Crowdsourcing the Last Mile[1]

Michael D. Bradley

George Washington University

Jeff Colvin

USPS Office of Inspector General

Mary K. Perkins

Howard University

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[1] The views presented in this paper are those of the authors, and do not necessarily represent those of the Office of the Inspector General, the US Postal Service, or any other organization.

M. D. Bradley
Professor
Department of Economics
George Washington University
Washington, DC, USA

J. Colvin
USPS Office of Inspector General
Arlington, VA, USA

M. K. Perkins
Graduate Professor
Department of Economics
Howard University
Washington, DC, USA

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UPS can put a driver on every block every day, Uber can put a driver on every block every minute – Ryan Peterson

. . . delivery systems are more likely to succeed with top-down optimization, no matter how badly a sharing economy corporation tries to screw its non-employee employees – Michael Byrne

1. Introduction

Recently, crowdsourced ridesharing companies have made moves to expand horizontally into last-mile package delivery. This sets up a potential competitive struggle between the national hub-and-spoke companies (NHS) and such crowdsourced delivery companies over the last mile delivery market. This is an issue hotly debated on the Internet,[2] but one which has thus far received relatively little academic attention.[3]

The delivery market is dominated by the NHS companies, like UPS, DHL, FedEx, and posts, whose optimized networks enjoy scale and scope economies. Fully private delivery companies employ very different business models from national posts, but they both thrive on density, including multiple pieces per stop and/or a large number of stops per geographic area. Such companies also maintain significant physical assets, such as a delivery fleets and staging centers.

[2] See Petersen (2015) and Byrne (2015).

[3] There has been keen interest in the economics of the 'sharing economy' generally, and also in analysis of crowdsourced grocery delivery, but so far not much on ridesharing companies wishing to expand into adjacent markets (see and Kung and Zhong, 2017)

Crowdsourced ridesharing platforms, such as Uber and Lyft, have achieved significant penetration of the passenger service industry. They have done so through constructing a two-sided platform linking consumers seeking rides with independent drivers and have avoided investing in a large physical network. Such companies have been quite successful at attracting capital; Uber's valuation is sometimes claimed to be as high as $70 billion making expansion possible. These companies are now moving into the same day delivery (SDD) market (see Jinks, 2016).

The question is whether such crowdsourcing companies can take enough volume from the NHS companies to grow their own networks. It seems clear that, at least initially, it would be difficult for crowdsharing delivery platforms to compete with the NHS on a national scale, given the vast NHS network of air and truck package delivery capacity. Moreover, NHS companies earn much of their profit on long-haul package transportation.

Nevertheless, the last mile is important to NHS companies, perhaps more so in the future if the demand for Same-Day Delivery (SDD) demand displaces some of the demand for Next-Day or Two-Day delivery service. Uber, like other ridesharing companies, lacks an inter-city gig infra-structure, but it does have an intra-city gig infrastructure in some cities with potential scope economies between passenger service and parcel delivery which might be capable of competing successfully for B2C parcel delivery (about 45% of US domestic package volume), especially if a significant portion of B2C demand is sliced off into SDD. Crowdsourcing delivery strength in SDD delivery may be further enhanced by the trend toward reliance upon fulfillment centers, which effectively decouples last mile delivery from long-haul transportation.

Not only are there likely scope economies between ridesharing packages and riders, ridesharing companies have introduced some novel pricing strategies that might strengthen their hand in the last-mile package market. For instance, the prices offered to riders, which affects the payment to drivers, can be manipulated to accommodate network effects. Uber famously manipulates its ridesharing prices on an ongoing basis to discriminate amongst consumers and to determine the supply of drivers on the road at a given hour, increasing rates at peak time to smooth demand for trips, but also to increase the supply of drivers (see Hall, *et al*, 2016). In the package delivery space, they could just as well influence the drivers on the road to enhance their package delivery network. This ability to readily change the capacity of the delivery network could provide an advantage in the face of stochastic variations in demand.

