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Regulation of the North American Taxicab Industry

Kuzey Amerika'da Taksi Sektörünün Düzenlenmesi

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ABSTRACT

We examine the evolution of taxi regulation in North America, providing a history of North American taxi regulation. We study the current structure of taxi regulation by generally looking at regulations in North America and specifically looking at regulation in New York City, the Boston metropolitan area, and Los Angeles. We discuss theoretical justifications for these regulations. By examining how the taxi industry differs from other industries, we explain the prevalence of price and quantity regulations, and why the industry remains heavily regulated despite numerous attempts at deregulation. We discuss the cost of current regulations and how emerging technologies may face similar regulatory challenges but may also offer new opportunities.

Keywords: Taxi; Regulation

ÖZET

Kuzey Amerika'daki taksi düzenlemesinin evrimini inceleyerek Kuzey Amerika'daki taksi düzenlemesinin tarihini ortaya koyuyoruz. Özellikle New York şehri, Boston metropol bölgesi ve Los Angeles'taki düzenlemeleri inceleyerek Kuzey Amerika'daki taksi düzenlemesinin güncel yapısını araştırıyoruz. Bu düzenlemeler için teorik gerekçeleri tartışıyoruz. Taksi endüstrisinin diğer endüstrilerden nasıl ayrıldığını inceleyerek, fiyat ve miktar düzenlemelerinin yaygınlığını ve düzenlemeleri kaldırmak için çok sayıda teşebbüse rağmen bu endüstrinin neden yoğun olarak düzenlendiğini açıklıyoruz. Mevcut düzenlemelerin maliyetini ve yeni ortaya çıkan ve yeni fırsatlar sunabilecek olan teknolojilerin nasıl benzer düzenleyici zorluklarla karşılaşabileceğini tartışıyoruz.

Anahtar Kelimeler: Taksi; Düzenlenme

1. Introduction

The North American taxicab industry is highly regulated, frequently including both price and entry regulation. A casual glance at the industry suggests that it would foster competition; there are few specialized skills needed to drive a taxi, and the cost of entering the industry is relatively low. All that is required to enter is a suitable vehicle and metering equipment. In cities where the primary mode of contracting is through a dispatcher, entrants also need to incur the modest cost of acquiring dispatching technology. Despite these low costs of entry, the taxi industry is one of the more highly regulated industries. This article examines the regulation of the taxi industry in North America. It looks at the history of taxi regulation, the industry's current regulatory structure, and theoretical justifications for the observed regulatory structure.

Taxi regulation in North America began in the 1920s and 1930s. Over time, most major cities adopted some form of price and quantity regulation. There was a trend to deregulate the industry in the 1970s and 1980s; however, this trend has since been reversed. Most municipalities that deregulated their taxi industries later reintroduced many of the regulations that they eliminated. The current regulatory structure in most jurisdictions, including the ones that experimented with deregulation, include some form of price and entry regulation. In addition to price and entry regulations, other forms of regulation are also common, including service-level regulation, safety and quality of service regulation, and regulation aimed at accomplishing other objectives.

A critical difference between the taxi industry and other industries with low barriers to entry is the nature of the search process. Passengers and drivers are at different locations and need to coordinate as part of the transaction process. Taxi service is provided using one of three methods; drivers cruising the street searching for passengers, passengers and drivers meeting each other at taxi stands, or passengers contacting drivers through a dispatcher. Each of these contracting methods has different sources of

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inefficiency and is better suited to specific types of taxi markets; cruising and taxi stands are more prevalent when there is a higher density of passengers whereas dispatching is more prevalent when the density of passengers is lower.

An unregulated taxi market will be inefficient under each method of contracting, and the types of regulations commonly observed in the taxi industry can improve efficiency. In unregulated taxi markets, the price and vacancy rates are not efficient. When contracting through cruising or taxi stands, the vacancy rate is not explicitly chosen as part of the contracting process. Many price and vacancy rates give drivers zero expected profit, so the equilibrium price and vacancy rates are unlikely to be efficient. Under dispatching, there are economies of scale. In unregulated markets, there will be either a few dispatchers with market power or many small dispatchers. When there are many small firms, there is inefficiency due to duplication of fixed costs. When there are few dispatchers, the dispatchers will choose an inefficiently high price. A regulated price can correct these issues.

Although contracting inefficiencies may justify price regulation, they do not explain the quantity regulation present in most cities. If contracting inefficiencies were the only source of inefficiency, regulators could regulate the price and allow entry. Because the second-best outcome has zero driver profit (Arnott, 1996), the corresponding equilibrium vacancy rate would be efficient. However, most municipalities have quantity restrictions. Quantity regulation may be preferred to free entry when there is an externality caused by taxi traffic or a regulatory preference towards driver profit. If the driving process creates a sufficiently large externality on surrounding traffic or the regulator has a sufficiently large preference towards driver profit, the price and quantity regulations we see in practice could be justified.

Regulation that increases the number of taxis during off-peak hours and in low-demand locations can increase efficiency. Efficiency can be increased through cross-subsidization, using the profit when demand is high to subsidize increased service levels when demand is low. To increase demand during off-peak periods, a regulator can require drivers to operate taxis for a minimum number of hours a day. To ensure adequate service levels in low demand locations when taxi service is provided by dispatchers, regulators can require dispatchers provide service sufficiently quickly after being contacted by a passenger. Both of these forms of cross-subsidization use the profit when demand is high to subsidize losses when demand is low.

When cruising taxis provide taxi service, cross-subsidization cannot be used to increase service levels because taxis will search for passengers at the most profitable locations. This search behavior may cause there to be too much congestion in high demand locations or inadequate service levels in low demand locations. Exclusive cruising regulations can designate a group of taxis that only has the right to provide service in specific locations, thereby increasing the service provided to these locations while preventing drivers from searching for passengers in the high demand location. In each of these instances, efficiency can be increased by adopting regulations that increase service levels when demand is low.

