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Market Power and the Nonprofit Sector

Gabriel Courey
University of Wisconsin-Milwaukee

MARKET POWER AND THE NONPROFIT SECTOR

by

Gabriel Courey

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ABSTRACT

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Gabriel Courey

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The first chapter of this dissertation is composed of three related notes on spatial price discrimination under convex production costs. First, I consider upstream monopoly when two firms downstream have convex production costs. I find that the reduction in social welfare associated with the location distortions from upstream monopoly remain but are reduced under convex costs. This first section has been published (Courey, 2016). Second, I consider sequential location choice by two firms with convex costs (without a upstream monopoly). I find that when the slope of the marginal cost curve is steep enough, sequential choice can yield locations with greater social welfare than simultaneous choice. Third, I consider both upstream monopoly and sequential location choice together. I find that under constant marginal production costs and upstream monopoly, sequential and simultaneous choice yield identical locations. Yet this is not true with convex costs. The leader always locates closer to the center of the market than under simultaneous choice leaving less market for the follower. Regardless of increasing or constant marginal costs, social welfare is less than without upstream monopoly or sequential choice.

The second chapter estimates gender and racial wage differential in nonprofit and for-profit hospitals. Past studies have found that economy-wide gender and racial wage differentials

are smaller in the nonprofit sector than in the for-profit sector. I show that the massive US hospital industry exhibits a different pattern. Gender and racial differentials in nonprofit hospitals are larger than in the for-profit hospitals. These findings are robust to various model specifications, appear throughout the earnings distribution and in most sub-samples. I argue this may reflect weakened monitoring in nonprofit hospitals and contrast this with the traditional theory that nonprofits must emphasize wage equality to motivate their workers.

The third chapter considers for the first time the endogenous choice of nonprofit status by firms in a Cournot duopoly. When firms value profit and consumer surplus (as in the corporate social responsibility literature) outputs can be strategic compliments. Thus, a firm adopting nonprofit status increases output to meet the zero profit constraint and is rewarded by a further increase in output by its unconstrained for-profit rival. This can result in an endogenous mixed market despite identical objective functions of the two firms and so provides an explanation for the routine presence of such markets. The government's optimal choice of nonprofit tax-exemption can generate a socially superior endogenous mixed market.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

This dissertation is dedicated to Trena Rose, Callie Ruth and Baby Ezra.

"Give thanks to the LORD for he is good. His love endures forever" (Psalm 136:1).

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1 Spatial Price Discrimination and Convex Production Costs: Three Related Notes

1.1 Introduction

In Hurter and Lederer's (1985) canonical model of spatial price discrimination, locations are first-best. Given inelastic demand, their locations yield social efficiency. Thus subsequent additions to the model which alter location choice necessarily reduce welfare. Gupta, Katz and Pal (1994) show that when firms purchase inputs from an upstream monopoly, downstream firms will move away from the transport cost minimizing locations in order to force an upstream monopoly to lower its price. Gupta (1992) shows that when firms locate sequentially (instead of simultaneously as in Hurter and Lederer) the first-mover locates closer to the center of the market causing a reduction in social welfare. Critically, throughout these papers, marginal production costs are assumed to be constant.

In this paper, I adopt a model of spatial price discrimination where firms have convex production costs (increasing marginal cost). With convex costs locations are not first-best even without upstream monopoly or sequential location choice (Gupta, 1994). When delivered marginal cost generates the final price, firms have a strong incentive to give away marginal customers. Doing so reduces their own delivered marginal cost while increasing that of their rival. The consequence is a larger profit margin on each infra-marginal customer. Thus, the equilibrium with convex costs has the two firms sharing the market but each has moved inefficiently toward the edge of the market. Therefore, modifications to the model such as an upstream monopoly or sequential location choice will alter locations but do not necessarily reduce social welfare.

This essay consists of three sections that are each "note" length presentations. First, I consider upstream monopoly when two firms downstream have convex production costs. I find that the reduction in social welfare associated with the location distortions from upstream monopoly remain but are reduced under convex costs. This first section has been published (Courey, forthcoming). Second, I consider sequential location choice by two firms with convex costs (without a upstream monopoly). I find that when the slope of the marginal cost curve is steep enough, sequential choice can yield locations with greater social welfare than simultaneous choice. Third, I consider both upstream monopoly and sequential location choice together. I find that under constant marginal production costs and upstream monopoly, sequential and simultaneous choice yield identical locations. Yet this is not true with convex costs. The leader always locates closer to the center of the market than under simultaneous choice leaving less market for the follower. Regardless of increasing or constant marginal costs, social welfare is less than without upstream monopoly or sequential choice.

This paper enriches the expansive literature on location choice under spatial price discrimination. Spatial price discrimination is both common (Greenhut, 1981) and socially beneficial. Given the choice of pricing policy, firms will usually choose to use said spatially discriminatory pricing (Thisse and Vives, 1988). The equilibrium locations under such pricing strategy are Pareto superior to the well-known Hotelling (1929) and d'Aspermont et. al (1979) pricing systems (Hurter and Lederer, 1985).

Though inspired by the choice of physical location, spatial models also can be used to describe other types of choices. For example, product variety (e.g. sweetness of cereal) can be thought of as a line segment. Different firms locate by choosing which variety they will produce. Thus the characteristics of these spatial models have been applied more generally than to only the physical locations of firms.

1.2 Upstream Monopoly

For two decades it has been recognized that under spatial price discrimination one of the costs of upstream monopoly has been distortion in downstream location. Gupta, Katz and Pal (1994) show that downstream firms will move away from the transport cost minimizing locations in order to force an upstream monopoly to lower its price. Specifically, downstream firms locate asymmetrically, crowding one side of a linear market to increase the transport cost to reach distant customers and so forcing the monopolist's input price down. While this has been confirmed for linear production costs downstream, the case of convex production costs has not been examined and brings unique aspects worthy of examination.

More recently, Beladi, Chakrabarti and Marjit (2008, 2010) confirm location distortions from upstream monopoly. Their model assumes constant marginal cost and, ad-hoc, that each firm sells to a predetermined fraction of the consumers, regardless of location. I build off the more traditional case, as in Gupta, Katz and Pal (1994).

Convex costs under spatial price discrimination has also long been known to generate inefficient locations even without upstream monopoly (Gupta, 1994). When delivered marginal cost generates the final price, firms have a strong incentive to give away marginal customers. Doing so reduces their own delivered marginal cost while increasing that of their rival. The consequence is a larger profit margin on each infra-marginal customer. Thus, the equilibrium with convex costs has the two firms sharing the market but each has moved inefficiently toward the edge of the market. Thus, it is interesting whether the distortion caused by an upstream monopoly reinforces or mitigates that caused by cost convexity.

In this paper, I adopt the duopoly-downstream case of Gupta et al. (1994) and consider the cost of upstream monopoly with convex costs downstream. Unique to this model, the cost of the upstream monopoly potentially includes both distortions in transport and production cost. Despite this, upstream monopoly hurts welfare less than when downstream production costs are linear.

1.2.1 Model and solution

Consumers are distributed uniformly on the unit line, each with perfectly inelastic demand and reservation price r.[1] Identical goods are provided by two downstream firms who purchase their input from an upstream monopolist who, in turn, sets the input price. Downstream firms are subject to transport cost equal to the distance from the firm to the customer.[2] Downstream firms have convex production costs, or increasing marginal cost; specifically, $C(q_i) = P_u^* q_i + \frac{1}{2}kq_i^2$.

Timing is organized in 4 stages. In stage 1 it is determined whether it is both downstream firms or just one downstream firm that will be critical in determining the upstream price. In stage 2, the downstream firms choose their locations on the unit interval. In stage 3, the upstream firm sets the price of the input. In stage 4, the downstream firms set the price schedule of the final good, consumers purchase the good, and profits are calculated. The timing of stages 2 through 4 follows Gupta et al. (1994). They suggest this is a sensible order since location is typically a long run choice and price is typically a short run choice. The inclusion of stage 1 is necessary for determining which firm benefits from asymmetric payoffs (as in Gupta et al., 1994). The game is solved with backward induction.

Payoffs are as follows: The upstream firm earns profit equal to the price of the input times the number of customers served. The downstream firms' profit are total revenue minus transport cost, production cost, and total cost of inputs.

In stage 4, consumers purchase from the downstream firm who charges them the lowest price. If two firms charge the same price, the consumer buys from the firm with the lower delivered marginal cost. This is commonly justified by the fact that the firm with the lower delivered marginal cost can lower price slightly below that of the other firm and take the sale.

No downstream firm charges a price higher than the reservation price, r, since no consumer would buy. Neither firm sets price below their own delivered marginal cost. Thus, the firm with the lower delivered marginal cost wins the sale by pricing no higher than their rivals delivered marginal cost. Figure 1 illustrates the price schedule by a darkened line: both firms charge either the reservation price or the delivered marginal cost of their rival, whichever is lower.

[Figure 1 about here. Title: "Marginal costs, market division, prices and locations"]

[1] While inelastic demand is a critical assumption, Hamilton, Thisse and Weskamp (1989) have examined cases of downward sloping demand at each location.

[2] Transport cost is normalized to one.

This leads to the profit equations for downstream firms:

$$\pi_1 = \int_0^a r dx + \int_a^{x^*} \left[P_u^* + k(1-x^*) + (L_2 - x)\right] dx - \int_0^{L_1} (L_1 - x)dx - \int_{L_1}^{x^*} (x - L_1)dx - \frac{1}{2}k(x^*)^2 - P_u^* x^* \quad (1)$$

$$\pi_2 = \int_{x^*}^{b} \left[P_u^* + k(x^*) + (x - L_1)\right] dx + \int_b^1 r dx - \int_{x^*}^{L_2} (L_2 - x)dx - \int_{L_2}^{1} (x - L_2)dx - \frac{1}{2}k(1-x^*)^2 - P_u^*(1-x^*) \quad (2)$$

where $a = L_2 - (r - k(1-x^*) - P_u^*)$ and $b = L_1 + (r - kx^* - P_u^*)$ are shown in Figure 1, and

$$x^* = \frac{k + L_2 + L_1}{2k+2} \quad (3)$$

is the market division.[3]

In stage 3, the upstream firm sets the price of the input, P_u^*, to maximize its own profit. Crucially, the input price can be set so high that the downstream firms cannot afford to serve the most distant customer(s). Whether upstream profit is maximized when all the market is served or when some customers are not served depends on the reservation price, r. If r is low enough, then the upstream firm could do better by increasing the input price even if it means losing some customers. However, if r is big enough, upstream profit is maximized when all customers are served.