In effect, the crowdsourced platform provides consumers with a fleet of on-demand delivery services, setting the stage for a contest between instant delivery and NHS local, next-day residential shipments. Of particular concern to an NHS company is the potential fall in the NHS share of urban volume, which could force the delivery giants to rely on the rural delivery market, a lower margin business.

In this paper, we investigate the conditions under which a crowdsourcing, two-sided platform could successfully enter the same day package delivery market. We model the pricing decisions of the platform under which it both sets prices to consumers receiving package delivery and rates paid to independent drivers delivering the packages. We determine conditions under which ridesharing provides can successfully complete with NHS companies and investigate conditions in the market that facilitate ridesharing provides achieving successful entry. Section 2 reviews literature on the topic, Section 3 summarizes lessons learned from existing attempts to establish crowdsourced delivery networks, Section 4 brings up some issues in Integrating ride-sharing and goods delivery. The model is introduced and analyzed in Section 5 and Section 6 concludes.

2. Literature Review

There is a growing literature on the general topic of two-sided markets, per se and the role of two-sided platforms in the economy. Armstrong, (2006), Rochet and Tirole (2003), and Eisenmann, *et al* (2005) are some of the classic works on the subject. What distinguishes a market with two 'sides' is fundamentally the external effect of actions of one set of consumers, those on one side of the market, upon another set, those on the other side, or other sides in the case of multiple-sided markets. This characteristic of such markets, dubbed "cross-side network effects," highlights the increase in the value to consumers on one side of a market as the number participants increases on the other side.

Some well-known examples of two (or more) sided markets are eBay (brings together buyers and sellers), Airbnb (connects property owners and renters, Uber (connects drivers and passengers), and Facebook (brings together users, advertisers, and game developers). Less sexy examples include shopping centers (retailers and shoppers), credit cards (merchants and consumers), and newspapers (advertisers and consumers).

Of particular interest to economists are the implications for pricing brought on by the presence of cross-side effects. Pricing on one side of the market depends not only on the demand sensitivity and marginal cost of the commodity, but also on the impact of changes in participation on the value of the market on the other side. Hence, the elasticity of response of one side to changes in participation, and therefore on prices, on the other, figures importantly in determining the profit maximizing price. [4] And since the same is true on the other side of the market, prices on either side depend upon elasticities and marginal costs on both sides.

A related issue is the so-called chicken-and-egg problem, sometimes encapsulated in the phrase 'no side will join while the other side is missing.' A critical mass of participants on one side is needed to attract participants on the other. Once the network is mature it may stay in business owing to its significant entry barrier, but how to get started? One way sometimes chosen is to subsidize one side or the other, especially in the early phases of the growth of the network. For example, a delivery platform, that will ultimately earn its profit from the difference between the delivery charge to the consumer and the payment to the driver, might delay taking profits, essentially allowing drivers to keep the entire delivery fee, until a sufficient number of drivers join the market to attract consumers to using the service. Of, if the concern is to grow the number of consumers, the platform may offer free delivery, effectively subsidizing the ordering consumers.[5]

In an insightful paper, Hagiu (2014) describes the strategic issues companies in multi-sided markets need to confront.[6] Hagiu indicates there are at least three. The first issue is how open the platform should be. Openness refers to the number of open sides of a platform and to just how open they are. Many platforms include more than two open sides. Opening more sides, in principle, increases cross-side effects and revenue, but may entail a risk of friction among the sides. An example of both is LinkedIn, which puts together professional, recruiters and advertisers and gets significant revenue from each side. But in seeking to add a fourth side,

[4] See Rysman (2009)
[5] "Penetration pricing" and similar strategies are discussed in …
[6] Hagiu (2014)

corporate users, the company may suffer the loss of professionals, who may not appreciate the presence of their own bosses on the system.