Safety and service quality regulations can improve efficiency because these aspects of quality are difficult for passengers to observe when choosing a taxi. Because quality is difficult to observe, passengers cannot take it into account. When quality is unregulated, drivers will choose levels of quality that are too low. Drivers have an incentive to choose a slightly lower quality level than the other drivers because passengers are unlikely to refuse a taxi with a slightly lower quality than other taxis. In the absence of safety regulations, the incentive to choose a slightly lower quality than other taxis places downward pressure on quality. The presence of price and quantity regulations may give drivers a further incentive to provide low safety levels, as taxis cannot use price as a way of signaling quality.

Although economic arguments may justify the observed regulations, there are costs of imposing these regulations. Consumers and drivers are negatively affected by quantity regulation. Consumers face higher prices and lower service levels than would be present in the absence of entry restrictions. Fewer drivers are hired, resulting in lower wages. The regulatory structure also limits the ability for the price and quantity to respond to the changes in demand throughout the day, potentially leading to low vacancy rates during peak demand periods. The presence of mobile dispatch platforms, such as Uber and Lyft, has caused an increase in the cost of inflexible prices and qualities. The mobile dispatch platforms can adjust their prices and quantities in real time to the current market conditions.

The article proceeds as follows: Section 2 provides an overview of the history of taxi regulation in North America. In Section 3, we examine the types of regulatory frameworks typically present in North American municipalities, focusing on the institutional structures in New York City (NYC), the Boston Metropolitan area, and Los Angeles. We consider different modes of contracting for service in taxi markets in Section 4. In Section 5, we provide normative justifications for the current regulatory structures. We examine the cost of current regulations in Section 6. Section 7 concludes by discussing how regulation of the taxi industry may be applied to new trends in personal transportation, such as rideshare and driverless cars.

2. History of Regulation and Deregulation

Regulation of the taxi industry has historical roots in the regulation of horse-drawn carriages in London. The London Hackney Carriage Act of 1831 (London, 1831) is similar to current taxi regulation. The act required carriages to obtain a license to provide service to passengers on the street. It imposed a maximum fare that drivers could charge their passengers. The regulations also required drivers to provide non-discriminatory service; drivers could not refuse any passenger willing to pay the fare. There were basic elements of service-level regulation, including the requirement that drivers treat passengers courteously.

Regulation of the North American taxi industry started later. Before the industry was regulated, there was considerable entry and exit. In NYC, between 1923 and 1930, the number of taxis operating in a given year varied significantly. The average yearly absolute change was 10.8% (Shreiber, 1975). The number of drivers tended to vary counter-cyclically with economic output (Davis, 1998). Complaints of high prices (Shreiber, 1975; Dempsey, 1996) and low prices (Davis, 1998) have both been suggested as initial motivations for regulation of the taxi industry. Both high prices and low prices coincided with low driver profit, as high prices often coincided with low occupancy rates (Shreiber, 1975).

The movement to regulate the North American taxi industry originated in the 1920s. This movement was supported by governments and the taxi industry. Before NYC introduced taxi regulation, various Mayor's Committees of New York City suggested that the occupancy rates were too low and that reasonable service levels could be provided by reducing the number of taxis by 20% – 30% (Shreiber, 1975). Established taxi companies were also pushing for more regulation (Davis, 1998). Both taxi companies and mass transportation companies were concerned about competition from carpooling services[1] (Davis, 1998).

Taxi regulation started to become common in North American cities in the 1930s (Dempsey, 1996). In the early stages of regulation, authority was delegated to either state governments or municipal governments. Over time, decisions have increasingly been carried out at the municipal level (Dempsey, 1996). Early regulation typically restricted prices and entry. Some regulations limited the tasks that drivers were able to carry out, limiting or eliminating carpooling services. Restrictions were placed on the characteristics of vehicles used for providing taxi service, often requiring that taxis be equipped with specific metering technology. Early regulations were also geared towards ensuring certain working standards for the drivers, including maximum work days and minimum wages (Davis, 1998).

In the 1970s and 1980s, there was a movement to deregulate the taxi industry. The structure of deregulation varied by city. Some cities only removed entry restrictions whereas others also eliminated price regulations. A majority of the cities that deregulated their industry later chose to reintroduce regulation (Dempsey, 1996). Business groups from other industries were among those advocating for the return to regulation, due to concerns that the deregulation deteriorated the quality of service (Frankena and Pautler, 1986).

Municipalities that deregulated price saw little competition at taxi stands (Schaller, 2007; Teal and Berglund, 1987). Prices increased more in municipalities that relied more on cruising and taxi stands for contracting than they did in municipalities which heavily relied on dispatch. In municipalities that deregulated entry, many of the new entrants went to taxi stands at hotels and airports and had a negligible impact on service levels (Teal and Berglund, 1987). The expectation that passengers take the next available

[1]We use carpooling service to refer to the situation where a single for-hire vehicle picks up multiple passengers. The earlier literature refers to this as rideshare; however, this is term currently commonly used for peer-to-peer ridesharing.

taxi continued to prevail, resulting in limited price competition at taxi stands.[2] In some cities, there was an increase in reported refusals of service and no-shows that coincided with the deregulation process (Teal and Berglund, 1987). The reversal of deregulation resulted in a return to quantity controls and price regulation (Schaller, 2007).