Following Gupta, et al. (1994) I focus on the case where r is sufficiently high so that all customers are served. Specifically, when $r \geq r^* = \frac{k^2+6k+4}{2k+2}$, P_u^* is such that all consumers are served.

Under this assumption, the upstream firm sets the highest price such that the entire market is served. This requires the input price to be set such that the price charged to a "critical" customer equals the reservation price. In Figure 1, the critical customer, marked by a dot, is located at 1, and firm 2 is the critical firm. The firm which sells to the critical customer in equilibrium is labeled the "critical" firm. The distance between

[3]Setting delivered marginal cost of both firms equal, $kx^* + x^* - L_1 = k(1-x^*) + L_2 - x^*$, and rearranging yields the result in (3).

the critical firm and the critical customer is the furthest distance between any customer and firm.

$$P_u^* = r - \max\{L_1 + kx^*,\, L_2 - x^* + k(1-x^*),\, 1 - L_2 + k(1-x^*)\} \tag{4}$$

It is possible to have one, two or three critical customers and one or two critical firms. With constant marginal costs in duopoly, only one firm is critical (see Gupta, et al., 1994). I confirm that with increasing marginal costs in duopoly, only one firm is critical. First, no more than one firm is critical in equilibrium.[4] Second, given that only one firm is critical, neither firm can increase its profit by deviating so as to change the critical firm or customer.[5] This process closely follows Gupta et al. (1994) and the demonstration is available upon request.

Whether a firm is critical is left to be decided in stage 1. I investigate the subgame in which firm 2 is critical, as shown in Figure 1. The input price from (4) is now

$$P_u^* = r - [1 - L_2 + k(1-x^*)] \tag{5}$$

Since the market is a unit line, P_u^* is also the profit of the upstream monopolist.

In stage 2, the downstream firms locate to maximize their own profit given P_u^* and the delivered price schedule. Taking the first derivative of (1) and (2) with respect to L_1 and L_2 yields the first-order conditions which can be rearranged to reveal best response functions. Solving the system of best response functions yields unique locations that exist for all k. The objective functions satisfy the necessary second-order conditions.[6] The Nash equilibrium in downstream locations is

$$L_1^* = \frac{4k^2 + 9k + 2}{32k^2 + 48k + 12},\; L_2^* = \frac{20k^2 + 27k + 6}{32k^2 + 48k + 12} \tag{6}$$

Table 1 shows equilibrium locations from (6) at selected values of k. These are a generalization of Gupta et al. (1994) and return their result when $k = 0$. Within the subgame with firm 2 critical, this location equilibrium is unique.

[4]There are four potential cases in which both firms are critical: (a) one critical customer is located at the center of the market, (b) two critical customers, each at one edge of the market, (c) two critical customers, one at an edge and one at the market division, and (d) three critical customers, two at the edges and one at the market division. In each of these cases, at least one firm can improve its profit by deviating. This demonstration is available upon request.

[5]Within the case when firm 2 is the critical firm, there are six possible deviations in location. If firm 1 deviates left or firm 2 deviates left while remaining to the right of firm 1, the critical firm and customer do not change. Firm 2 clearly will not locate to the left of firm 1. If either firm deviates far enough right, the critical firm and/or critical customer could change. By comparing the firms' highest profits from any of these deviations to their original locations reveals no firm can increase its profit by deviating so as to change the critical firm or critical customer.

[6]These conditions are $\frac{\partial^2 \pi_1}{\partial L_1^2} = \frac{-(8k^2+15k+6)}{4k^2+8k+4} < 0$; $\frac{\partial^2 \pi_2}{\partial L_2^2} = \frac{-(24k^2+31k+10)}{4k^2+8k+4} < 0$. Together with the demonstrations that no more than one firm is critical and, given that only one firm is critical, no firm will deviate so as to change the critical firm or customer, these imply that the locations in (5) are a Nash equilibrium.

[Table 1 about here]

Combining (6) with (1), (2), (3) and (5), yields profits and market division. These results are unique conditional on firm 2 being critical.

$$\pi_1^* = \frac{128k^5 + 528k^4 + 784k^3 + 493k^2 + 132k + 12}{1024k^4 + 3072k^3 + 3072k^2 + 1152k + 144} \tag{7}$$

$$\pi_2^* = \frac{128k^5 + 528k^4 + 800k^3 + 549k^2 + 172k + 20}{1024k^4 + 3072k^3 + 3072k^2 + 1152k + 144} \tag{8}$$

$$P_u^* = r - \frac{16k^3 - 40k^2 - 29k - 6}{32k^2 + 48k + 12} \tag{9}$$

$$x^* = \frac{4k^2 + 5k + 1}{8k^2 + 12k + 3} \tag{10}$$

Proposition 1 summarizes the effect of convex costs on location, market division and profits.

Proposition 1: As k increases

(a) The non-critical firm locates closer to the center until $k = 0.2242$, and then locates closer to the edge of the market; and, the critical firm always locates closer to the edge.

(b) π_1^* and π_2^* increase

(c) P_u^* decreases

(d) x^* approaches $\frac{1}{2}$

Proof: Consider the subgame when firm 2 is critical. For (a) - (c), differentiate equations (6) - (9). For (d), take the limit of (10) as k goes to infinite. The results are identical in the subgame with firm 1 critical.

In stage 1, it is determined whether one of the two firms is critical. The outcome could be determined by the firms' technology, size, other "objective" characteristics, or by sheer luck. Conditional on stage 1, the subgame Nash equilibrium locations, prices and payoffs are unique.[7]

Before analyzing the cost of upstream monopoly, I derive the costs of serving the market in the equilibrium with convex costs. Unique to this model, there are two types of costs: transport and production cost.

Transport (TC) and production cost (*PC)* are

[7] In a subgame with firm 1 critical, unique equilibrium locations exist that are symmetric to those in equation (6) and Table 1. In this case, for example, if $k = 0.1$, then $(L_1^*, L_2^*) = (0.480, 0.828)$.

$$TC = \int_0^{L_1} (L_1 - x)dx + \int_{L_1}^{x^*} (x - L_1)dx + \int_{x^*}^{L_2} (x - L_2)dx + \int_{L_2}^{1} (L_2 - x)dx \tag{11}$$

$$PC = k(x^*)^2 + k(1 - x^*)^2 \tag{12}$$

The costs in equilibrium come from combining (6) with (11) and (12), yielding

$$TC^* = \frac{80k^4 + 224k^3 + 229k^2 + 90k + 12}{512k^4 + 1536k^3 + 1536k^2 + 576k + 72} \tag{13}$$

$$PC^* = \frac{32k^5 + 96k^4 + 98k^3 + 38k^2 + 5k}{128k^4 + 384k^3 + 384k^2 + 144k + 18} \tag{14}$$

Total social cost is the sum of transport and production cost, $SC^* = TC^* + PC^*$, so in equilibrium

$$SC^* = \frac{128k^5 + 464k^4 + 616k^3 + 381k^2 + 110k + 12}{512k^4 + 1536k^3 + 1536k^2 + 576k + 72} \tag{15}$$

Proposition 2 summarizes the effect of convex costs on transport, production, and total social cost.

Proposition 2: As k increases

(a) TC^* decreases until $k = 1.3902$, and then increases. TC^* is largest when $k = 0$

(b) PC^* increases

(c) SC^* increases

Proof: Differentiate equations (13) - (16).

The location equilibrium in (6) can be compared with the equilibrium locations without upstream monopoly. Without the upstream monopoly, downstream firms choose the locations derived by Gupta (1994): $L_1^G = \frac{k+2}{8k+8}$ and $L_2^G = \frac{7k+6}{8k+8}$. These locations collapse to first best with firms at the first and third quartiles when $k = 0$. As the marginal cost curve becomes steeper the firms move away from their efficient quartiles toward the edge of the market: L_1^G decreases and L_2^G increases.

The location distortion caused by upstream monopoly as opposed to perfect competition is summarized in Proposition 3.

Proposition 3: With convex costs, upstream monopoly causes both firms to crowd one edge of the market.

Proof: Consider the subgame when firm 2 is critical. Compare (6) with the Gupta (1994) locations. For all values of $k > 0$, $L_1^* < L_1^G$ and $L_2^* < L_2^G$. The result holds in the subgame with firm 1 critical.

Since the size of the market is fixed, the cost of upstream monopoly can be measured by comparing total social cost with an without upstream monopoly.

Total transport and production cost without upstream monopoly, TC^G and PC^G, come from plugging L_1^G and L_2^G into (11) and (12). Transport and production cost added by upstream monopoly are

$$TC^* - TC^G = \frac{64k^5 + 276k^4 + 424k^3 + 295k^2 + 96k + 12}{2048k^6 + 10240k^5 + 20480k^4 + 20736k^3 + 11040k^2 + 2880k + 288} \tag{16}$$

$$PC^* - PC^G = \frac{4k^3 + 4k^2 + k}{256k^4 + 768k^3 + 768k^2 + 288k + 36} \tag{17}$$

Social cost without upstream monopoly is $SC^G = TC^G + PC^G$. Social cost of upstream monopoly is

$$SC^* - SC^G = \frac{96k^5 + 372k^4 + 528k^3 + 343k^2 + 104k + 12}{2048k^6 + 10240k^5 + 20480k^4 + 20736k^3 + 11040k^2 + 2880k + 288} \tag{18}$$

Transport and production cost added by upstream monopoly and the total social cost of upstream monopoly are summarized in Proposition 4.

Proposition 4: As k increases

(a) $TC^* - TC^G$, decreases and remains positive.

(b) $PC^* - PC^G$ increases until $k = 0.8117$, and then decreases, and remains positive.

(c) $SC^* - SC^G$ decreases and remains positive.

Proof: Differentiate equations (16) - (18).

Proposition 4.(a) and 4.(b) are illustrated in Table 1 where transport and production cost from upstream monopoly are shown for various values of k. The increase in social cost associated with this model is the sum of these two costs. For larger k, this increase is smaller.

1.2.2 Summary

In a spatial price discrimination model, an upstream monopoly imposes a cost to society. I evaluate this cost when there are convex production costs downstream. For the first time, upstream monopoly distorts both transport and production costs. However, as the marginal cost curve becomes steeper, added transport cost decreases, added production cost increases initially and then decreases, and total social cost associated with upstream monopoly decreases.

