission below a certain critical threshold, workers are better off as employees in a CM firm. Whilst being intuitive, these findings are also suggestive, as they fit available anecdotal evidence showing that WM platforms are confined to activities related to on-line trade of ethical goods and artistic products, where demand bunching effects matter. On the other side, where network effects are milder and overhead commissions are set strategically by CM firms, as in the peer-to-peer transportation sector, WM via-app platforms are virtually absent.

While providing a contribution to both the stylization of via-app labour platforms and to the literature on the rarity of WM organizations, needless to say, the model also suffers from some limitations. First, we referred to a general platform firm, being it CM or WM, without disentangling possible variants of via-app activities. A broad distinction may be traced among the various forms of commercial digital labour platforms according to whether the platform deals with cloud work (web-based) or gig work (location-based). Location-based platforms provide services and tasks which are bound to a specific location (this is the case of *Uber*, for instance). When it is so, the total number of potential customers (i.e. the potential demand) at a geographical level is finite and may be entirely served by a single sufficiently large firm. This introduces the issues of market power and market structure, that influence the way prices and workers' earnings are determined. Moreover, we didn't consider many additional aspects, which may play some significant role in the framework, including crowdfunding, as a way to raise finance at a relatively low costs for financially constrained workers, effort and productivity levels, which may differ across diverse ownership structures (also depending on an endogenous sorting of workers), and the fact that workers in a WM firm may maximize a more complex welfare function where democratic participation is inherently valued, in addition to per-capita earnings and employment level, and where also income stability and job stability are included.

A Worker-side network effects (endogenous effort)

Suppose that, at a cost e, the worker can share information that increase the quality of the service or that improve the ability of other workers to raise higher unit revenues. Moreover, assume that algorithmic monitoring reduces to zero the possibility of shirking. Let us normalize normal effort to zero and consider that the cost of the additional (cooperative) effort needed to share information with colleagues equals 1, so that $e = \{0, 1\}$. While $e = 0$ is contractible, i.e. we have no shirking (due to algorithmic monitoring), $e = 1$ is not contractible, i.e. the worker may or may not exert additional effort above 0. Suppose that the cooperative effort exerted by one worker causes the other workers to increase unit revenues by Δr. Clearly, in a CM firm, where the wage is determined as $(1-\alpha)r$, the worker has no incentive to exert cooperative effort, since he is paid a fraction of individually raised revenues and the cost $e = 1$ translates only into higher wages for the rest of the workforce. In a WM firm, where total revenues are divided equally, the worker may have incentive to improve partners' performance.

Consider the case of an income maximizing WM platform, where $n = c = n^*_{WM} = \bar{c}$. For a worker being cooperative, his payoff after exerting $e = 1$ must be higher than that with $e = 0$, even if he is the only worker choosing the cooperative strategy. Formally, the payoff of the worker concerned with the possibility of exerting additional effort, under the belief that the other workers are not, is:

$$\pi_{WM} = \left[r - \frac{I(1+i)+m}{n}\right](1-e) + \left[\frac{r + (r+\Delta r)(n-1)}{n} - \frac{I(1+i)+m}{n}\right]e \tag{24}$$

Some simple algebra shows that a worker will thus choose exerting cooperative effort $e = 1$ if:

$$\frac{\Delta r(n-1)}{n} > e \tag{25}$$

If condition (25) holds, all the workers will opt for $e = 1$. Hence, the final per-capita income will be:

$$\pi_{WM} = \frac{n(r + \Delta r(n-1))}{n} - \frac{I(1+i)+m}{n} \tag{26}$$

which can be rewritten in a more compact form, as:

$$\pi_{WM} = rn^{\rho-1} - \frac{I(1+i)+m}{n} \tag{27}$$

with $\rho = \frac{\ln(n(r+\Delta r(n-1))}{\ln(n)+\ln(r)}$. As it can be easily noticed, per-capita incomes raised by workers in a WM platform with worker-side externalities of the type modeled here have the same form as in the case of user-side network effects (except for the fact that the user-side network parameter δ may be different from the worker-side one, ρ). On the other hand, under worker-side externalities, the workers' payoff in a CM firm remains unchanged with respect to the baseline case and, precisely, equal to $(1-\alpha)r$. Hence, to make some simple comparative statics without further calculation, assuming that $\delta = \rho$, we will have lower s_{WM} and α_E in the case of worker-side than in the case of user-side network effects. This reinforces the conclusion that, when network effects are present (whether they be on the user- or worker-side), WM platforms are relatively better viable than when newtork externalities are absent.