Although there were issues with the deregulation process, there were also issues in cities that did not experiment with deregulation. Cities that did not deregulate their industry, such as Boston and NYC, were often slow to adjust their regulated quantities to changing demand. In these two cities, the number of licensed taxis changed very little despite changing economic conditions. In NYC, the number of taxis remained the same between 1941 and 2006 (Ashenfelter et al., 2010), despite a substantial increase in the population over that time. Despite the number of taxis remaining fixed, the price periodically increased.

3. The Structure of Regulation

Taxis are regulated at the municipal level, and there are similarities in the structure of these regulations. Most municipalities regulate taxi fares, requiring drivers adhere to a specific fare structure. Regulators frequently limit the number of taxis that can provide service, restricting entry at either the taxi or firm level. Some cities have regulation aimed at providing adequate service levels during off-peak hours and in low demand locations. Municipalities have regulations aimed at improving service quality. There are other regulations aimed at accomplishing social goals, such as improving access for passengers with reduced mobility. In each of these areas of regulation, we provide a general characterization of the common types of regulations.

As there is some variation in taxi regulation from one municipality to another, we examine the regulations in three major American metropolitan areas. We choose to look at NYC, the Boston metropolitan area, and Los Angeles because they offer a range of regulatory frameworks. The Boston metropolitan area includes three municipalities that border each other: Boston, Cambridge, and Brookline. In addition to looking at NYC and Los Angeles, we discuss relevant regulations from each of these municipalities.[3]

3.1 Price Regulation

Municipalities typically have price regulation requiring drivers adhere to a prescribed fare structure. The fare structure includes a fixed component for entering the taxi, and variable components for distance traveled and time spent idle. Municipal regulators may also have fees for additional services. These include extra fees for trips to and from the airport, handling luggage, having additional passengers, and using taxi services during specific times of the day. Los Angeles and the Boston metropolitan area both have fees that passengers pay when they take taxis to and from the airport. NYC has surcharges based on the time of day, charging higher rates during the evening rush hour and at night. Some municipalities give drivers limited flexibility to set their fares below the regulated rate. Los Angeles allows drivers to offer a senior's discount of up to 10%. Cambridge allows drivers to charge a lower rate at their discretion.

Other models of pricing exist but are less common. Zone pricing divides the city up into zones, calculating the total price based on the zones that drivers drive through. Washington DC used zone pricing until 2008 when it was discarded for the typical regulated fare structure (Sabar, 2008). The zone structure is more commonly used for long trips outside the service area. NYC has zone pricing for trips outside of the city. Similarly, Boston, Cambridge, and Brookline use zone rates when drivers make trips outside of the Boston metropolitan area. Los Angeles uses a fixed price for trips from the airport to downtown Los Angeles. NYC uses a fixed rate for all trips from the airport.

Some municipalities choose not to regulate the fare structure. These municipalities either impose a maximum price to prevent opportunistic behaviors by drivers or choose not to restrict prices. Phoenix is one of the only major cities in North America that has an entirely unregulated price (Schaller, 2007).

3.2 Entry Regulation

Municipalities can regulate entry at the driver or firm level. When entry is regulated at the driver level, individual drivers can enter the industry. When entry is

[2]This norm is not universal. Williams (1980) said this norm was not present in Melbourne, and that the experience there with a deregulated price was generally positive.

[3]The regulations can be found in Town of Brookline Transportation Board (2015), New York City Taxi & Limousine Commission (2017a, 2017b, 2017c), City of Los Angeles (2017a, 2017b), City of Cambridge Board of License Commissions (2017), and Boston Police Department (2008).

regulated at the firm level, only firms meeting specific standards can enter. These standards may include providing dispatch service, having a minimum fleet size, and providing service for a minimum number of hours each day. Regardless of whether entrance is carried out at the driver or firm level, regulators can choose whether to prevent additional entry.

At the driver level, entry is frequently restricted using medallions. Each medallion grants its owner the right to drive a single taxi in the regulator's jurisdiction. Medallions are transferable assets that can be bought and sold. They usually have a positive selling price, providing evidence that they restrict entry. In many municipalities, the medallion price is so high that few drivers can afford to own medallions. In these municipalities, medallions are usually owned by investors who rent them out to drivers.

At the firm level, entry is often restricted using 'public convenience and necessity' regulations. Under these regulations, potential entrants need to show that their entrance would provide sufficient benefit to the public. For instance, potential entrants may be required to show that their entrance would sufficiently decrease the wait time or increase service quality. Depending on the regulator's interpretation of "public convenience and necessity," this could make entering the industry quite difficult. Regulators may also place restrictions on the fleet sizes of established firms.

Schaller (2007) categorizes entry regulation for 43 North American municipalities, based on whether entry is at the driver or firm level and whether entry is restricted. There were only four cities in his survey that allowed entry of taxis at the individual level and did not limit entry; Washington (DC), Phoenix, Indianapolis, and Orange County (FL). There were only two cities in the survey that only allowed entry at the firm level but did not restrict the entry of firms, Orange County (CA) and San Jose. The remaining 37 municipalities had some form of entry restriction; 21 choosing entry restrictions at the driver level and 16 choosing entry restrictions at the firm level. Of the cities we investigate, there is a mixture of driver-level entry restrictions and firm-level entry restrictions. Los Angeles and Brookline restrict entry at the firm level, whereas Boston, Cambridge, and NYC have a medallion system.

3.3 Service-level Regulation

Some municipalities require companies to provide adequate service levels. Service-level regulation typically takes one of two forms: minimum service level regulation and exclusive cruising regulation. Minimum service regulation requires that companies maintain minimum service levels, either requiring companies to provide service sufficiently quickly or to maintain a sufficiently large number of operating taxis. The town of Brookline requires that dispatchers provide service within a sufficiently short period as a condition of being licensed to provide service.