1.3 Sequential Location

This paper uniquely demonstrates that with convex production costs the influence of location timing on social welfare differs from that anticipated with constant marginal production costs. With constant marginal costs sequential location always increases transport costs and lowers social welfare relative to simultaneous location (Gupta 1992; Hurter and Lederer, 1985). I demonstrate for the first time that with convex production costs sequential location frequently yields welfare superior locations. Thus, the prevailing notion that first mover advantages hurt welfare under spatial price discrimination does not apply with convex productions.

This difference emerges, in part, because of the distortion from first best generated by convex costs. Gupta (1994) shows that two firms locating simultaneously with convex costs locate inefficiency far apart. She demonstrates that when delivered marginal costs set the final price, firms have a strong incentive to give away marginal customers in order to retain larger profit on the infra-marginal customers. They retain symmetric locations but move outside the efficient quartiles. This gives rise to the possibility that sequential location can improve welfare.

I derive for the first time a sequential location equilibrium and compare it with Gupta's (1994) well known simultaneous location equilibrium. While sequential location results in asymmetric locations, I demonstrate that this asymmetry fades as costs become more convex (the marginal cost curve slope increases). This fading asymmetry reduces the production cost disadvantage of sequential location. Moreover, the two firms locate strictly closer to each other than with simultaneous location lowering transport cost. Thus, with sufficient cost convexity the inefficiency associated with asymmetry is outweighed by the efficiency of being closer together.

Delivered pricing is both commonly modeled and frequently observed. Such spatial models have proven especially useful in capturing aspects of competition in horizontally differentiated markets (Tirole 1988). They provide a general method for examining markets in which either actual location or an ordered product characteristic (for example, sweetness of cereal or time of service) differentiates output. As the price includes delivery, the price a firm is able to charge depends upon how "close" it is to its rivals. Such models differ from freight-on-board models in which delivery is not part of the final price (Hotelling 1929 and d'Aspermont et al. 1979). Thisse and Vives (1988) show that spatial price discrimination and the associated delivered pricing is the preferred alternative whenever firms are able to adopt it and Greenhut (1981) identifies it as "nearly ubiquitous" among products with substantial freight costs.

Since Gupta (1994), the assumption of convex costs has been a recurring aspect of regional science research. In the short run, convex costs fits the basic intuition of diminishing marginal productivity. In the long run, this cost assumption implies firm level diseconomies of scale. Indeed, studies of manufacturing, pharmaceuticals and banking confirm such diseconomies (Hsieh 1995, Huang and Wang 2001, Assaf 2010, Ramcharran 2011 and Nubuyuki 2004). For example, Hsieh (1995) estimates industry-wide cost functions and finds decreasing returns in the US tobacco, apparel and petroleum industries. Thus, at minimum, cost convexity stands as a realistic alternative to constant costs and its implications deserve further study.

Models using convex costs in spatial price discrimination include Heywood and Wang (2014, 2016) who examine mergers and consistent location conjectures, Courey (2016) who examines vertical relations between an upstream monopoly and downstream competition, and Heywood et al. (forthcoming) who examine the difference that convex costs make for collusion among spatial rivals (Gupta and Venkatu 2002). These models all imagine two rivals with simultaneous location. Thus, my comparison between location timings represents important value-added.

Considering sequential location in location models goes back at least 40 years (Hay 1976) and continues to attract attention (Götz 2005). This attention reflects the reality that locating plants takes time and rarely happens simultaneously. Sequential entry examinations within spatial price discrimination focus on zoning (Barcena-Ruiz and Casado-Iziga 2014), mixed oligopoly (Heywood and Ye 2009), mergers (Rothschild, Heywood and Monaco 2007; Heywood and Ye 2013), and R&D (Heywood and Wang 2017). I contribute by uniquely introducing the realism of convex costs for sequentially locating firms.

In what follows, the next section compares the simultaneously and sequential location equilibria. The critical point of comparison is the welfare which with the assumption of inelastic demand is willingness to pay minus the sum of production and transport costs.

1.3.1 Model and solution

In this section, I first derive the sequential location equilibrium and second, compare it with Gupta's (1994) simultaneous location equilibrium. The model is the same as that in the first note with respect to consumers and transport cost. The difference is that the input price is not set by an upstream monopoly so production cost is $C(q_i) = \frac{1}{2}kq_i^2$. Timing is organized in 3 stages. In stages 1 and 2 the leader and follower choose their locations on the unit interval.[8] In stage 3, the firms set the price schedule of the final good and consumers purchase the good. This timing follows Gupta (1992). The game is solved by backward induction.

Payoffs (profits) for the firm's are total revenue minus the sum of transport and production cost. In each stage, firms act so as to maximize their own profit, given the action or expected response of their rival.

In stage 3, consumers purchase from the firm charging the lowest price. If two firms charge the same price, the consumer buys from the firm with lower delivered marginal cost. This is commonly justified by

[8] I assume that firm 1, the firm on the left side of the market, is the leader. Of course, a symmetric case exists where firm 1 is the follower.

the fact that the firm with the lower delivered marginal cost can lower price just below that of the rival and take the sale. Neither firm sets price below their own delivered marginal cost. Thus, the firm with the lower delivered marginal cost wins the sale by pricing no higher than their rivals delivered marginal cost (Gupta, 1994). Figure 2 illustrates the resulting price schedule by a darkened line.

[Figure 2 about here]

This leads to the profit equations for firms 1 and 2, respectively:

$$\pi_1 = \int_0^{x^*} [k(1-x^*) + (L_2 - x)]\, dx - \int_0^{L_1} (L_1 - x)dx - \int_{L_1}^{x^*} (x - L_1)dx - \frac{1}{2}k(x^*)^2 \tag{19}$$

$$\pi_2 = \int_{x^*}^{1} [k(x^*) + (x - L_1)]\, dx - \int_{x^*}^{L_2} (L_2 - x)dx - \int_{L_F}^{1} (x - L_2)dx - \frac{1}{2}k(1-x^*)^2 \tag{20}$$

where $L_i \in (0, 1)$ is firm i's location and

$$x^*(L_1,\, L_2) = \frac{k + L_1 + L_2}{2k + 2} \tag{21}$$

divides the market and identifies the indifferent consumer.

In stage 2, the follower chooses the location that maximizes profit, given the leader's location. Taking the first derivative of π_2 with respect to L_2 and rearranging to solve for L_2 yields the best-response function for the follower,

$$L_2^{BR} = \frac{(k+2)L_1 + 7k^2 + 12k + 4}{8k^2 + 15k + 6}. \tag{22}$$

In stage 1, the leader knows the follower's best response function. Plugging (22) into (19), and differentiating (19) with respect to L_1 yields the subgame perfect Nash location for the leader,

$$L_1^* \quad = \quad \frac{8k^4 + 38k^3 + 62k^2 + 40k + 8}{64k^4 + 232k^3 + 289k^2 + 140k + 20}. \tag{23}$$

Plugging (23) into (22) yields the subgame perfect Nash location of the follower,[9]

$$L_2^* = \frac{56k^4 + 195k^3 + 232k^2 + 108k + 16}{64k^4 + 232k^3 + 289k^2 + 140k + 20}. \tag{24}$$

[9]Second-order conditions for profit-maximization are met for these locations.

These generalize Gupta (1992) and collapse to her result of $L_1 = 0.4$ and $L_2 = 0.8$ when $k = 0$. Combining (23) and (24) with (19), (20), and (21) yield equilibrium profits, which are available from the author, and market division

$$x^*(L_1^*, L_2^*) = \frac{32k^4 + 116k^3 + 145k^2 + 72k + 12}{64k^4 + 232k^3 + 289k^2 + 140k + 20}. \tag{25}$$

The sequential choice location equilibrium in (23) and (24) can be contrasted with an equilibrium where firms choose locations simultaneously (Gupta, 1994):

$$L_1^{**} = \frac{k+2}{8k+8} \tag{26}$$

$$L_2^{**} = \frac{7k+6}{8k+8}. \tag{27}$$

These locations collapse to first best with firms at the first and third quartiles when $k = 0$. As the marginal cost curve becomes steeper the firms move away from their efficient quartiles toward the edge of the market: L_1^{**} decreases and L_2^{**} increases.[10] These inefficient locations caused by convex costs means social welfare can possibly be improved by sequential location. This improvement is possible because the sequential locations are closer than simultaneous locations (see Figure 3). The distance between simultaneous locations is $D^{**} \equiv L_2^{**} - L_1^{**} = \frac{3k+2}{4k+4}$. The distance between sequential locations is $D^* \equiv L_2^* - L_1^* = \frac{48k^4+157k^3+170k^2+68k+8}{64k^4+232k^3+289k^2+140k+20}$. Subtracting these yields $D^{**} - D^* = \frac{4k^4+23k^3+46k^2+36k+8}{256k^5+1184k^4+2084k^3+1716k^2+640k+80}$. This is positive for all $k \geq 0$, confirming that the sequential locations are closer.

[Figure 2 about here]

Figure 3 compares equilibrium locations for various values of k. With sequential location, the leader always locates closer to the center, while the follower locates closer to the edge. As the slope of the marginal cost curve, k, increases, firms locate further apart. Sequential locations become more symmetric and the market shares become more equal. Indeed, L_1^* approaches $\frac{1}{8}$ and L_2^* approaches $\frac{7}{8}$ as k goes to infinity.

Since the firms always locate closer to one another with sequential location, the inefficiency caused by convex costs, locating too far apart, can be mitigated. Proposition 5 compares social welfare under sequential location, SW^*, and under simultaneous location, SW^{**}, where $\triangle SW = SW^* - SW^{**}$.

Proposition 5: $\triangle SW > 0$ if $k > 0.300$ and $\triangle SW \leq 0$ otherwise.

[10] Equilibrium profits are available from the author.