A platform can choose to 'close' a side. The NHS companies operate with a closed driver side and a crowdsourced delivery platform might decide to hire its deliverers. Alternatively, a platform might partially close a side by developing the ability to provide the services currently being performed by the participants of a side, and then compete with them. For example, Amazon might choose to open last mile delivery to many sources, choosing the cheapest or best competitor, then change course and buy trucks to deliver its own retail products. Generally, such a closure makes it harder for participants of the previously open side to compete, once the platform provider offers a substitute.

Of course, a platform could also elect to open a side previously under its own control, though at the cost of losing control over the quality of the service. In general, more open sides leads to larger cross-side effects, larger scale and diversified sources of revenue, but openness might create excess complexity on the platform and entail collisions of conflicting interests.

Haigu (2014) also indicates that multi-sided markets present complex pricing challenges. It will generally be more profitable to charge a higher price to the side with less price sensitivity. However, the appropriate price needs to recognize not only sensitivity of demand of a side with respect to price but as well to sensitivity with respect to the number of participants on the other side. _Lastly, Haigu(2014) emphasizes the importance of platform governance. This decision involves a trade-off of quantity and quality. In other words, the attraction of a side is not solely a function of the number of participants. In some cases, restricting access to a side will enhance its strength. The dating service eHarmony has stringent requirements for participation beyond a willingness to pay the membership fee. Access is restricted to avoid creating a "market for lemons" in which high quality dates are driven from the market. As discussed in Kontio (2016), goods delivery services, who put together drivers and consumers, sometimes partially close the driver side by requiring drivers to take training or pass tests. This is done in the interest of improving quality, after the initial goal of establishing a network has been accomplished.

3. Strategic Considerations in Crowdsourcing Goods Delivery

The home delivery market is mainly served by the NHS companies, who have benefitted significantly from its rapid growth. However, last-mile delivery is not always profitable. Distances between stops, variation in pieces/stop (cross sectional and longitudinal), varying demand for delivery times, make optimization challenging. All the usual difficulties in optimization of the last mile are made more critical with the growth in on-demand (two hour, one hour, same day, etc.) delivery.

Crowdsourcing offers a different approach to the delivery optimization problem, one that involves opening the driver side of the market. The design of a delivery platform rests on engaging drivers to make deliveries, vastly expanding the capacity of the network and reducing the 'fixed cost' incurred by NHS companies.[7] This is in contrast to NHS companies, who keep closed the driver side of their market and fight for the volume of packages to defray the cost of maintaining permanent employees and fleets of trucks.

[7] Such a development is highly dependent on technology, especially mobile technology. On the mobile technologies enabling the expansion of crowdsourcing into goods delivery, see Rouges & Montreuil (2014).

Kontio (2016), who conducted a survey of crowd-shared good delivery platforms, discusses cases of platforms growing by opening an additional side. A grocery delivery company, for example, may begin with just two sides: drivers and consumers. But once the company has enough consumers, it can sometimes open a third side by getting a retail grocer to offer groceries at a discount, essentially paying to participate in the delivery platform, and then either take profits, pay drives more or charge consumers less. The retail grocer not only gets more consumers but pays a reduced cost of last-mile delivery as horizontal scale economies make it costlier to offer a delivery system from each store, as opposed to a horizontally integrated grocery delivery business that serves many retail grocers.

Grocery delivery companies have sometimes found adding a third side profitable, but it does make governance more complicated, especially regarding quality. In store data may not match web site data, for example.

Alternatively, there are cases where delivery platforms have closed a side by hiring their drivers as full-time employees. The purpose is typically to increase reliability and availability of service to consumers. This has occurred where the flexibility of crowdsourced driver supply allowed a platform to make a profit even at low volume, but also resulted in infrequent and unreliable deliveries. In some cases, drivers were hired full-time to operate in the busiest areas. The hired drivers and the crowdsource drivers worked in parallel in busy areas.

Moreover, the flexibility of crowdsourcing is what distinguishes a delivery platform from traditional shipping companies. Closing a side (hiring deliverers) would trade off the flexibility that allows them to expand into the market without high upfront cost. Further, flexibility helps to avoid risk: platforms can operate profitably even in uncertain environments prone to demand fluctuations.