Exclusive cruising regulations occur when a taxi market is divided into multiple affiliated locations, with restrictions placed on which drivers can pick up passengers. A single municipality may subdivide the municipality into multiple affiliated locations, restricting which areas the drivers can pick up passengers. An individual municipality may do this to ensure that there are adequate service levels in low demand locations of the municipality. Los Angeles and NYC specifically chose to divide their city into multiple affiliated locations, placing restrictions on where drivers can pick up passengers. Alternatively, exclusive cruising may occur in metropolitan areas when municipalities prevent drivers affiliated with other municipalities from picking up passengers, as is the case in the Boston metropolitan area.

Los Angeles subdivides its municipality into multiple zones. Each taxi company is affiliated with a subset of the zones. Drivers are not able to cruise for passengers outside their affiliated zones. Although regulations do not prevent taxi companies from providing dispatch services to customers outside of their affiliated locations, the city imposes regulations aimed at reducing the amount of dispatch service provided to unaffiliated locations. Taxi companies are prevented from advertising outside of their zone and are required to have a phone number with an area code that is associated with their zone. Companies also have the right to refer passengers outside their affiliated area to a taxi firm that is affiliated with the passenger's location.

NYC adopted a form of exclusive cruising regulation in 2014. Previously, NYC had one type of taxi which provided service to the entire city. Due to high demand in the inner city, most of the drivers chose to provide service in central Manhattan. The service levels in the outer boroughs of the city were too low, resulting in long wait times and unlicensed vehicles providing service in these areas. The city created a type of medallion that only allows the driver to serve the outer boroughs of the city, aiming

to combat the illegal market and provide adequate service to the outer boroughs. These "Street Hail Livery Service" vehicles are painted an apple green color and are only able to provide service to the outer portions of the city. The original Yellow taxis continue to be able to provide service throughout the entire city. Beyond the exclusive cruising restriction, the Street Hail Livery Service vehicles have the same general regulatory structure as the Yellow taxis.

In the Boston metropolitan area, exclusive cruising occurs due to multiple municipalities being near each other. Each municipality has regulations preventing drivers affiliated with other municipalities from picking up passengers. Drivers frequently drive passengers from one municipality to another and cannot pick up passengers at their destination. They are forced to return to their original municipality before they can pick up another passenger.

3.4 Safety and Quality of Service Regulation

Municipalities have regulations aimed at increasing the safety of passengers. Basic safety regulations apply to drivers and taxis, resembling safety regulations in other transportation industries. Municipalities impose additional regulations aimed at improving observable aspects of service quality, such as the cleanliness of the taxi.

Municipalities typically require drivers have a special license, have a clean driving record, and pass a training and certification course to drive a taxi. Drivers are also required to pass a background check. Regulations requiring drivers have additional insurance are also common. These regulations are present in most cities, including the cities we examine. Cities may impose additional requirements aimed at improving safety. In Los Angeles and NYC, drivers are subject to periodic controlled substance testing. Drivers that test positive for controlled substances have their license suspended. Boston requires drivers to have an American driver's license for at least two years before they can drive a taxi.

There are also regulations aimed at ensuring that taxis are in good working order. Most municipalities require that taxis have periodic vehicle inspections, often at a rate that is more frequent than regular passenger cars. All the cities we examine require regular inspections. Taxis in NYC are subject to inspections every four months. Taxis in Brookline are subject to inspections every six months. Taxis in Los Angeles and Cambridge are subject to inspections every year. The maximum vehicle age is also regulated in most cities. The maximum age varies by municipality. Boston taxis can operate for up to six years, with owner-operators able to operate their taxi an additional year. NYC taxis can operate for seven years. Los Angeles has a maximum taxi age that is between eight and ten years depending on the type of vehicle. Brookline requires all taxis put into service must be new cars and limits the total mileage of the taxi to 300,000 miles.

Most municipalities have regulations ensuring that minimum service levels are maintained. These regulations require drivers achieve minimum fluency in English and maintain a certain standard of appearance. Brookline and Los Angeles's place restrictions on the types of clothes that drivers can wear. Drivers are also required to keep their taxi clean and in good physical shape. All the cities we examine require that taxis be clean. Additionally, Boston and Brookline require that the taxi's inside and outside is washed daily. In Los Angeles, vehicles can be taken out of service because of "unsightly dirt, grime, and stains inside and out including trunk."

Municipalities often place restrictions on the nature of vehicles that can be used as taxis. Regulating the color of taxis ensures that they are easily identifiable. Los Angeles and Brookline require that taxis conform to an approved vehicle coloring scheme, with the company name and telephone number on the vehicle. Taxis in NYC are all painted yellow or green, corresponding to their medallion type. Boston, Cambridge, and Brookline each require taxis have their affiliated municipality's name on the outside of the taxi. Regulators frequently restrict the characteristics of the vehicle, ensuring that the vehicle has adequate space for passengers. It is also common to limit the amount and type of advertising that is permissible. The cities we examine all have limits on advertisements on and inside the vehicle.

Regulations for electronic payment are also common. Municipalities often require that taxis have this equipment. Some regulations also either prevent or limit the surcharge that drivers can charge for the use of the payment mechanisms. The cities that we examine require that drivers accept electronic payments. In NYC, taxis are also required to have a display panel that shows the location of the taxi and the current fare as part of the electronic payment system.

3.5 Other Regulations

Regulators typically enact regulations aimed at providing non-discriminatory service. The regulated

fare structure typically requires that drivers charge all passengers the same fare, regardless of their characteristics. Drivers are not able to refuse passengers and are required to drive passengers to their desired destination, regardless of the location. These regulations exist in all the cities that we examine; however, drivers are known to refuse fares on unprofitable trips. In areas that are subject to exclusive cruising, drivers have a stronger incentive to refuse service when passengers demand trips to unaffiliated locations.