Proof: Since the size of the market is fixed, $SW = r - SC$, where SC is the sum of production and transport cost,

$$SC = \int_0^{L_1} (L_1 - x)dx + \int_{L_1}^{x^*} (x - L_1)dx + \int_{x^*}^{L_2} (x - L_2)dx + \int_{L_2}^{1} (L_2 - x)dx + k(x^*)^2 + k(1-x^*)^2. \quad (28)$$

Social cost with sequential location comes from combining (23) and (24) with (28) yielding

$$SC^* = \left[2048k^9 + 16128k^8 + 54144k^7 + 101210k^6 + 115561k^5 + 83319k^4 + 37936k^3 + 10568k^2 + 1648k + 112\right]/\Omega \quad (29)$$

where $\Omega = 8192k^8 + 59392k^7 + 181632k^6 + 304032k^5 + 302082k^4 + 180400k^3 + 62320k^2 + 11200k + 800$. Similarly using (26) and (27) from simultaneous location yields

$$SC^{**} = \frac{8k^3 + 21k^2 + 16k + 4}{32k^2 + 64k + 32}.$$

Thus,

$$\begin{aligned} \Delta SW &= (r - SC^*) - (r - SC^{**}) = SC^{**} - SC^* \\ &= \left[512k^9 + 4768k^8 + 18504k^7 + 38565k^6 + 46040k^5 + 30380k^4 + 8640k^3 - 976k^2 - 1152k - 192\right]/\chi \quad (30) \end{aligned}$$

where $\chi = 131072k^{10} + 1212416k^9 + 4937728k^8 + 11627008k^7 + 17468448k^6 + 17417536k^5 + 11603232k^4 + 5059840k^3 + 1368320 * k + 204800k + 12800$.

Equation (30) has one root of $k = 0.300$ when $k \geq 0$. Values to the left of the root are negative and values to the right of the root are positive.[11]

Sequential location has greater social welfare than simultaneous location with sufficiently convex costs.[12] Note that the parameter k serves two roles. It determines both the level of production cost and the slope of the marginal cost curve. The first effect (the production cost level) becomes irrelevant assuming the reservation price r is high enough. Thus the second effect (the marginal cost curve slope) drives the main results.

Timing affects social welfare both through transport and production costs. Denote $TC^*$and PC^* as

[11] Plotting values for very large k suggests that (30) stays positive but converges to zero.

[12] One could imagine a pre-game delay that allows firms to choose their location stage (Hamilton and Slutsky 1990). Given such a delay the subgame perfect equilibrium would have both firms locating in the first stage. Thus the socially superior sequential timing in Proposition 1 requires exogenous sequential location. The proposition makes clear that a welfare maximizing government has an incentive to establish such sequential location. Furthermore, experimental research on the pre-game delay demonstrates that subjects often fail to act simultaneously even if doing so is superior (Fonseca, Muller and Normann 2006).

transport and production cost, respectively, with sequential location; while TC^{**} and PC^{**} are the costs with simultaneous location. Let $\triangle TC = TC^* - TC^{**}$ and $\triangle PC = PC^* - PC^{**}$ be the difference in transport and production costs between sequential location and simultaneous location. The greater social welfare from sequential location is the smaller sum of additional transport and production costs, $\triangle SW = -(\triangle TC + \triangle PC)$. The effect of timing on transport and production costs is summarized in Proposition 6.

Proposition 6: When $k > 0.300$, and social welfare is improved by sequential location, the larger production cost, $\triangle PC > 0$, is outweighed by the smaller transport cost, $\triangle TC < 0$.

Proof: Social cost has two elements: transport (TC) and production cost (PC) where

$$TC = \int_0^{L_1} (L_1 - x)dx + \int_{L_1}^{x^*} (x - L_1)dx + \int_{x^*}^{L_2} (x - L_2)dx + \int_{L_2}^{1} (L_2 - x)dx \tag{31}$$

$$PC = k(x^*)^2 + k(1 - x^*)^2. \tag{32}$$

These costs with sequential location come from inserting (23) and (24) into (31) and (32) yielding

$$TC^* = \left[1280k^8 + 8736k^7 + 25202k^6 + 40040k^5 + 38215k^4 + 22344k^3 + 7752k^2 + 1440k + 112\right]/\Omega \tag{33}$$

$$PC^* = \left[2048k^9 + 14848k^8 + 45408k^7 + 76008k^6 + 75521k^5 + 45104k^4 + 15592k^3 + 2816k^2 + 208k\right]/\Omega. \tag{34}$$

Similarly, using (26) and (27) yields costs with simultaneous location:

$$TC^{**} = \frac{5k^2 + 8k + 4}{32k^2 + 64k + 32} \tag{35}$$

$$PC^{**} = \frac{k}{4}. \tag{36}$$

Thus,

$$\begin{aligned} \triangle TC =& TC^* - TC^{**} \\ =& \left[512k^9 + 4768k^8 + 18512k^7 + 38645k^6 + 46368k^5 + 31084k^4 + 9472k^3 - 464k^2 - 1024k - 192\right]/\chi \end{aligned} \tag{37}$$

$$
\begin{aligned}
\triangle PC =& PC^{*} - PC^{**} \\
=& \frac{k^5 + 8k^4 + 24k^3 + 32k^2 + 16k}{16384k^8 + 118784k^7 + 363264k^6 + 608064k^5 + 604164k^4 + 360800k^3 + 124640k^2 + 22400k + 1600)}.
\end{aligned} \tag{38}
$$

Equations (37) and (38) each have one root, and each root is less than $k = 0.300$. To the right of their respective roots, in particular at $k = 0.300$, (37) is negative and (38) is positive.[13]

Sequential location improves social welfare because it yields lower transport cost than simultaneous location. The efficiency is gained from locating closer together, despite the inefficient asymmetry. Meanwhile, production costs are always higher with sequential location since the symmetry under simultaneous location minimizes production cost. The additional production cost under sequential location is outweighed by the reduction in transport cost. The result is that social welfare is improved with sequential location.

1.3.2 Summary

It has been understood that sequential location hurts social welfare by generating asymmetry and increasing transport cost. The leader uses its timing advantage to take more market share and the firms end up inefficiently close to one another. However, this assumes constant marginal production costs. I find that with convex production costs locating closer together can improve social efficiency. I derive for the first time the sequential location equilibrium under convex costs, and compare it with Gupta's (1994) simultaneous locations. The social costs of the asymmetry associated with sequential locations are smaller than those associated with the too distant simultaneous locations.

A possible extension to this analysis would consider more than two firms. Three firms with constant marginal cost that enter sequentially locate symmetrically but inefficiently close (Gupta, 1992). However, models of spatial price discrimination have yet to consider more than two firms with convex costs. Thus, with convex costs, it is not obvious how timing affects social welfare if three or more firms enter the market.

1.4 Upstream Monopoly and Sequential Location Downstream

I derive the Stackelberg equilibrium location choices when firms with convex costs buy a input from an upstream monopoly. Since an upstream monopoly requires one of the firms to be specified as the "critical" firm, it must be determined whether the critical firm moves first or second. I consider both cases separately and discuss their results. I contrast sequential moves to simultaneous moves, focusing on the relationship of convex costs to locations, profits, and social costs.

[13] Plotting for very large k suggests that (37) and (38) remain positive and negative, respectively, until they converge to zero.

1.4.1 Model and solution

Reintroducing an upstream monopoly who sets the input price means cost functions return to $C(q_i) = P_u^* q_i + \frac{1}{2} k q_i^2$. Since there is an upstream monopoly one of the two firms will be critical. While under simultaneous location choice the critical firm was determined in a first stage, the sequential choice set up allows the leader to choose whether she is critical or not (implicitly by her location choice). Thus, timing is organized in 4 stages. In stage 1, the leader firm chooses its location on the unit interval. In stage 2, the follower chooses its location. In stage 3, the upstream firm sets the price of the input. In stage 4, the downstream firms set the price schedule of the final good, consumers purchase the good, and profits are calculated. The game is solved with backward induction. Payoffs are calculated in the same way as under simultaneous choice.

In stage 4, prices and consumption decisions are identical to the simultaneous choice model, and so profit functions and market division are (1), (2) and (3).

In stage 3, the upstream price is set in the same way as in the simultaneous choice model, and so input price is (4). Recall that the upstream firm sets the highest price such that the entire market is served. This requires the input price to be set such that the price charged to a "critical" customer equals the reservation price. The firm which sells to the critical customer in equilibrium is labeled the "critical" firm. The distance between the critical firm and the critical customer is the furthest distance between any customer and firm.

It is possible that the leader chooses (implicitly by her location) to be critical or non-critical. In fact, the leader will always choose to be critical. Doing so always yields more market share and profit. Following a process similar to that under simultaneous choice, there is always one critical firm, who is the leader. Thus, this model does not require a first stage to predetermine which firm is critical. To provide consistency and allow comparison with the simultaneous choice locations, I derive results for the leading (critical) firm locating on the right side of the market. A symmetric equilibrium also exists which is identical in terms of profits and welfare. Thus, from equations (1) and (2), the leader's profit equation is (2) and the follower's profit equation is (1). To avoid confusion I change subscripts to L for leader and F for follower. In this case the input price (which is also the upstream monopoly's profit) is again (5).

In stage 2, follower chooses the location that maximizes its profit, taking the leader's location as given. Taking the first derivative of (1) with respect to L_1 (location of the follower) yields the best-response function for the follower,

$$L_F^{BR} = \frac{(k+2)L_L + k^2 + 2k}{8k^2 + 15k + 6}. \tag{39}$$

In stage 1, the first mover has the advantage of knowing the best response function of the follower. Plugging (38) into (1), and differentiating (1) with respect to L_1 yields the equilibrium location for the leader,

$$L_L^* = \frac{120k^4 + 346k^3 + 331k^2 + 116k + 12}{192k^4 + 584k^3 + 595k^2 + 228k + 28}. \tag{40}$$

Note that when $k < 0.19043$, $L_1^* < 0.5$. This is not possible in equilibrium because firm 2 would always choose to jump to the right of its rival. In order to ensure firm one does not jump to the right side of the market, firm 2 cannot locate to the left of 0.5. Thus, in equilibrium

$$L_L^* = \begin{cases} 0.5 & \text{for } k \leq 0.19043 \\ \frac{120k^4+346k^3+331k^2+116k+12}{192k^4+584k^3+595k^2+228k+28} & \text{for } k > 0.19043 \end{cases} \tag{41}$$

Plugging (40) into (38) yields the equilibrium location of the critical firm,

$$L_F^* = \begin{cases} \frac{2k^2+5k+2}{16k^2+30k+12} & \text{for} k \leq 0.19043 \\ \frac{24k^4+91k^3+105k^2+40k+4}{192k^4+584k^3+595k^2+228k+28} & \text{for } k > 0.19043 \end{cases} \tag{42}$$

Table 2 shows equilibrium locations at selected values of k. Proposition 7 summarizes the effect of convex costs on equilibrium sequential locations.

Proposition 7:

(a) When $k = 0$, sequential choice yields identical locations as simultaneous choice.