B Buyouts

Suppose that a CM platform is already established and that it is profit-maximizing. Under the assumption that a WM platform would maximize per-capita earnings, the workers will opt for a buyout only if, by running their own platform, they expect to get overall profits greater than the compensation asked by the capital owners for selling their platform plus the cost of rising the external finance needed for the buyout and if the per-capita earnings of the self-managed workers will be higher than the monetary payoff they would get as employees in a CM firm. Formally, the following conditions must hold:

$$\begin{cases} rn_{CM} - m > [rn_{CM} - (I + m + n_{CM}(1-\alpha)r)](1+i) \\ \frac{rn_{CM}-m}{n_{CM}} - \frac{[rn_{CM}-(I+m+n_{CM}(1-\alpha)r)](1+i)}{n_{CM}} > (1-\alpha)r \\ n_{CM} = \bar{c} \end{cases} \tag{28}$$

where $n_{CM} = \bar{c}$ must hold if the existing CM platform is profit-maximizing.[7] Manipulating, we can obtain that the conditions for which a buyout is convenient for the workers simplifies to

$$i < \frac{I}{r\bar{c}\alpha - (I+m)} \tag{29}$$

i.e., income-maximizing workers will opt for a buyout only if the interest rate is lower than a certain

[7] We are not considering coalition costs here. One may argue that also the coalition costs for setting a buyout up are positive (Dow, 2018, Chapter 13). While this might be true, however, it is reasonable to normalize these costs to zero, as the workers of a CM platform already have relevant information on the platform's characteristics and on their potential partners, who are those involved as employees in the CM firm.

threshold. In particular, this threshold is decreasing (and therefore condition (29) is more restrictive) as $\overline{c}$ and the unit revenues increase.

Condition (29) may be in fact very strict, as the total revenues of an established and profit-maximizing CM platform may be much higher than the initial cost of the platform, so that the threshold showed in Equation (29) may be very low. Hence, Equation (29) also suggests that workers are more likely to buyout less efficient platforms (that is, platforms with a relatively high cost-to-revenue ratio).

References

[1] Abraham, K., Haltiwanger, J., Sandusky, K. and Spletzer, J. (2017) Measuring the gig economy: Current knowledge and open issues. In *Measuring entrepreneurial businesses: Current knowledge and challenges*, NBER Book Series Studies in Income and Wealth.

[2] Alchian, A. and Demsetz, H. (1972) Production, information costs and economic organization. *American Economic Review*, 62: 777-795.

[3] Andreoni, J., Harbaugh, W. and Vesterlund, L. (2003) The carrot or the stick: Rewards, punishments, and cooperation. *American Economic Review*, 93(3): 893-902.

[4] Bai, C.E. and Xu, C.G. (2001) Ownership, incentives and monitoring. LSE Discussion Paper no.te/01/413. London School of Economics, London.

[5] Belloc, F. (2017) What deters labor-owned firm creation? Evidence from Italian manufacturing sectors. *Journal of Comparative Economics*, 45(1): 139-153.

[6] Bonin, J.P., Jones, D.C. and Putterman, L. (1993) Theoretical and empirical studies of producer cooperatives: Will ever the twain meet? *Journal of Economic Literature*, 31: 1290-1320.

[7] Bowles, S. and Gintis, H. (2008) The democratic firm: An agency-theoretic evaluation. In Bowles, S., Gintis, H.A., Gustafsson, B. (Eds.), *Markets and Democracy: Participation, Accountability and Efficiency*. Cambridge University Press, Cambridge, pp. 11-39.

[8] Brewer, A.A. and Browing, M.J. (1982) On the 'employment' decision of a labour-managed firm. *Economica*, 49(194): 141-146.

[9] Burdín, G. (2016) Equality under threat by the talented: evidence from worker-managed firms. *Economic Journal*, 126(524): 1293-1633.

[10] Burdín, G., and Dean, A. (2009) New evidence on wages and employment in worker co-operatives compared with capitalist firms. *Journal of Comparative Economics*, 37: 517-533.