There are regulations aimed at improving equity, which tend to be more diverse. In some municipalities, regulations require that a certain number of taxis have specialized equipment to assist individuals with disabilities. These regulations are present in Brookline, where a portion of each fleet must have this equipment. NYC collects taxes on fares to provide subsidies to buyers of taxis with equipment that improves accessibility. Brookline and Boston offer senior's discounts, increasing the affordability of taxi service for passengers with limited mobility. There are also regulations aimed at increasing drivers' wages. Cambridge requires that drivers on commission must receive a sufficiently large share of total receipts. NYC has maximum rates that taxi owners can charge drivers for leasing vehicles and medallions.

Municipalities enact regulations that create incentives for taxis to be environmentally friendly. To increase the use of environmentally friendly vehicles, Boston has more relaxed regulations on the minimum passenger space in hybrid vehicles. Cambridge and NYC also provide incentives for medallion owner to purchase environmentally-friendly vehicles.

4. Contracting Structure of Taxi Markets

The search process is an important consideration in taxi markets. Passengers searching for taxis incur the cost of waiting for drivers, the cost of contacting drivers, and the cost of walking to the location where they meet drivers. Having a greater number of vacant taxis decreases each of these costs. Drivers incur search costs due to the time it takes to find passengers, the cost of contracting with the passenger, and the cost of driving to the passengers' location. The costs that passengers and drivers incur depend on their method of contracting.

There are three methods that passengers and drivers use to contact each other; drivers can cruise the street looking for passengers, drivers and passengers can meet at taxi stands, and passengers can use a dispatch service to contact drivers. Each of these modes of contracting imposes different types of costs on passengers and drivers; therefore, the prevalence of each of the methods in a city depends on the characteristics of the city and regulations that support or impede the methods of contracting.

Cruising taxis drive around the city searching for passengers. A passenger desiring taxi service signals the cruising taxi. The driver picks up the passenger and drives to the passenger's desired location. Cruising drivers can choose the location where they search for passengers and focus their search on locations with a higher likelihood of finding a passenger. Despite being able to direct their search, drivers do not know the exact location of passengers and do not always drive to the nearest passenger.

Taxi stands are predefined locations for passengers and drivers to meet. Taxi stands usually have places for drivers to wait when they arrive and find no available passengers. Drivers and passengers go to the taxi stand knowing that there is a large number of trips originating from the location. Taxi stands are set up by local governments, at places on public streets and airports, and by private companies, at places like malls and hotels. Taxi stands are stationed at these locations because there is a high density of nearby passengers, making it easy for drivers to find passengers.

In dispatch markets, passengers contact firms that send drivers to the passengers' locations. Dispatchers were traditionally contacted via telephone, but it is increasingly common for dispatching through smartphone technology. Once contacted, the dispatcher sends a driver to the passenger's location. The dispatched taxi drives straight to the passengers' location. When there are competing dispatchers, a passenger's wait time is determined by the location of the vacant taxis affiliated with the contacted dispatcher. However, the passenger may not have contacted the dispatcher with the closest taxi.

Under each of the modes of contracting, increasing the number of vacant taxis benefits consumers by reducing the expected time it takes passengers to find taxis. More vacant cruising taxis decreases the time it takes a driver to find a passenger. A large number of vacant taxis at taxi stands decreases the probability that passengers have to wait for taxis when arriving at a stand. If taxi stands always have taxis, new taxi stands can be introduced by cities and private organizations,

decreasing passengers' costs of traveling to the taxi stand. Under the dispatch model, additional vacant taxis affiliated with a dispatcher decrease the expected distance of the nearest vacant taxi of that dispatcher.

We use Figure 1, below, to illustrate inefficiency under each of these systems. Under the cruising mode of contracting, drivers searching for passengers do not know where passengers are located and take an indirect route to the passenger's location. Passengers have to wait longer for a vacant taxi. Due to this inefficient search process, drivers also spend more time finding passengers, resulting in a lower expected occupancy rate and lower expected profit. The drivers' search process also places an external cost on other vehicles, as drivers may slow down traffic when searching for passengers.

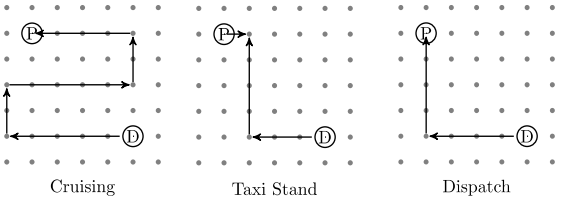

Figure 1: Modes of Contracting

Under the taxi stand mode of contracting, both passengers and drivers go directly to the taxi stand. They both incur the cost of getting to the taxi stand. As passengers must walk to the nearest taxi stands, their cost can be quite high when the nearest taxi stand is far away. The queuing process imposes additional costs. Passengers and drivers arrive at different times, so one party will have to wait for the other party to arrive. For instance, it is common in airports to have a large number of taxis waiting for passengers. There are also costs associated with providing the space for the taxi stand. The space used for a taxi stand usually has an alternative use, such as parking.

Due to the differences in the sources of inefficiency under the three modes of contracting, the method of contracting that is best suited to a particular area depends on the characteristics of the area. Cruising and taxi stands will be advantageous in high-density areas. When the density of passengers is higher, the losses under cruising due to the indirect route will be small. As cruising is profitable when drivers can find passengers in a reasonable amount of time, drivers are more likely to cruise in areas with a large density of passengers, such as city centers.

For a taxi stand to be efficient, a high density of passengers is needed within walking distance. Because a minimal rate of arrival of passengers is necessary to make taxi stands viable, they tend to be located in areas having many passengers within walking distance. Taxi stands are often established at airports, hotels, and malls, as a large number of passengers are nearby. Governments and businesses have an incentive to build taxi stands to make traveling from these locations easier.