(b) $\frac{\partial L_L}{\partial k} = 0$ if $0 < k < 0.190$; $\frac{\partial L_L}{\partial k} > 0$ otherwise.

(c) $\frac{\partial L_F}{\partial k} < 0$ if $0 < k < 0.190$ or $k > 0.388$; $\frac{\partial L_F}{\partial k} > 0$ otherwise.

Proof: For (a), compare (37) and (38) with locations from Gupta et. al (1994). For (b) and (c), differentiate and identify roots for equations (37) - (38).

Profits and market division in equilibrium come from combining (37) and (38) with (1), (2), and (3), respectively, yielding

$$\pi_L^* = \begin{cases} \frac{32k^5+144k^4+274k^3+257k^2+116k+20}{256k^4+960k^3+1284k^2+720k+144} & \text{for} k \leq 0.19043 \\ \frac{48k^5+200k^4+307k^3+214k^2+68k+8}{384k^4+1168k^3+1190k^2+456k+56} & \text{for } k > 0.19043 \end{cases} \tag{43}$$

$$\pi_F^* = \begin{cases} \frac{4k^3+12k^2+9k+2}{32k^2+60k+24} & \text{for} k \leq 0.19043 \\ \frac{9216k^9+66432k^8+203248k^7+343198k^6+349260k^5+220117k^4+85000k^3+19032k^2+2144k+80}{73728k^8+448512k^7+1139072k^6+1565024k^5+1262162k^4+608048k^3+170608k^2+25536*k+1568} & \text{for } k > 0.19043 \end{cases} \tag{44}$$

$$x^* = \begin{cases} \frac{4k^2+6k+2}{8k^2+15k+6} & \text{for} k \leq 0.19043 \\ \frac{96k^4+268k^3+248k^2+84k+8}{192k^4+584k^3+595k^2+228k+28} & \text{for } k > 0.19043 \end{cases} \tag{45}$$

The costs in equilibrium come from combining (37) and (38) with (11), (12) and (30), yielding

$$TC^*_{seq} = \begin{cases} \frac{26k^4+86k^3+109k^2+60k+12}{128k^4+480k^3+642k^2+360k+72} & \text{for} k \leq 0.19043 \\ \frac{11520k^8+67872k^7+169970k^6+234264k^5+192483k^4+95816k^3+28200k^2+4512k+304}{73728k^8+448512k^7+1139072k^6+1565024k^5+1262162k^4+608048k^3+170608k^2+25536k+1568} & \text{for } k > 0.19043 \end{cases} \tag{46}$$

$$PC^*_{seq} = \begin{cases} \frac{32k^5+120k^4+165k^3+96k^2+20k}{128k^4+480k^3+642k^2+360k+72} & \text{for} k \leq 0.19043 \\ \frac{18432k^9+112128k^8+285920k^7+396008k^6+323321k^5+158528k^4+45640k^3+7104k^2+464k}{73728k^8+448512k^7+1139072k^6+1565024k^5+1262162k^4+608048k^3+170608k^2+25536k+1568} & \text{for } k > 0.19043 \end{cases} \tag{47}$$

$$SC^*_{seq} = \begin{cases} \frac{32k^5+146k^4+251k^3+205k^2+80k+12}{128k^4+480k^3+642k^2+360k+72} & \text{for} k \leq 0.19043 \\ \frac{18432k^9+123648k^8+353792k^7+565978k^6+557585k^5+351011k^4+141456k^3+35304k^2+4976k+304}{73728*k^8+448512*k^7+1139072*k^6+1565024*k^5+1262162k^4+608048k^3+170608k^2+25536k+1568} & \text{for } k > 0.19043 \end{cases} \tag{48}$$

Proposition 8 summarizes the effect of convex costs on transport, production, and total social cost.

Proposition 8: As k increases

(a) TC^* increases until $k = 0.19043$, decreases until $k = 2$, and then increases.

(b) PC^* increases

(c) SC^* increases

Proof: Differentiate and identify roots for (42) - (44).

Costs under this sequential choice equilibrium locations in (37) and (38) can be compared with costs under the simultaneous choice equilibrium locations. In simultaneous choice, firms choose the locations derived previously in equation (6) and total transport, production and social cost are expressed in (13) - (15). Subtraction these costs in sequential choice from the cost in simultaneous choice yields three long expressions which are available from the author.The difference in transport, production, and total social cost between simultaneous and sequential choice are summarized in Proposition 9.

Proposition 9: Let $\triangle TC = TC^*_{seq} - TC^*_{sim}$, $\triangle PC = PC^*_{seq} - PC^*_{sim}$ $\triangle SC = SC^*_{seq} - SC^*_{sim}$.

(a) $\triangle TC > 0 \,\forall k$. $\frac{\partial \triangle TC}{\partial k} > 0$ if $0 < k < 0.190$; $\frac{\partial \triangle TC}{\partial k} < 0$ otherwise.

(b) $\triangle PC > 0 \,\forall k$. $\frac{\partial \triangle PC}{\partial k} > 0$ if $0 < k < 0.190$; $\frac{\partial \triangle PC}{\partial k} < 0$ otherwise.

(c) $\triangle SC > 0 \,\forall k$. $\frac{\partial \triangle SC}{\partial k} > 0$ if $0 < k < 0.190$; $\frac{\partial \triangle SC}{\partial k} < 0$ otherwise.

Proof: Set (45) - (47) equal to zero and solve for k. Differentiate and calculate positive roots of equations (45) - (47).

Total transport, production and social cost are always greater under sequential choice than under simultaneous choice when there is an upstream monopoly setting the input price.

Additionally, costs of serving the market under sequential entry can be compared with and without upstream monopoly. Costs are always greater with upstream monopoly than without, yet these cost difference diminish as convexity increases. This result is similar to the findings presented in note one.

1.4.2 Summary

In this note, I show that with upstream monopoly and constant marginal cost, locations under sequential choice are identical to those under simultaneous choice. This is because with simultaneous choice a critical firm locates at the center of the market to drive down the input price leaving no further advantage of leadership. This is not the case with convex costs. The leader remains at the center for low degrees of convexity, but the follower locates further from the center than they would under simultaneous choice. For higher degrees of convexity, the leader moves away from the center of the market. Costs are always larger under sequential choice than simultaneous choice.

1.5 Conclusion

In this essay, I explore three inter-related extensions to a model of spatial price discrimination with convex production costs. These extensions include allowing for upstream monopoly, sequential location choice and both together. I find that the effect of these additions to the baseline model (with neither upstream monopoly nor sequential choice) can generate results that would not be anticipated with constant marginal costs. My findings are organized into three notes.

In the first note, which is also published (Courey, forthcoming), I show that the reduction in social welfare caused by the presence of an upstream monopoly is lower with convex costs than with constant marginal cost. This follows because convex costs cause the leader to have less incentive to locate near the center of the market. Locations become more efficient, though they always remain less efficient than without an upstream monopoly.

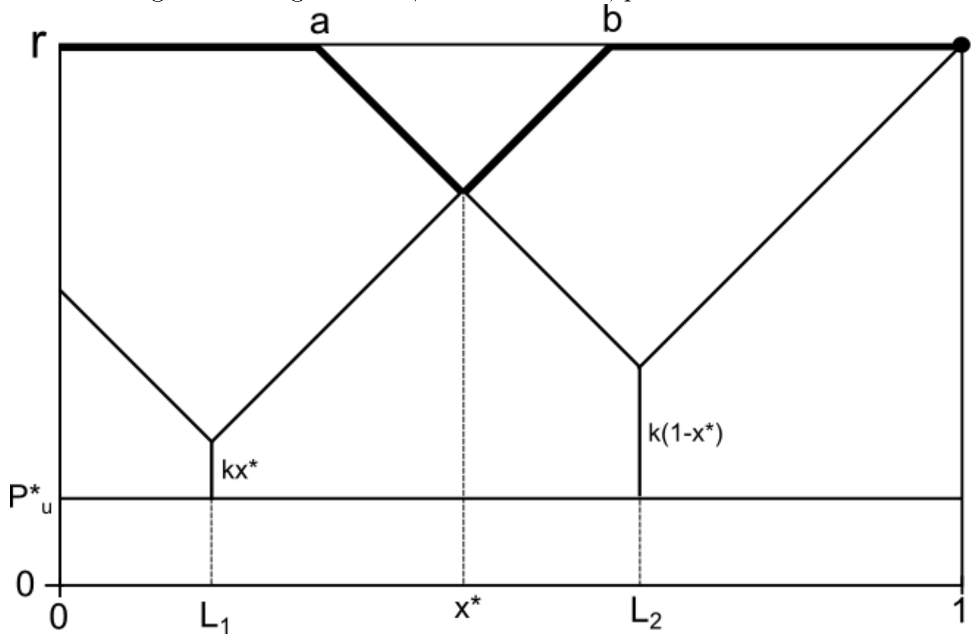
The second note returns to the case without upstream monopoly but allows the firms to locate sequentially rather than simultaneously. While previous study work shown that sequential entry reduces social welfare under constant marginal cost, I show that this need not be true when production costs are convex. The leader moves further from the center of the market and transport cost decreases. In contrast, when firms locate sequentially and cost convexity is larger both firms locate so far from the center that social welfare is less than under sequential choice. This mirrors the result with constant marginal costs and no upstream monopoly.

In the third note, I investigate the model with both upstream monopoly and sequential choice. I find that, as in the first note, the distortion in social welfare from upstream monopoly is reduced but always positive with convex costs. I also find that with upstream monopoly, in contrast to the case without upstream monopoly in the second note, sequential entry always yields lower social welfare than simultaneous entry.

A possible extension to this analysis is to make endogenous the timing of the game. Hamilton and Slutsky (1990) consider a pre-game stage in which two firms can choose whether to produce in one of two sub-stages. If both produce in the same sub-stage the equilibrium is identical to Cournot competition, and if they produce in different sub-stages the equilibrium is identical to Stackelberg. If firms' payoffs are larger as a Stackelberg follower than with Cournot competition, firms with choose to produce in different sub-stages yielding the Stackelberg equilibrium. Otherwise, the firms will choose to produce in the same sub-stage yielding the Cournot equilibrium. I have investigated both simultaneous and sequential location choice timing structures under two different types of upstream markets. Since social welfare is sometimes larger in sequential timing rather than simultaneous, it is potentially interesting to think about whether firms would choose this structure endogenously. Additionally, their preference of timing structures might also depend on the upstream market structure.