[11] Coca, N. (2017) Interview to Joshua Danielson, available at https://www.shareable.net/blog/how-loconomics-empowers-gig-workers (last access Feb 26, 2018).

[12] Craig, B. and Pencavel, J. (1992) The behavior of workers cooperatives: The plywood companies of the Pacific Northwest. *American Economic Review*, 82:1083-1105.

[13] Craig, B. and Pencavel, J. (1993) The empirical performance of orthodox models of the firm: Conventional firms and worker cooperatives. *Journal of Political Economy*, 102(4):718-744.

[14] Cramer, J. and Krueger, A.B. (2016) Disruptive change in the taxi business: The case of Uber. *American Economic Review: Papers and Proceedings*, 106(5): 177-182.

[15] Dow, G.K. (1996) Replicating Walrasian equilibria using markets for membership in labor-managed firms. *Review of Economic Design*, 2(1): 147-162.

[16] Dow, G.K. (2003) *Governing the firm: Workers' control in theory and practice.* Cambridge, UK: Cambridge University Press.

[17] Dow, G.K. (2018) *The labor-managed firm: Theoretical foundations.* Cambridge, UK: Cambridge University Press.

[18] Dow, G.K. and Putterman, L. (2000) Why capital suppliers (usually) hire workers: What we know and what we need to know. *Journal of Economic Behavior and Organization*, 43, 319-336.

[19] Grossman, S.J. and Hart, O.D. (1986) The cost and benefit of ownership: a theory of vertical and lateral integration. *Journal of Political Economy*, 94(4): 691-719.

[20] Hall, J.V. and Krueger, A.B. (2017) An analysis of the labor market for Uber's driver-partners in the United States. *Industrial and Labor Relations Review*, forthcoming.

[21] Hansmann, H. (1996) *The ownership of enterprise.* Harvard University Press, Cambridge, MA.

[22] Harris, S.D. and Krueger, A.B. (2015) A proposal for modernizing labor laws for twenty-first-century work: The "Independent Worker". The Hamilton Project, Discussion Paper 2015-10, Brookings.

[23] Hart, O.D. and Moore, J. (1990) Property rights and the nature of the firm. *Journal of Political Economy*, 98(6): 1119-1158.

[24] Huet, E. (2014) How Uber's shady firing policy could backfire on the company. *Forbes*, October 30.

[25] Hueth, B. and Marcoul, P. (2015) Agents monitoring their manager: A hard-times theory of producer cooperation. *Journal of Economics and Management Strategy*, 24(1): 92-109.

[26] Kandel, E. and Lazear, E.P. (1992) Peer pressure and partnerships. *Journal of Political Economy*, 100(4): 801-817.

[27] Katz, L.F. and Krueger, A.B. (2016) The rise and nature of alternative work arrangements in the United States, 1995-2015. *Industrial and Labor Relations Review*, forthcoming.

[28] Krueger, A.B. (2018) Independent workers: What role for public policy. *The Annals of the American Academy of Political and Social Science*, 675(1): 8-25.

[29] Miyazaki, H. and Neary, H.M. (1983) The Illyrian firm revisited. *Bell Journal of Economics* 14: 259-270.

[30] Pencavel, J., Pistaferri, L. and Schivardi, F. (2006) Wages, employment and capital in capitalist and worker-owned firms. *Industrial and Labor Relations Review*, 60(1): 23-44.

[31] Pérotin, V. (2016) What do we really know about worker co-operatives? Co-operatives UK Report.

[32] Podivinsky, J.M. and Stewart, G. (2007) Why is labour-managed firm entry so rare? An analysis of UK manufacturing data. *Journal of Economic Behavior and Organization*, 63(1): 177-192.

[33] Putterman, L. (1984) On some recent explanations of why capital hires labor. *Economic Inquiry*, 22: 171-187.

[34] Rogers, B. (2017) The social costs of Uber. *University of Chicago Law Review*, 82(1): 85-102.

[35] Rosenblat, A. and Stark, L. (2016) Algorithmic labor and information asymmetries: A case study of Uber's drivers. *International Journal of Communication*, 10: 3758-3784.

[36] Sertel, M.R. (1987) Workers' enterprises are not perverse. *European Economic Review*, 31(8): 1619-1625.