"Some of our (noncrowdsourcing) competitors are very slow to expand. It just shows how expensive it is to expand when you've got a fleet of drivers to pay and have to make sure you give them constant work" – YellowGrocer, quoted in Kontio (2016)

Regarding pricing, the users are generally divided into subsidy side users and the users that pay for the subsidy, the money-side users. The subsidy side users are generally the most price-sensitive that provide a large externality for the other sides of the platform. The money side users benefit the most from the other side's activity.

However, there is significant variation among goods delivery platforms as to which is the subsidy side and which is the money side. In other words, consumers might be subsidized by very low delivery prices to get enough consumers used to this kind of delivery. Or, drivers might get a premium, paid for by the consumers or financed by the platform, until there are enough to provide a delivery frequency sufficient to attract a critical mass of consumers. These features vary both among firms and over the life cycle of individual platforms.

Market developments, such as a need for improved quality, might require a change in the magnitude or even the direction of subsidy. Higher prices for higher quality might improve delivery quality if it entails expensive investment, or other cost on the deriver side. Hence prices can be used to regulate the platform. Uber peak (or bad weather) pricing is great example, drivers provide high quality rides (that is rides that are reliable irrespective of weather) for a higher price. Those unable to provide that quality drop out.

Strength of network effects depend not only on the number of users and the interactions among them but also on the quality of the service. It is as if service quality on the network were supercharged, leading to reduced demand on both sides. Low quality (e.g., slow delivery time, lost items) delivery could so reduce demand by consumers that the number of drivers collapses, further reducing the value of the network consumers.

As a delivery platform matures and the number of drivers comes to match demand, the platform may lower driver remuneration in order to lower fees to consumers. It may be important to lower remuneration because excess competition – fewer orders per driver – can actually reduce the value of the platform to deliverers.

4. Integrating Ride Sharing and Goods Delivery

Amazon has made initial efforts to utilize crowdsourcing for delivery of packages. The company advertises Amazon Flex to those wanting to earn from $18 - $25 per hour while setting their own schedule.[8] As reported in 2015, the company's plan is to sign up retailers to store packages. Then drivers would use an app to learn pickup and delivery points, required delivery time, etc.[9] At the same time, Uber, Postmates and Instacart are all seeking to develop their own logistical networks for package delivery.[10]

Like any platform, a delivery platform that expands ride-sharing operations into package delivery faces the problem of realizing sufficient network effects to attract a crowd, though in this case the crowd is already assembled, it just needs expansion into the new activity. And again, the complications of managing a platform arise as soon as it engages entities on both

[8] See Amazon (2017).
[9] See (Binsinger (2015)
[10] *Ibid.*

sides. In the case of ridesharing – goods delivery integration, a platform would put together drivers with senders (the other side of the platform), where the value of the platform increases for consumers increases as more drivers are available to go more places at more times, and at some point the platform may subsequently need to alter its strategy to improve delivery quality by partially closing its driver side, taking on some of the risks formerly associated with the NHS companies it may (partially or fully) replaced.

5. The Model

This model is designed to identify the characteristics of a same-day delivery market that would permit a ride-sharing platform to enter and compete with a traditional large-scale delivery enterprise. The market we describe is local, same-day delivery of packages from retail stores to consumers.

Prior to the entry of the ride-sharing platform, same day service is provided by a monopoly NHS company. The NHS monopoly has built its network to serve the multi-day delivery market (one- or two-day delivery), by comparison to which the same-day market is small. For that reason, we assume the NHS monopolist has little incentive to alter the structure of its delivery network to capture the relatively small same-day volume.

Consequently, the quality of the delivery, essentially the delivery time, provided by the NHS company is low relative to the willingness of consumers to pay for more rapid delivery. This leaves room for entry by crowdsource package delivery enterprise that can beat the NHS service quality.