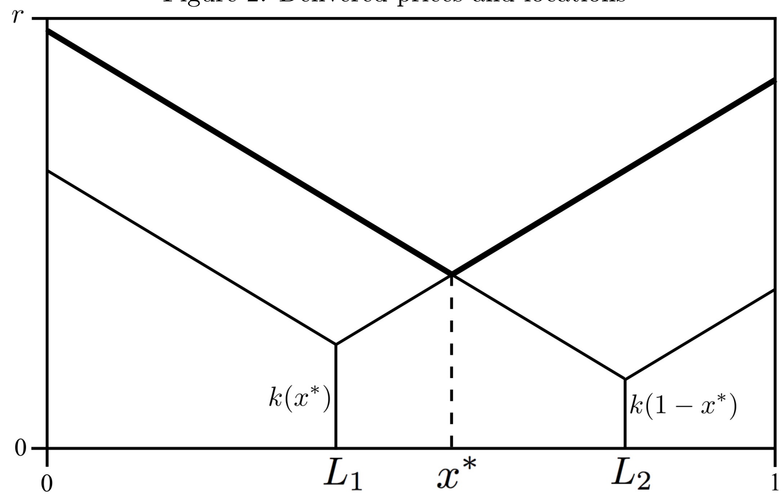
Another possible extension is to consider the firm's choice of different production costs downstream. Gupta, Heywood and Pal (1995) show that in the presence of an upstream monopoly, a downstream firm chooses to adopt an inefficiently high transportation cost. Assuming the monopoly's profit is maximized when the entire market is served, the higher transport cost causes the monopoly to reduce the input price in order to accommodate the market. The same thing might be true with production cost convexity: if the firm can choose the level of k, it might choose an inefficiently high level, forcing the input price down and increasing total profit to the firm.

Figure 1: Marginal costs, market division, prices and locations



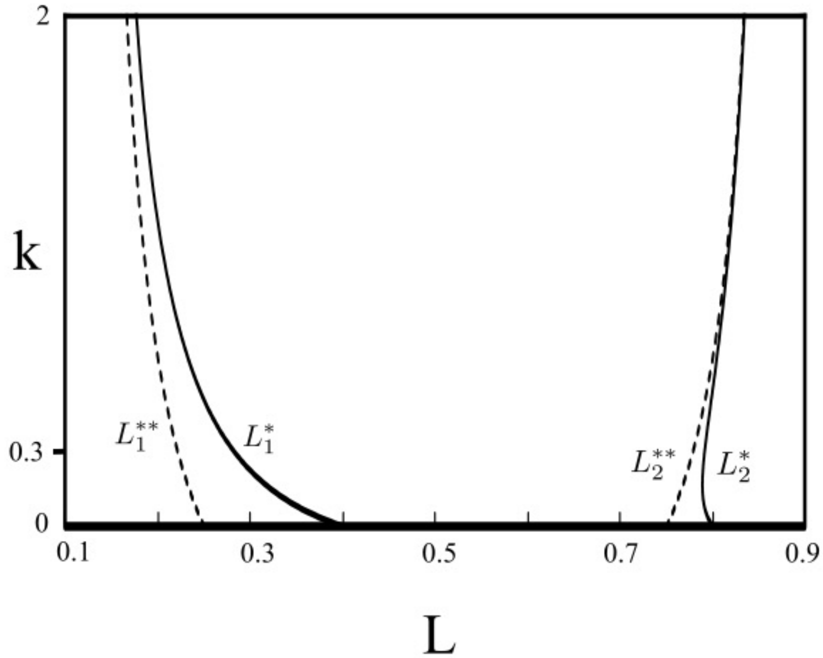
Consumers have reservation price r and pay a price depending on their location denoted by the darkened line. The indifferent consumer at x^* denotes the market division between the firms. Firms 1 and 2 have locations $L_1$and L_2, incur marginal costs of production kx^* and $k(1-x^*)$, and transport cost normalized to 1. The input price P_u^* is set by the upstream monopoly.

Figure 2: Delivered prices and locations



Firms locate at L_i and the market division is x^*. The darkened line is the sum of the rival's marginal production and transport cost, and k is the slope of the marginal cost curve.

Figure 3: Equilibrium Locations with Sequential and Simultaneous Location



Sequential locations, L_1^* and L_2^*, are always to the left of the symmetric simultaneous locations, L_1^{**} and L_2^{**}, respectively. Sequential locations are closer together than simultaneous locations. Sequential location improves social welfare when $k > 0.300$.

Table 1: Equilibrium downstream locations and the cost of upstream monopoly

	Locations	Cost of Upstream Monopoly	
k	(L_1^*, L_2^*)	$TC^* - TC^G$	$PC^* - PC^G$
0	(0.166, 0.500)	0.0417	0.0000
.1	(0.172, 0.520)	0.0352	0.0020
.2	(0.173, 0.533)	0.0311	0.0030
.3	(0.173, 0.543)	0.0280	0.0036
.5	(0.172, 0.551)	0.0236	0.0041
.75	(0.166, 0.568)	0.0199	0.0043
1	(0.163, 0.576)	0.0172	0.0043
2	(0.155, 0.593)	0.0112	0.0036
5	(0.140, 0.609)	0.0054	0.0022
10	(0.133, 0.616)	0.0029	0.0013

The cost of upstream monopoly is the sum of added transport cost $(TC^* - TC^G)$ and added production cost $(PC^* - PC^G)$.

Table 2: Stackelberg equilibrium locations with monopoly upstream

Cost Convexity	Locations
k	(L_F^*, L_L^*)
0	(0.167, 0.500)
.1	(0.166, 0.500)
.1904	(0.165, 0.500)
.2	(0.166, 0.502)
.3	(0.168, 0.520)
.5	(0.168, 0.542)
.75	(0.165, 0.558)
1	(0.162, 0.569)
2	(0.152, 0.590)
5	(0.140, 0.608)
10	(0.133, 0.616)

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2 Gender and Racial Wage Differentials in the Nonprofit Sector: Are Hospitals Different?

2.1 Introduction

This paper focuses on gender and racial wage differentials within the enormous US hospital industry. It contrasts the size of such differentials in the nonprofit sector with those in the for profit sector. Economists have long been interested in labor markets which involve nonprofits and question whether the process of earnings determination mimics that for for-profit firms. While the evidence on relative wage levels between sectors is ambiguous, it remains very typical to show that nonprofits have lower gender and race differentials. My study provides contradictory evidence for hospitals.

I find that both gender and racial wage differentials are larger among hospital workers in the nonprofit sector than among hospital workers in the for-profit sector. This result casts doubt on a theory often used to explain the traditional finding of smaller gender and racial differentials in the nonprofit sector. Past researchers have argued that "nonprofit organizations rely disproportionately on intrinsically motivated employees" (Leete, 2000). They cite a large literature from social sciences linking wage equality and intrinsic motivation: when workers feel working conditions are unfair (inequitable), they are less intrinsically motivated. They conclude that nonprofits, more than for-profits, emphasize wage equality across visible differences (including race and gender) as a tool for maintaining their workers' intrinsic motivation (and/or attracting workers with such motivation).

This theory appears obviously at odds with my findings of larger race and gender differentials in the nonprofit sector. Not only do I find larger differentials for the hospital industry on average, but also throughout the earnings distribution and in most subsamples. I suggest an alternative theory to explain of these patterns based on Pauly and Redisch's (1973) model of nonprofit hospitals as physician cooperatives. In this model, nonprofit hospitals are associated with weakened monitoring of physicians who make important decisions in the organization. I argue that one result of this weakened monitoring could be more latitude to indulge in taste-based discrimination among nonprofit hospitals.

I use data from the Current Population Survey (CPS) from 1995 to 2013. After controlling for factors commonly thought to determine workers' earnings such as occupation, age and education, I find that in both the nonprofit and for-profit sectors, Female and Black hospital workers make less on average than Male and Non-Black hospital workers, respectively. The pay penalties associated with Female and Black workers are statistically significant in both sectors. Importantly, both differentials are significantly larger in magnitude among workers in nonprofit hospitals than among workers in for-profit hospitals.

Quantile regression estimates reveal that these patterns vary throughout the earnings distribution. The larger gender differential in nonprofit hospitals is most strongly experienced by workers at the top of the earnings distribution. Meanwhile, the larger racial differential in nonprofit hospitals is most strongly experienced by workers at the bottom of the earnings distribution. In both sectors, the gender differential is larger at the top of the distribution, suggesting that Female hospital workers experience a glass ceiling. However, Black workers do not seem to experience a glass ceiling as the racial differential generally decreases throughout the distribution.

I inspect 20 different subsamples based on unionization, part-time, full-time and marital status, race, gender and occupation. In all 20 subsamples, the gender and racial differentials are at least as large in the nonprofit sector as in the for-profit sector. In fact, many subsamples continue to reflect the industry-wide finding of larger differentials in the nonprofit sector.

In what follows, I place my study in the related literature and motivate my focus on the US hospital industry. In section 3, I describe the data used in my analysis. In section 4, I present my approach and results. Section 5 concludes.

2.2 Motivation

The study of racial and gender wage differentials has a long, rich history among economists interested in labor markets (for a review, see Altonji and Blank, 1999; for a meta-analysis of findings, see Weichselbaumer and Winter-Ebmer, 2005). Female and Black workers, on average, earn less than their Male and Non-Black counterparts, after controlling for important earnings determinants. These findings may, but need not be, the result of discrimination by employers.

Many focal-points have emerged within this vast literature on race and gender wage inequality. Among them, a growing body of research contrasts the sizes of racial and gender differentials in the nonprofit sector with those in the for-profit sector. These studies have routinely found smaller differentials in the nonprofit sector as compared to the for-profit sector.

The common theory put forth in the literature is based on a link between the nonprofit sector, intrinsic motivation and wage inequality. Leete (2000) argues that "nonprofit organizations rely disproportionately on intrinsically motivated employees" (p. 423). She cites a large literature from social science (e.g. Adams, 1963; Clark and Oswald, 1996; Deci, 1975; Deci and Ryan, 1985; Akerlof, 1982) to support a link between wage equality and intrinsic motivation. When workers feel working conditions are fair, they are more intrinsically motivated. She predicts that nonprofits emphasize wage equality as a means to increasing their workers' intrinsic motivation. Thus, the theory seemingly involves two links: intrinsically motivation is more common in the nonprofit sector, and wage equality stimulates these workers' intrinsic motivation.