[37] Smith, R. and Leberstein, S. (2015) Rights on demand: Ensuring workplace standards and worker security In the on-demand economy. National Employment Law Project, Report. New York.

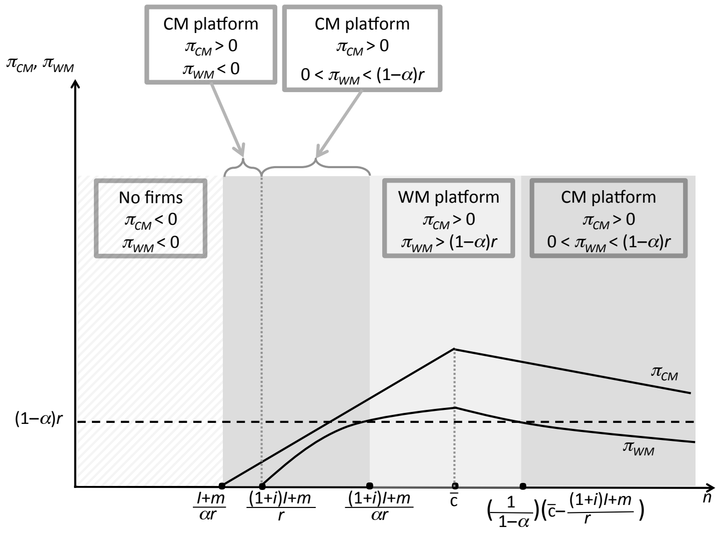
[38] Staatz, J.M. (1983) The cooperative as a coalition: A game-theoretic approach. *American Journal of Agricultural Economics*, 65(5): 1084-1089.

[39] Steinherr, A. and Thisse, J.F. (1979) Are labour managers really perverse? *Economics Letters*, 2(2): 137-142.

[40] Uber Newsroom (2015) New survey: Drivers choose Uber for its flexibility and convenience. Retrieved from: https://newsroom.uber.com/driver-partner-survey/. Last access 9 Feb 2018.

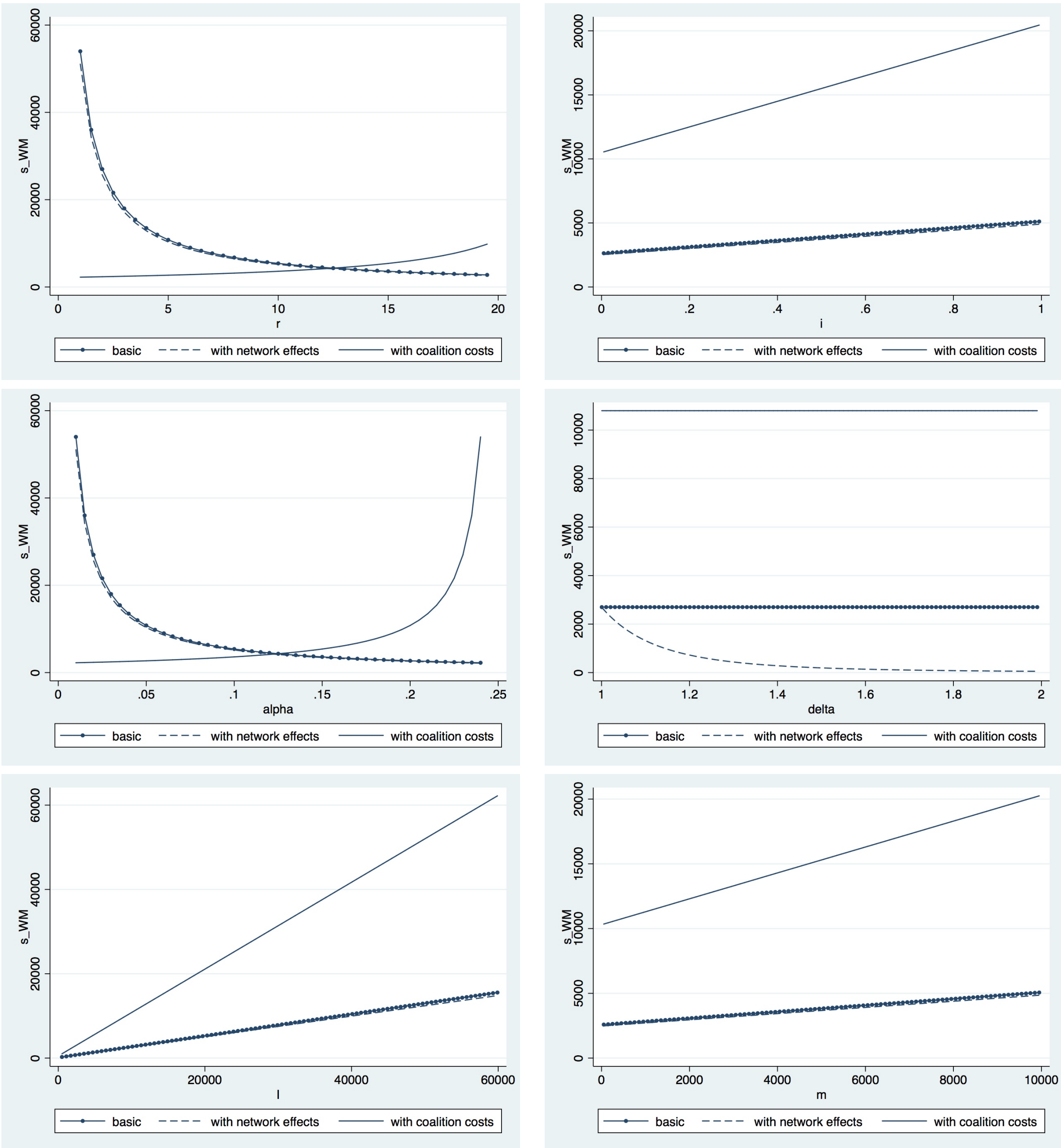
[41] Ward, B. (1958) The firm in Illyria: market syndicalism. *American Economic Review*, 48: 566-589.