Consider entry by a two-sided delivery platform, connecting ride-sharing drivers with consumers seeking delivery of packages. The driver goes to the retail store, picks up the package and delivers it to the consumer. For this service, the platform charges the consumer a fee, ρ, and the driver is paid a fee denoted by δ. To study this market development, we apply the general framework proposed by Kung and Zhong (2017) for understanding the economic structure of a two-sided platform delivery firm in a sharing economy.

In this framework, consumers gain by participating in the two-sided delivery platform if the time for delivery is less than the hub-and-spoke and/or the price of delivery is less than p_H. Following Kung and Zhong, we treat the perceived quality, q, of package delivery as a function of delivery time, in which quality increases as delivery time decreases. Since delivery time falls as the number of drivers, n_d, increases, and quality is a function of delivery time, we specify that quality is a positive but decreasing function of the number of drivers. To grasp the intuition behind this specification, compare the impact of doubling the number of drivers in a given area to adding a single driver to a mass of, say, twenty drivers already present. Hence,

$$q = n_d^{\propto}, 0 < \propto < 1.$$

Consumers are heterogeneous with regard to their willingness to pay for rapid same day delivery. The array of consumers is uniformly distributed over this preference interval, and indexed by θ on the interval $(0, 1)$. $N > 0$ is the expected number of orders per consumer in the time period. The utility a consumer enjoys from participation in the platform is given by

$$U(\theta)=N(\theta(q - \underline{q}) - \rho),$$

where $\underline{q}$ is the quality provided by the NSA delivery company. The consumer will join the platform coalition if $U(\theta) > 0$.

We next model drivers, The driver incurs a cost c_d to pick up and deliver a parcel and experiences disutility from labor, indexed by (λ)[11]. Drivers earn net income of δ - c_d and their utility is found by comparing net income to their disutility. Hence, since

$$V(\lambda) = N(\delta - c_d - \lambda)\left(\frac{n_c}{n_d}\right)$$

drivers will join if $V(\lambda) > 0$.

Since N is the expected orders per consumer per time period, $Nn_c\frac{n_c}{n_d}$ is the expected number of packages per driver. Therefore, there exists a critical value $\theta*$ such that a consumer joins if and only if $\theta > \theta*$ and a critical value $\lambda*$ such that a driver joins if and only if $\lambda < \lambda*$.

This means that

$$n_c = 1 - \theta* \text{ and } n_d = \lambda*.$$

The platform's profit function is given by

$$\Pi_{\rho,\delta} = Nn_c(\rho - \delta)$$

We can gain some insight into the solution by examining the utility functions for a given ρ and δ. Recall that consumers join the market when $\theta > \theta*$, so that $U(\theta^*)$= 0.

$$U(\theta^*)=N\left(\theta^* {n_d}^{\alpha} - \underline{\theta} - \rho\right) = 0$$

Note we use $\underline{\theta}$ to capture the level of utility associated with use of the hub and spoke network for delivery. This is associated with $\underline{q}$ is the quality provided by the NSA delivery company.

Drivers will join so long as their disutility is less than their net income, or $\lambda < \lambda*$, $V(\lambda^*)$ will equal zero for the marginal driver. Hence,

[11] We include such items as wear and tear on their vehicles in the drivers' cost.

$$V(\lambda^*) = N\left(\frac{1-\theta^*}{\lambda^*}\right)(\delta - c_d - \lambda^*) = 0.$$

Solving yields

$$\theta^* = \frac{\rho+\theta}{n_d^{\alpha}} = \frac{\rho+\theta}{\lambda^{\alpha}}$$

As θ^*declines there are more orders for delivery coming from consumers. And as ρ increases or $\theta*$ increases, there are fewer consumer orders. But as n_d rises, more drivers and more consumers enter the market.