The first modern study of racial and gender wage differentials in the nonprofit and for-profit sectors was done 15 years ago.[14] Leete (2000) uses data from the 1990 US Census and finds that, after controlling for conventional earnings determinants, gender and racial wage differentials are smaller in the nonprofit sector. She shows that these sectoral differences are statistically significant both economy-wide and in white collar occupations.

Since then, other researchers have performed similar studies. Narcy (2006) uses French data and employs an Oaxaca decomposition technique. He finds that gender pay gaps are smaller among workers in the nonprofit sector than for similar workers in the for-profit sector. Etienne and Narcy (2010) also use French data and investigate the gender pay gap across the earnings distribution. They also use a decomposition technique and account for sample selection. They show that gender pay gaps among workers in the nonprofit sector are smaller across the entire earnings distribution. Yet, they find that after controlling for occupation the differential is only smaller in the nonprofit sector at the top of the earnings distribution. Thus, they conclude that occupational segregation plays a part in explaining the observed gender pay gap. Most recently, Falk, Edwards, Lewis and McGinnis (2013) use data from the American Community Survey over the time period 2001 - 2006. They find that gender wage differentials are smaller in industries with a higher share of nonprofit workers.

I build on this literature by being the first to study whether the patterns found in past economy-wide studies also prevail within a single but important industry. Additionally, as opposed to the more recent economy-wide studies, I analyze racial as well as gender differentials.

2.2.1 The Case of U.S. Hospitals

The U.S. Hospital industry is extremely large and growing. Healthcare expenditure in the United States is over 17% of GDP, the largest share claimed by any industry (Center for Medicare and Medicaid Services, 2013; henceforth CMS). A third of this expenditure goes to hospitals, the largest of any service within the industry (American Health Association, 2014b; henceforth AHA). In the last half century, national expenditure on hospital services has grown from 1.8 to 5.6% of GDP. Over this period, in real per capita terms, expenditure on hospital services has grown by 460% (CMS, 2013).

Wages for hospital workers is of great and growing interest to both workers and employers. Hospitals hire more workers (nearly 5.6 million) than any other industry, except for full-service restaurants. In the last 20 years, 1.2 million workers have been added to the hospital workforce. While the share of US workers in

[14] Much older studies have analyzed racial and gender wage differentials in the public and private sectors (e.g. Long, 1976; Smith, 1976).

hospitals is nearly the same as it was in 1995, the market has grown by over 25%, according to the author's calculations (AHA, 2014a).

Nonprofits are particularly important to the hospital industry. Of the 4,999 US Community Registered Hospitals,[15] 1,068 are Investor-Owned For-Profit Hospitals and 2,894 are Non-government Not-For-Profit Hospitals (AHA, 2014a).[16] Half of all nonprofit workers in the US are employed in healthcare (Lakdawalla and Philipson, 2006).

The last 20 years have seen a dramatic rise in private for-profit hospitals. In 1995, there were only 752 for-profit hospitals (AHA, 2014a).[17] Whether these workers have received different treatment than their counterparts in the nonprofit sector demands a closer look.

Moreover, hospitals are often regarded as different from other industries. Important decision-makers, physicians, are often not employed by the hospitals they work in. Furthermore, physicians' ability to influence service provision is likely stronger in nonprofit hospitals.

> "The private, nonprofit hospital has usually been regarded by economists as an organizational anomaly. In particular, it has been alleged that the predominance of the not-for-profit structure within the American hospital system is associated with a weakening of the usual market constraints of competition and profit maximization." (Pauly and Redisch, 1973, p. 87)

Nonprofit organizations in general are associated with weakened monitoring (Handy and Katz, 1998). The nonprofits' objectives are typically more difficult to measure, making it more difficult to monitor whether the objectives are being achieved. Thus, nonprofit hospitals probably have a harder time monitoring physicians than for-profit hospitals.

Further, the extent of which monitoring is weakened in nonprofit hospitals is likely greater than in other types of nonprofits. The hospital-physician relationship exhibits large information asymmetry problems. Doctors possess a majority of the human capital required for providing quality and cost-effective services. This human capital is implicitly difficult to monitor.

A possible consequence of this weakened monitoring in nonprofit hospitals is a greater ability of physicians to indulge taste-based discrimination. Physicians (on average Male and White) may have discriminatory tastes about who they work with. Certainly, there is a large literature on whether doctors provide different treatment based on the race and gender of their patients (Werner at al. 2005, Liu et al. 2011). Thus, wage differentials that reflect the ability to indulge discriminatory taste may be larger in nonprofit hospitals.

[15] Community Hospitals are non-federal, short-term general and other specific hospitals. Registered Hospitals are those identified by the AHA as a hospital facility.

[16] These numbers are from 2012.

[17] The number of beds in all for-profit hospitals has increased at a comparable rate.

I adapt Pauly and Redisch's (1973) model of a nonprofit hospital to illustrate how discriminatory physicians could cause wage differentials for hospital workers, despite the fact that they often don't work for the hospital directly. I make the extreme assumption that physicians enjoy full control of operations in nonprofit hospitals and so can fully indulge their discriminatory preferences.

Assume a "hospitalization service" has the production function

$$Q = F(L_a + L_b) \tag{49}$$

where L_a and L_b are non-physician labor of two types (i.e. Black and non-Black, or Female and Male) whose marginal products of labor are assumed to be identical. Other inputs include physical capital and physician labor. However, these inputs are not the focus and so are assumed to be constant. It is assumed that customers pay the full price of the service, P_T, which is taken as given.[18]

As is typical, upon receipt of the service, customers receive two separate bills, one from the hospital and one for the services of the physician. The nonprofit hospital always sets the total price of its service equal to the total cost of non-physician labor. If P_H is the price of the hospital services not associated with physician labor, then the hospital always sets P_H to break even:

$$P_H Q \equiv w_a(L_a)L_a + w_b(L_b)L_b \tag{50}$$

where w_i is the wage rate for worker type i. Assume $w_i^{'}(L_i) > 0$, so each hospital faces an upward sloping labor supply curve. This could be a result of monopsony power in the labor market or transactions costs (Hirsch and Schumacher, 1995, 2005).

Thus the income for the physician is

$$\pi_{Ph} = P_T Q - P_H Q = P_T F(L_a + L_b) - w_a(L_a)L_a - w_b(L_b)L_b. \tag{51}$$

As preference over co-workers enters the utility function of the physician, they maximize utility

$$u = u(L_b, \pi_{Ph}), u_1 > 0, u_2 > 0. \tag{52}$$

In the equation (52), the physician prefers working with type b workers. If instead, the physician disliked working with type a workers, the result would be symmetrical. Holding price constant and differentiating

[18]The assumption that customers pay the full price is obviously not realistic but simplifies the analysis. Pauly and Redisch discuss the effect of insurance on hospital service production and price.

with respect to non-physician labor yields first-order conditions

$$P_T F_L(L_a + L_b) \quad = \quad w_a(L_a) + w_a^{'}(L_a)L_a = w_a(L_a)\left[1 + \frac{1}{\eta_a}\right] \tag{53}$$

$$P_T F_L(L_a + L_b) + \frac{u_1}{u_2} \quad = \quad w_b(L_b) + w_b^{'}(L_b)L_b = w_b(L_b)\left[1 + \frac{1}{\eta_b}\right] \tag{54}$$

where η_i is the wage elasticity of labor supply for worker type i, and I assume $\eta_a = \eta_b$. On the left-hand side, $P_T F_L(L_a + L_b)$ is the value of the marginal product. The only remaining term is $\frac{u_1}{u_2}$ which is the marginal rate of substitution between profit and hiring another type b worker. This term can be thought of as Becker's (1957) "coefficient of discrimination." Since this term is positive, the left hand side of equation (54) must be greater than the left hand side of equation (54). Subsequently, the same relation must be true on the right hand side of both equations. This implies that

$$w_b^* > w_a^*. \tag{55}$$

This inequality is not found in the for-profit hospital, as physicians who have discriminatory tastes can more easily exert their prejudice within the nonprofit hospital. Additionally, it is unlikely that the theory can be generalized to all nonprofit industries. It relies on the dual-billing nature of the hospital service and information issues that are generally absent in other industries. Thus, this predicts that unlike other industries, wage differentials in nonprofit hospitals are larger than those in for-profit hospitals. It need not be the only theory, but it provides at least one alternative to Leete's theory based on intrinsic motivation.

In the next sections, I show that the observed gender and racial wage differentials in the nonprofit and for-profit hospitals are consistent with patterns predicted by the logic just presented.

2.3 Data

I use data from the Merged Outgoing Rotations Group (MORG)[19] of the Current Population Survey (CPS). Every month, 30,000 Americans complete the CPS questionnaire. Each individual participates for four consecutive month, takes an eight month break and concludes by completing the survey for another four months. The MORG includes only the final month of each individual's four month rotation so each individual appears twice with observations one year apart.

Following Schumacher (2008), I drop observations with imputed wages. Since the imputation process can involve assigning a nonprofit hospital worker the wages from a for-profit hospital worker, differentials could be biased toward zero (Hirsch and Schumacher, 2004). September 1995 is when the CPS began including

[19]Provided by the National Bureau of Economic Research.

indicator variables for whether wages were imputed, so I use observations from then until 2013.

After restricting the sample to only hospital workers, Healthcare Practitioners make up more than half of the sample. Further, more than half of Practitioners are Registered Nurses. I therefore control for Registered Nurses and "Other Practitioners"[20] separately such that all occupation groups are mutually exclusive. Physicians, Dentists and Veterinarians are excluded from the sample.[21]Only workers at least 18 years old who report positive earnings and positive weekly hours worked are considered. Workers with wages between \$2.75 and \$135 are included in the sample.

Wages are expressed in 2013 dollars. When hourly wages are reported, those are used. Otherwise, weekly earnings is divided by the reported usual hours worked per week. If usual hours worked per week is not reported, hours worked last week is used.

The CPS topcodes earnings. Hirsch and Macpherson estimate the mean earnings of those above the cap assuming a Pareto income distribution.[22] I use these estimates to replace the earnings of workers whose reported incomes are exactly equal to the cap. Roughly 2% of the workers in my sample are topcoded.[23]

Summary statistics from the two sectors are presented in table 3. Of the 79,482 observations in the sample, 36,180 are in nonprofit hospitals and 43,302 are in for-profit hospitals. Nonprofit workers are paid about 10% more than for-profit workers. Nonprofit hospitals hire a smaller share of Female (80%) and Black (7%) workers than do for-profit hospitals (82 and 13%, respectively).[24]

[Table 3 about here]

Before controlling for other observable characteristics, the raw gender wage gap is larger for workers in the nonprofit sector (women make 92% as much as men) than for workers in the for-profit sector (95%). Meanwhile, the raw race wage gap is identical in both sectors. Black hospital workers earn 78% as much as Non-Black workers in both sectors. In the next section, I show that, after controlling for observable characteristics, significant differentials emerge and are larger in the nonprofit sector.