Figure 1: Per-capita earnings and the emergence of CM and WM via-app labour platforms.



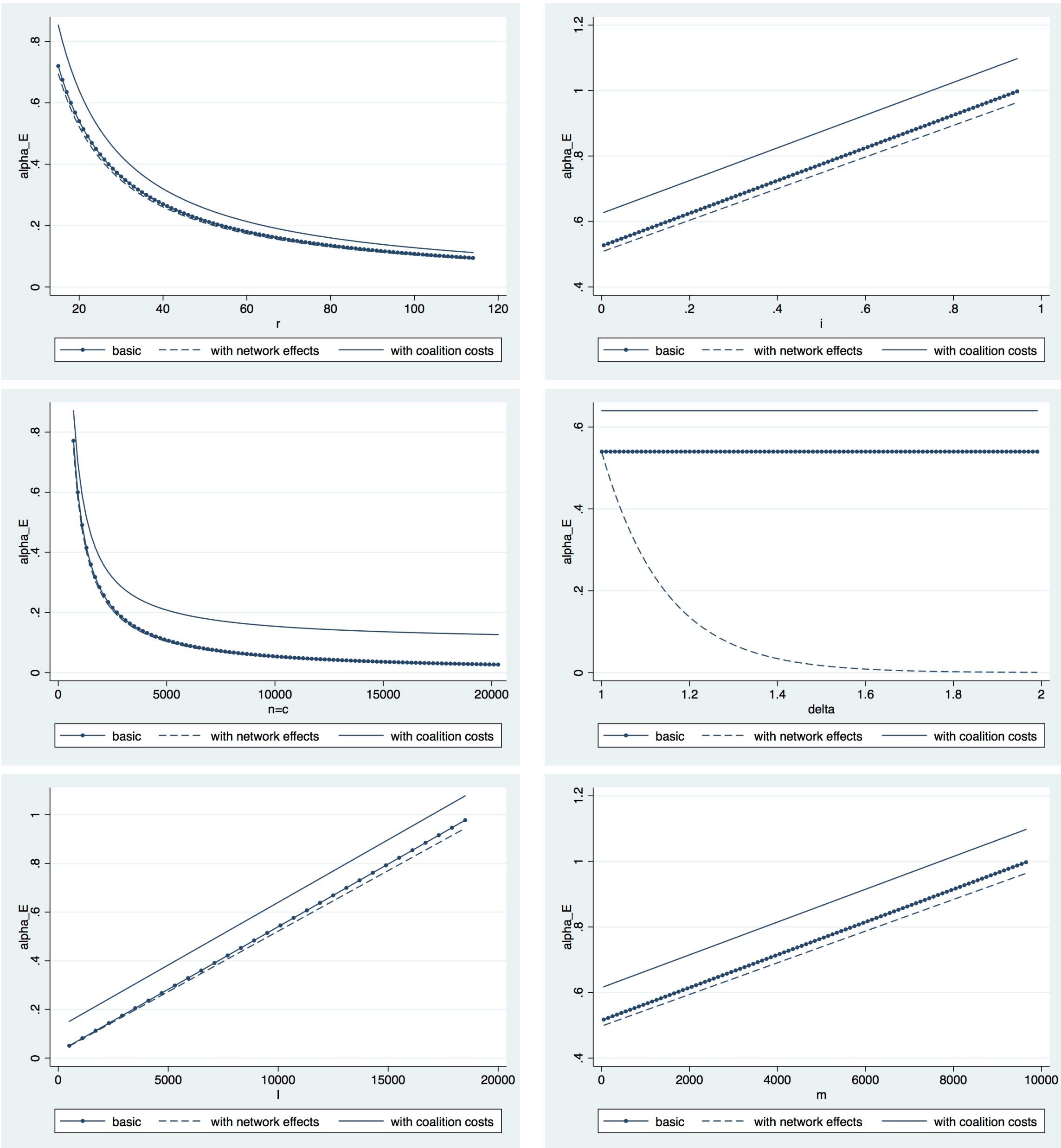
Note: I = initial sunk investment for platform provision; i = interest rate; m = workers organization and monitoring costs; $\bar{c}$ = equilibrium number of customers; r = revenues per unit of service; n = number of workers employed; α = overhead parameter to be paid to capitalist employers.