Under the dispatch mode of contracting, the passenger incurs a cost of contacting the dispatcher. A driver affiliated with the dispatcher goes directly to the passenger's location. When multiple dispatchers are covering the same area, the passenger may not contact the dispatcher with the driver that is closest to the passenger's location. Contacting the wrong dispatcher increases the passenger's wait time and the driver's cost. Dispatching is more efficient than the other modes of contracting when there is a low population density. Under dispatching, the time it takes for a passenger to find a taxi is inversely proportional to the square root of the density of taxis of the contacted dispatcher, whereas it is inversely proportional to the density of vacant taxis under cruising (Arnott, 1996). In practice, dispatching tends to be the most common method of contracting in areas with low population densities.

5. Theoretical Justifications for Regulation

In this section, we consider theoretical justifications for the regulations discussed in Section 3. We start by considering a deregulated environment where taxis are free to choose prices and discuss factors that could lead to price regulation being desirable. Given price regulation, we discuss normative justifications for quantity regulation. We then consider justifications for safety and service-quality regulation when there is of price and quantity regulation.

5.1 Price Regulation

In deregulated taxi markets, the equilibrium price will not be efficient. When passengers and drivers contract through cruising or at a taxi stand, the availability of vacant taxis depends on the price and the total number of drivers. The price and vacancy are not directly chosen as part of a bargaining process; therefore, the bargaining process may not lead to the efficient price and vacancy rate. Alternatively, when drivers are contracted through a dispatcher, providing

dispatch service and vacancy both have economies of scale. Under economies of scale, competition does not lead to the efficient outcome. In each of these cases, price regulation can improve efficiency.

In cruising markets, there is a range of prices and vacancy rates that have zero profit (Douglas, 1972). The relative bargaining power of the drivers and passengers determines which of these prices and vacancy rates are chosen in equilibrium. In theory, the equilibrium price and vacancy rate could either be too high or too low (Flath, 2006). However, many have argued that the drivers have much stronger bargaining power as they repeat the bargaining process frequently (Douglas, 1972; Cairns and Liston-Heyes, 1996). When drivers have stronger bargaining power, the equilibrium outcome has high equilibrium prices and vacancy rates. A maximum price may be useful for solving these bargaining issues (Frankena and Pautler, 1986).

In addition to the bargaining process leading to an inefficient price and vacancy rate, it also creates a congestion externality. While the driver and passenger are in the process of bargaining, the driver remains idle and obstructs the flow of surrounding traffic. A regulated fare would eliminate this cost of bargaining. The combination of the inefficiencies occurring as a result of the bargaining process and the external cost of bargaining justify price regulation in markets that heavily rely on cruising.

When passengers and drivers contract using taxi stands, the bargaining process depends on whether passengers are expected to choose the first driver in line. When this norm is present, it gives significant bargaining power to the drivers. The corresponding equilibrium price and equilibrium vacancy rate are likely to be above the efficient values. When this first-in-first-out norm is not as strong, the agreed price depends on the number of passengers and drivers, their relative bargaining power, and their future expectations. Depending on the bargaining power, the price may either be too high or too low.

In dispatch markets, bargaining issues are not problematic because passengers take into account the vacancy rate when choosing a dispatcher. Dispatchers choose both the price and the number of vacant taxis, taking into account the effect of vacancy on wait time. Passengers choose between competing dispatchers and contact the dispatcher that provides the highest expected net benefit; therefore, the dispatchers account for the value their passengers place on vacancy when choosing vacancy levels.

The inefficiencies under dispatching arise from economies of scale due to the costs of maintaining specific vacancy rates and acquiring the dispatch technology. To maintain a given wait time, there needs to be a sufficiently high number of vacant taxis, regardless of the total number of trips an operator makes. The cost of maintaining a given number of vacant taxis remains the same as the quantity of trips increases, creating economies of scale. Acquiring the dispatch technology also imposes a fixed cost. The stochastic nature of the calls to dispatchers also leads to economies of scale in hiring dispatch operators. When a dispatcher employs twice as many operators and is contacted by twice as many passengers, the probability of an operator being unavailable decreases. As a result, two operators can handle more than twice the number of calls than one operator can handle.

The combined economies of scale from cost of maintaining a given service level and the cost of the dispatch technology means that the market outcome will be inefficient. In an unregulated equilibrium, there are either many firms that operate at an inefficient scale or few firms with market power. A regulated price allows a small number of firms to operate without the inefficiency due to market power.

5.2 Entry Regulation

Although quantity restrictions are common in taxi markets, the arguments for price regulation cannot be used to justify quantity regulation. Price regulation is sufficient to eliminate the inefficiency caused by bargaining and market power. In the absence of other frictions, the optimal outcome can be achieved without regulating quantity. As quantity restrictions are quite common, we consider two additional frictions that justify quantity restrictions. We offer two possible explanations for why municipal regulators prefer to restrict entry, either there is an externality caused by driving or the regulator has a preference towards driver profit.

When there is no externality or preference towards driver profit, taxi travel should be subsidized (Douglas, 1972; Arnott, 1996). The efficient fare equals the cost of operating an occupied taxi. The revenue generated by this fare equals the driver's cost of being occupied, and drivers incur a loss due to the costs incurred while vacant. To achieve the first best, the regulator needs to provide a subsidy to cover this loss. When subsidizing

taxi travel is infeasible, drivers require a non-negative expected discounted profit; therefore, when there is no externality or preference towards driver profit, the driver profit under the second-best outcome is zero. By choosing the second-best price and allowing entry, the second-best outcome can be implemented without quantity regulations, suggesting that quantity regulation is unnecessary.