Solving also yields:

$$\lambda^* = \delta - c_d$$

Recall that $V(\lambda) > 0$ for all $\lambda < \lambda*$, so as $\lambda*$ falls, fewer drivers participate in the market. As δ rises or c_d falls, more drivers enter. And this also means more consumers join the market as an increase in n_d implies an increase in q.

We can now express the platform's profit maximizing problem as:

$$\Pi^* = \max_{\rho,\delta}\left[1 - \frac{\theta+\rho}{\delta - c_d}\right]\big(N(\rho-\delta)\big)$$

for which the first order conditions are

$$\frac{\partial\pi^*}{\partial\rho} = \frac{-(\delta-c_d)^{\alpha}}{[(\delta-c_d)^{\alpha}]^2}\big(N(\rho-\delta)\big) + N\left[1 - \frac{\theta+\rho}{\delta-c_d}\right] = 0$$

and

$$\frac{\partial\pi^*}{\partial\delta} = \frac{\alpha(\delta-c_d)^{\alpha-1}(\theta+\rho)}{[(\delta-c_d)^{\alpha}]^2}\big(N(\rho-\delta)\big) + N\left[1 - \frac{\theta+\rho}{\delta-c_d}\right] = 0$$

These conditions can be solved for the profit maximizing values of ρ and δ. However, because of the complexity of the first order conditions, it is not feasible to solve for the profit maximizing charge to consumers and payment to drivers analytically. To gain insight into the factors influencing those rates, the resulting profits and the numbers of drivers and consumers that participate in the platform we solve the model numerically. To facilitate the investigation, we choose values for the parameters and exogenous variables that support an interior solution in which the platform exists and both drivers and consumers participate.

Recall that the model assumes a continuum of consumers and a continuum of drivers, both defined by the uniform distribution in [0, 1]. Thus, the number of participating consumers and drivers will fall between zero and one. We set the expected number of packages sent per unit time at 10, although this value plays no role in the first order conditions or the profit maximizing values for ρ or δ. We initially set α at a value of 0.25, and we set $\underline{\theta}$ to a value of 0.05. A low value for this parameter is required for an interior solution. If consumers get relatively high utility from the monopoly NHS company, then it will not be possible for the platform to find a positive set of prices that will yield a positive profit. In other words, the platform would not be able to enter the market. Finally, we set the driver's cost of making the delivery to 0.10.

The next table presents the profit maximizing rates along with the values for θ^*, λ^*, profits and the proportions of consumers and drivers participating. The values themselves have no particular meaning but can be used as the basis for calculating numerical comparative statics. In addition, the relative values of the solutions can be compared. For example, the model provides a value for the charge to consumers that is above what the platform pays drivers, allowing the platform to make positive profits.

Baseline Solution

ρ	0.3588
δ	0.2022
θ*	0.4472
λ*	0.1022
Π	0.4338
Nc	0.5528
Nd	0.1022
Nc over Nd	5.4085

Our first comparative statics exercise, is to increase the cost to the driver for making the delivery. The driver's cost is increased by 50 percent from 0.10 to 0.15. As one would expect, this leads to a large (29 percent) increase in the payment to drivers. A higher payment is needed to entice drivers to participate in the platform. It also leads to a higher charge to consumers, as the platform is attempting to preserve profit. However, the consumer charge increase is just 10 percent and the platform must avoid driving too many consumers out of the platform. The number of participating consumers does fall and this, combined with a smaller profit margin per delivery causes profit-maximizing profits to fall. In contrast to the decline in participating consumers, the number of participating drivers increases slightly. The increase in the value of the network to consumers, from the external cross effect, is swamped by the increase in the delivery charge. As shown above, a profit maximizing platform will be forced to raise the driver payment and the delivery charge to consumers. A platform more concerned about growth over time might forego the profit, temporarily, to grow the network.

Increasing Cd

ρ	0.3941
δ	0.2610
θ*	0.4808
λ*	0.1110
Π	0.3069
Nc	0.5192
Nd	0.1110
Nc over Nd	4.6763

Our next experiment is to assume a higher level for $\underline{\theta}$, (increasing it by 50 percent) the utility associated with provision of delivery by the hub and spoke company. A higher value means the crowdsourcing platform is facing a more challenging environment in which consumers are getting a higher level of satisfaction from the NHS provider.