Figure 2: Minimum size at which WM platforms become attractive for workers.



Note: each panel shows s_{WM} patterns across different levels of the models' variables, considered separately. s_{WM} patterns obtained by means of different model's versions are disentangled: "basic" (without network effects and coalition costs), "with network effects" (and without coalition costs), "with coalition costs" (and without network effects). Recall that s_{WM} does not change depending on whether the WM platform is income-maximizing or also concerned with employment, all else being equal. Symbols: I = initial sunk investment for platform provision (in \$); i = interest rate; m = workers organization and monitoring costs (in \$); α = overhead parameter; r = revenues per unit of service (in \$); δ = network externalities parameter; n = number of workers-members. Baseline parameters are set as follows: $r = 20$, $i = 0.03$, $\alpha = 0.2$, $d = 1.005$, $I = 10000$, $m = 500$, $p = 2$.

Figure 3: Maximum levels of α making WM platforms never convenient.



Note: each panel shows α_E patterns across different levels of the models' variables, considered separately. α_E patterns obtained by means of different model's versions are disentangled: "basic" (without network effects and coalition costs), "with network effects" (and without coalition costs), "with coalition costs" (and without network effects). Recall that α_E does not change depending on whether the WM platform is income-maximizing or also concerned with employment, all else being equal. Symbols: I = initial sunk investment for platform provision (in \$); i = interest rate; m = workers organization and monitoring costs (in \$); $\bar{c}$ = equilibrium number of customers; r = revenues per unit of service (in \$); δ = network externalities parameter. Baseline parameters are set as follows: $r = 20$, $i = 0.03$, $n = \bar{c} = 1000$, $d = 1.005$, $I = 10000$, $m = 500$, $p = 2$.

Figure 4: Simulated levels of α_E and s_{WM} from random values of the model's variables (1000 iterations).

$omitted \quad for \quad reasons \quad of \quad file \quad dimension \quad (2m \quad limit)$

Note: kernel density distributions of α_E and s_{WM} generated from random values (1000 iterations) of the models' variables, with $r \in [5, 50]$, $i \in [0.005, 0.5]$, $d \in [1.00001, 1.1]$, $I \in [500, 50000]$, $m \in [50, 5000]$, $p \in [1, 10]$, $\alpha \in [0.05, 0.5]$. Different model's versions are disentangled: "basic" (without network effects and coalition costs), "with network effects" (and without coalition costs), "with coalition costs" (and without network effects). Recall that both α_E and s_{WM} do not change depending on whether the WM platform is income-maximizing or also concerned with employment, all else being equal.