When there is an externality caused by taxi travel or a regulatory preference to driver profit, quantity restrictions may be justified. Taxis increase congestion and emit pollution, in a similar fashion to other vehicles. Drivers create an additional externality by slowing traffic when they pick up and drop off passengers. When the externality caused by taxi travel is sufficiently high, the surplus-maximizing price and vacancy levels could have positive driver profit (Beesley, 1973; Shreiber, 1975; Cairns and Liston-Heyes, 1996). The first-best price is equal to the cost of operating the taxi plus the external cost. If the profit is positive at the first-best vacancy rate, then quantity restrictions can increase surplus.

A regulatory preference towards driver profit can lead to quantity restrictions being beneficial from the regulator's perspective. The regulator may have a preference towards driver profit due to regulatory capture by the taxi industry or due to the regulator being able to capture some of the rents from the taxi industry. When the quantity of taxis is restricted, either through medallions or franchise rights, the owners of these exclusive rights can make positive economic profit. The owners of these rights have an incentive to convince the regulator to maintain entry restrictions and choose a higher price and have the ability to organize among themselves to lobby for quantity restrictions and high prices.

The regulator may also prefer to restrict entry because it can capture part of the profit by selling new medallions or charging licensing fees. When a regulator introduces new medallions, they are often auctioned. By auctioning medallions, local governments receive a portion of the revenue from having a positive medallion price. Alternatively, the regulators can use licensing fees to generate revenue. When the regulator's priority is revenue generation, licensing is the better way to generate revenue because licensing revenue can be captured from all taxis. Revenue from medallions sales is only received from the sale of additional medallions.

5.3 Service-level Regulation

Service-level regulation increase service levels at low demand locations and at low demand times. Demand varies throughout a city and drivers prefer to provide service in high-demand locations. There may be too many taxis in high demand locations and too few taxis in low demand locations. Demand also differs throughout the day, with lower demand late at night and early in the morning. At these times, service levels may be too low. Regulation aimed at increasing service levels when there is low demand can improve efficiency.

To increase service levels when service levels are too low, regulators can require firms use some profit from when demand is high to subsidize losses when demand is low. The cross-subsidization requires that companies provide adequate service levels in low demand locations as a condition of being allowed to operate a taxi in a given location. This form of cross-subsidization can increase efficiency. An additional taxi in the low-demand period may not be able to cover its operating cost but may increase surplus because all passengers will have lower wait times. When the increase in surplus in the low demand period is large enough, it can cover the loss in surplus from the regulator charging a higher price in the high-demand period. To implement the cross-subsidization across different times, the regulator can require that taxis remain operational for a specific number of hours for each day. To cross-subsidize different locations, the regulator can require that dispatch companies have sufficiently short wait times throughout the city. When these regulations are binding, the revenue from the high-demand period may subsidize losses in the low-demand period.

When taxi service is provided by cruising taxis and demand differs by location, drivers search behavior makes it difficult to cross-subsidize the low demand location. However, regulators may still want adequate service levels in low demand areas and may want to limit congestion in high demand areas. For instance, in the presence of an externality, the desired vacancy rate in a congested high-demand area may be exceeded, and there may be too little service in low-demand locations. However, drivers may prefer to search in that area. If the regulator allocates a certain number of taxis for the entire city, there may either be too many taxis in the city center, or too few taxis in lower demand locations.

Exclusive cruising regulations divide a city up into multiple regions and prevent drivers affiliated with one region from picking up passengers in other regions. As drivers are limited to providing service in their affiliated regions, exclusive cruising regulations ensure that there is an appropriate number of taxis in each location. Although exclusive cruising regulations require taxis that drive passengers to unaffiliated location return empty to an affiliated location, this system of regulation may be preferred to regulation where licensed taxis can move freely between locations.

5.4 Safety and Quality of Service Regulation

Safety regulations can increase efficiency because safety is difficult for passengers to observe. In the absence of regulation, the safety level drivers choose is too low. Safety concerns are less problematic under minimum safety standards. For instance, minimum insurance standards ensure that drivers can compensate individuals harmed in accidents. Uninsured drivers typically do not have much to lose in the event of a major accident and may not find it worthwhile to purchase insurance. In the absence of required insurance, passengers may not be compensated when they get injured.

Quality of service regulations help to eliminate some of the adverse incentives caused by the other regulations. When the price is regulated, drivers will choose a quality level that is too low under the cruising and taxi stand modes of contracting. Under the cruising mode of contracting, drivers choose a quality level in advance of meeting with passengers. When passengers and drivers meet, the passenger has a decision of whether to accept the driver. If the passenger rejects the driver, the passenger incurs a search cost while waiting for another taxi. Given an expected average quality, each driver has an incentive to choose a slightly lower quality than the average because it will not lose customers. These incentives put downward pressure on quality. Without quality regulation, a portion of the efficiency gains from price regulation are lost due to inefficiently low quality levels.

Under the taxi stand mode of contracting, the quality choice is inefficient. The nature of the inefficiency depends on the bargaining norms at taxi stands. If there is the expectation that the first taxi to arrive at the taxi stand gets the next passenger, then the quality will typically be too low. Drivers have an incentive to lower their quality below the optimal level because, from each passenger's perspective, drivers behave like a monopolist with a regulated price. If taxis at taxi stands compete for passengers, drivers choose different quality levels because the passenger chooses the taxi with the higher quality when multiple taxis are present. The only equilibria involve drivers choosing different quality levels, even when all passengers have the same preference towards quality.