Increasing θ Bar

ρ	0.3515
δ	0.2066
θ*	0.4828
λ*	0.1066
Π	0.3674
Nc	0.5172
Nd	0.1066
Nc over Nd	4.8503

In this environment, the platform charges a lower price to consumers in order to overcome their resistance to participating in the platform. The charge to drivers is slightly higher as is the number of drivers who participate, which provides a higher level of utility for consumers at a given price. Not surprisingly, the number of consumers participating in the platform is smaller in this environment leading to a reduction in profit.

The last experiment is to increase α, the rate at which increases in the number of drivers increase quality, as perceived by consumers by 50 percent.

Increasing α

ρ	0.3422
δ	0.2471
θ*	0.4448
λ*	0.1471
Π	0.1857
Nc	0.5552
Nd	0.1471
Nc over Nd	3.7748

A higher value for α leads to a higher rate earned by drivers but a lower price charged to consumers. This leads to an increase in both participating drivers and participating consumers. However, the decrease in the difference between the two causes the platform's profits to be lower.

The model helps to illustrate the tradeoffs facing the platform. An increase in δ, given ρ, will result in more drivers *and* consumers, because of the positive cross-side external effect, but lose profit. That these lower profits may make the increase in driver payment unsustainable, as the model shows. In fact, the platform will have to raise ρ to avoid losing profit. However, as we have seen, some crowdsource delivery companies have chosen a path to a larger network in the longer term that sacrifices short term profits.

An important aspect of integrating a ride-sharing platform with delivery could be the cost complementarity experienced by drivers. Drivers that are already close by, as a result of the passenger business, will experience little of no added disutility or cost from the package delivery. This will shift λ* or C_d, so that the number of drivers below the critical disutility value will increase, and n_d will rise. On the other hand, if drivers experience diseconomies of scope in the expansion, disutility will increase relative to net income and there will be fewer drivers. Similar effects will be present for changes in driver cost, regardless of the cause.

The model shows that successful entry by the platform depends crucially on beating the hub and spoke company in perceived quality. As the gap between the service quality of the platform and the hub and spoke company narrows, the number of consumers interested in the platform falls.

The power of the cross effect is evident in the model. As expected, fees and market participants grow as the cross effect gets larger. However, the platform in unable to raise the delivery charge and still keep enough consumers in the market, and so loses profits.

The strategic decisions before the platform is whether to take profits initially or let the network grow by allowing drivers to keep all or nearly all of the delivery charge, i.e., by setting $\rho = \delta$. At a later stage of development the question of openness will emerge; the platform may consider hiring its own drivers as full-time employees, though in that case the new platform would resemble a local version of the NHC it has replaced. Such a solution would not appear stable.

With regard to openness, it bears mentioning that Uber is not entirely open on the driver side, owing to its bilateral rating system. A partial closing that eliminates low quality drivers might serve to raise the value of the network to consumers beyond the value based solely on the number of drivers.

6. Conclusions

In this paper, we have developed a model of equilibrium delivery charges and driver remuneration rates for an ‘uberized’ delivery operation. Naturally, much of the action in the two-sided markets is dynamic, and incorporates issues of short term losses, subsidies and expected future growth through network effects. However, most two-sided platforms fail, so it is of value to investigate the conditions for one to succeed in last mile delivery. Future research on the time path of such strategic decisions through time would be interesting, as would empirical research on the parameters identified. This latter will have to wait, of course, for further market experimentation.

Apart from purely economic considerations, this business model faces an array of challenges. Who is responsible for lost or damaged packages? How willing are customers to welcome a new set of deliverers onto their porch? An important part of the model is the ‘nonworker’ status of drivers, to which there are substantial legal challenges in many countries.

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