The regulator may be concerned about quality because it affects the general image of the municipality. Tourists and business travelers disproportionately use taxis as a means of transportation. A high-quality taxi service improves the image of a city. Business groups that benefit from tourism and business travel have advocated for regulation of the taxi industry to ensure sufficiently high quality. The regulator chooses a higher quality to meet the demands of these groups.

5.5 Other Arguments for Regulation

Regulators may be concerned about drivers charging different rates to different passengers based on their characteristics. There is a particular concern that drivers will charge a higher rate to the elderly and people going to essential locations, such as hospitals. A regulated fare prevents drivers from charging discriminatory fares. Regulators can also use these regulations to ensure that additional services are provided for certain types of individuals. Regulations are used to increase the number of taxis equipped to handle people with disabilities and to give senior citizens and individuals with disabilities special rates on taxi service. These services may not be provided in the absence of regulation.

The methods typically used to implement price and quantity regulations give the regulator greater control of the taxi industry. The common regulatory structures increase the ability of the regulator to regulate the industry and increase the effectiveness of enforcement mechanisms because it is easier to track drivers and enforce punishments for violating regulations. If entry is only permissible at the firm level, the cost of monitoring regulation is lower because enforcement can be carried out at the firm level. It is easier to coordinate regulation with a small number of firms than it is with a large number of individual owners. The regulator also has a greater benefit of finding a regulation violation. A firm violates one regulation is likely to have additional violations. Using medallions to limit entry reduces the cost of

enforcing regulation. It is less costly to regulate a more concentrated industry with a smaller number of drivers. The enforcement cost per driver is also lower as the medallion tracking mechanism is a convenient way to track taxis and drivers.

6. Costs of Regulation

The two most significant cost of price and quantity regulation are the harm it causes certain stakeholders and the lack of flexibility it gives drivers to respond to changes in economic circumstances. The increased price and decreased quantity harm passengers and drivers. The fixed price and quantity prevents the price and availability of taxi service from adjusting to changes in demand based on location and time.

6.1 Stakeholders Negatively Affected by Regulation

Passengers are negatively affected by quantity restrictions. The price is higher and the vacancy rate is lower than they could be if entry was not restricted. Lower-income passengers are disproportionately harmed by the high price as they spend a greater share of their income on taxi service (Frankena and Pautler, 1986). Quantity restrictions are also seen to disproportionately affect the poorer members of society. Most taxis locate in high demand areas, leaving few vacant taxis in less wealthy neighborhoods. Drivers are also harmed by quantity restrictions. Whether restrictions are at the taxi level or the firm level, the right to provide taxi service is usually owned by investors rather than drivers. Most drivers are hired in a competitive market; therefore, quantity restrictions will decrease the demand for drivers. The limited quantity causes there to be fewer drivers than in the absence of quantity regulation, thereby decreasing the equilibrium wage that drivers receive (Frankena and Pautler, 1986). Regulations that increase driver wages would counter this effect and could lead to a higher wage; however, this type of regulation may have other distortions.

6.2 Limited Flexibility

The regulatory framework in most municipalities has a fixed price and quantity that do not respond to the demand for taxi service. The price does not adjust in response to factors that affect demand, such as the time of day, the weather, and presence of a major event in the city. This lack of flexibility can be partially alleviated by introducing a fare structure that accounts for some of these details; however, such a fare schedule would either be complicated or would have a limited ability to account for the variation in demand. Further, this setup still does not allow the supply of taxis to vary in response to changes in demand.

The evolution of digital dispatch technology, such as the technology used by Uber and Lyft, has increased the cost of the inflexibility. Dispatch technologies can connect passengers and drivers in real time, tailoring the prices and number of drivers to the demand characteristics. These companies charge different prices based on the demand for services and the number of available drivers. They also provide drivers a higher payment when demand is high, thereby increasing incentives for drivers to supply service. This process ensures that vacancy levels are more stable and allows the price of transportation service to reflect the market conditions better.

Regulation may also prevent innovation in the type of services that are provided. Taxi regulations commonly restrict carpooling services (Davis, 1998; Frankena and Pautler, 1986; Beesley, 1973). Regulation also reduces the range of service qualities offered. In principle, passengers could pay different prices for different speeds of service, customers who value shorter wait times could pay a higher price for quicker service whereas customers who place a low value on short wait times could prefer a lower fare for slower service. A more flexible price structure that incorporates these aspects of service quality may lead to more efficient outcomes.

7. Conclusion

In our discussion of the regulation of the North American taxi industry, we provide an overview of the history of taxi regulation and the current structure of regulation. We focus on the regulations of three North American metropolitan areas. In each of these areas, and in North America in general, the regulatory structure significantly restricts the actions of drivers. We examine theoretical justifications for price and quantity regulation and find there are normative justifications for the common types of regulations. The theory helps explain the evolution of regulation of the North American taxi industry. It also explains why most municipalities that experimented with deregulation in the 1970s and 1980s reintroduced some form of regulation.

Moving forward, two major innovations are affecting the taxi industry, competition from digital dispatchers and the emergence of driverless cars. Both

of these innovations have the potential to eliminate some of the current inefficiency in taxi markets. Digital dispatch technologies can help connect passengers and drivers. These technologies also make it so that the price and availability of taxis respond to changes in demand. Driverless cars have the potential to transform the taxi business as they do not have the additional cost of hiring a driver. These cost savings have the potential to expand the market for taxi services greatly.

However, these innovations also present new challenges. Many of the theoretical justifications for taxi regulation are still present with decentralized digital dispatching and driverless cars. Notably, there will either be inefficiency from duplication of costs when there are many dispatchers or inefficiency from market power when there are few dispatchers. There are also issues with simultaneously providing adequate service to low-demand locations of a city without having too much congestion in high demand portions of the city. Finding an effective way to implement policies that benefit from these technologies will continue to be a challenge for regulators.

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