[20]"Other Practitioners" includes: Chiropractors, Dietitians and nutritionists, Optometrists, Pharmacists, Physician assistants, Podiatrists; Audiologists, Occupational therapists, Physical therapists, Radiation therapists, Recreational therapists, Respiratory therapists, Speech-language pathologists, Exercise physiologists; Therapists, all other; Nurse anesthetists, Nurse midwives, Nurse practitioners; Health diagnosing and treating practitioners, all other; Clinical laboratory technologists and technicians, Dental hygienists, Diagnostic related technologists and technicians, Emergency medical technicians and paramedics, Health diagnosing and treating practitioner support technicians, Licensed practical and licensed vocational nurses, Medical records and health information technicians; Opticians, dispensing; Miscellaneous health technologists and technicians, Other healthcare practitioners and technical occupations.

[21]A hospital's relationship with Physicians is potentially different than with other occupations. The inclusion of these workers in the sample does not significantly affect my results.

[22]At http://unionstats.com.

[23]Dropping workers with topcoded earnings from the sample does not significantly affect my results.

[24]Descriptive statistics for the economy-wide estimates performed in the next section are available from the author.

2.4 Approach and Results

In this section, I show that gender and racial wage differentials are larger in nonprofit hospitals than in for-profit hospitals. I show this finding is robust to various specifications, and that it exists throughout the earnings distribution. It also persists in subsamples based on employment and demographic characteristics. This finding is consistent with the explanation that nonprofit hospitals experience weaker monitoring than for-profit hospitals but clearly does not prove that explanation.

Consider the log wage equation

$$\begin{aligned} \ln W_i = X_i'\beta + Nonprofit_i\beta_1 + Female_i\beta_2 + Black_i\beta_3 + \\ + (Nonprofit_i * Female_i)\beta_4 + (Nonprofit_i * Black_i)\beta_5 + \epsilon_i. \quad (56) \end{aligned}$$

Each individual i has real wage W_i , error term ϵ_i, and a vector X_i' of standard wage determinants including human capital, demographic and occupational characteristics, region[25] and year. $Nonprofit_i$ is a dummy variable which equals 1 if individual i works in the nonprofit sector and 0 if they work in the for-profit sector, $Female_i$ is a dummy variable which equals 1 if individual i is Female and 0 otherwise, and $Black_i$ is a dummy which equals 1 if individual i is Black and 0 otherwise. My focus is on weighted least squares (WLS) estimates of the parameters β_2 , β_3 , β_4 and β_5, which are the effect of working in the nonprofit sector on gender and racial wage differentials. WLS differs from ordinary least squares (OLS) in that each observation is weighted by the inverse probability of being in the sample. These weights, which focus on the workers' state, ethnicity, race and age, approximate the number of people in the population represented by each observation in the sample.[26] Estimates $\hat{\beta}_2$ and $\hat{\beta}_3$ can be transformed to generate gender and racial wage differentials for for-profit workers. These estimates can be combined with $\hat{\beta}_4$and $\hat{\beta}_5$, respectively, to calculate the differentials for nonprofit workers. For example, the gender wage differential in the for-profit sector is calculated as $\exp(\hat{\beta}_2) - 1$. Similarly, the gender differential in the nonprofit sector is $\exp(\hat{\beta}_2 + \hat{\beta}_4) - 1$.

[Table 4 about here]

Economy-wide results, shown in column 1 of table 4, reveal that in the for-profit sector, Female workers earn 0.184 less and Black workers earn 0.067 less in log wages. This translates to gender and racial differentials

[25] "New England" includes: ME, NH, VT, MA, RI, CT. "Middle Atlantic" includes: NY, NJ, PA. "East North Central" includes: OH, IN, IL, MI, WI. "West North Central" includes: MN, IA, MO, ND, SD, NE, KS. "South Atlantic" includes: DE, MD, DC, VA, WV, NC, SC, GA, FL. "East South Central" includes: KY, TN, AL, MS. "West South Central" includes: AR, LA, OK, TX. "Mountain" includes: MT, ID, WY, CO, NM, AZ, UT, NV. "Pacific" includes: WA, OR, CA, AK, HI.

[26] All standard errors presented in this paper are robust to heteroskedasticity. OLS parameter estimates reflected nearly identical patterns as those under WLS.

of -16.8% and -6.5%, as shown in column 2 of table 3. Following this same process reveals differentials for the nonprofit sector of -3.9% and -1.2%, as shown in column 1 of table 5. Thus both differentials are smaller in the nonprofit sector than in the for-profit sector, economy-wide. This finding confirms that patterns found in past studies are also present in the data used here.

[Table 5 about here]

However, this economy-wide pattern does not exist within the expansive US hospital industry. As shown in columns 3 and 4 of table 5, for-profit hospitals have gender and racial differentials of -3.9% and -5.2%, while those in nonprofit hospitals are -6.9% and -7.6%. Both differentials are larger in nonprofit hospitals than in for-profit hospitals. Furthermore, these sectoral differences are statistically significant, as shown by $\hat{\beta}_4$ and $\hat{\beta}_5$ in column 2 of table 4. These findings in the hospital industry are consistent with the explanation that nonprofit hospital experience more discrimination as a result of weaker monitoring.

Furthermore, focusing on all non-hospital workers reveals patterns different from the economy-wide findings. As shown in columns 5 and 6 of table 5, the gender and racial differentials are -16.9% and -6.5% in the for-profit sector and -5.6% and -1.0% in the nonprofit sector, for non-hospital industries. As can be seen by a closer look at table 5, the economy-wide differentials are not always a weighted average of those found in the hospital and non-hospital subsamples. The economy-wide gender differential in the nonprofit sector is -3.9%, while in hospital and non-hospital samples they are -6.9 and -5.6. This suggests the gender differential observed in nonprofits economy-wide is the result of composition effects. The composition effect is not present in the racial differential for nonprofits (-1.0 in non-hospital, -7.6 in hospital and -1.0 economy-wide). The for-profit sector exhibits a less dramatic pattern. In the for-profit sector, the racial differential is the same in the non-hospital sample as economy-wide (-6.5%). Thus the -5.2% racial differential found in for-profit hospitals seems to have no effect in the economy-wide result. The gender differential in the for-profit sector economy-wide (-16.8%) is bracketed by its hospital (-3.9%) and non-hospital (-16.9%) subsamples. The main point remains the surprising finding that among hospitals, race and gender differentials are larger in nonprofit hospitals.

These findings in the hospital industry are robust to more flexible wage structures. Equation (56) is restrictive because the coefficients on the set of controls are assumed to be constant across both sectors. A more flexible approach estimates the earnings of nonprofit and for-profit hospital workers separately:

$$\ln W_i^k = X_i'^k \beta^k + Female_i^k \beta_F^k + Black_i^k \beta_B^k + \epsilon_i^k \tag{57}$$

where $k \in (Nonprofit, For{-}Profit)$ denotes the sector. This estimation allows the controls to take different returns by sector. Now $\hat{\beta}_F^k$ and $\hat{\beta}_B^k$ are used on their own to calculate gender and racial wage differentials in each sector. Computing the differentials using the regression results shown in table 4, nonprofit hospitals have gender and racial differentials of -6.9% and -6.9%. Meanwhile, in the for-profit sector the gender differential is -5.3% and the racial differential is -5.0%. Furthermore, the estimated premiums for Female and Black workers are significantly different in the two sectors, as shown in column 3 of table 6.[27] These coefficients and the differences by sector are essentially identical to those found using the more restrictive equation. Thus, allowing coefficients to differ by sector has very little effect on the results.[28]

[Table 6 about here]

In addition to being impervious to more flexible wage structures, these findings are also present throughout the earnings distribution. I show this using quantile regression to estimate equations (57). Rows 1 and 2 of table 6 shows the regression results in the nonprofit and for-profit sectors at the 10th, 25th, 50th, 75th and 90th percentiles. At the median, the differentials are only slightly smaller than those previously estimated at the mean. Median gender and racial differentials are -5.6% and -6.7% in nonprofit hospitals, and -2.7% and -4.5% in for-profit hospitals. As shown in row 3 of table 7, differences between sectors are statistically significant at the median. Throughout the distribution, differentials exhibit a wide range. Gender differentials at the five quantiles are -0.7% (10th), -4.2% (25th), -5.6% (median), -8.1% (75th) and -12.5% (90th) in nonprofit hospitals; and 1.4%, 0.1%, -2.7%, -6.1% and -9.4% in for-profits hospitals. Racial differentials are -8.5%, -7.8%, -6.7%, -5.4% and -7.8% in nonprofit hospitals; and -6.0%, -5.4%, -4.5%, -3.9% and -3.4% in for-profit hospitals.

These patterns suggest that Female workers may experience a glass ceiling in both sectors: the gender wage differential is largest at the highest percentiles. This is similar to the findings of Etienne and Narcy, who find evidence of a glass ceiling in the French nonprofit and for-profit sectors. Furthermore, this glass ceiling seems to be more pronounced in nonprofit hospitals. In this sector, differentials at the 90th and 10th percentiles are more drastically different ($12.5\% - 0.7\% = 11.8\%$) than in the for-profit sector (10.8%). However, as is typically found, racial differentials generally decreases throughout the income and skills distribution (Heywood and Parent, 2012). The racial differential also seems to exhibit a wider range

[27] In results not shown, the use of 314 specific occupation controls rather than the 8 broad controls yields similar results. The time period 1995-2013 does not include consistent occupation categories throughout. The longest span with consistent occupation categories is 2000-2010. Restricting analysis to only this time period has minimal effect on the results. The economy-wide patterns shown in table 2 also persist using specification (9).

[28] Alternatively, one could allow returns to characteristics to differ by race or gender but not by sector. Estimating separate equations for Female, Male, Black and Non-Black workers reveals that all four groups earn more in nonprofit hospitals than in for-profits. Nonprofit premiums are larger for Male and Non-Black workers than for Female and Black workers respectively. The difference between racial groups is statistically significant. Regression results are available from the author.

throughout the distribution in the nonprofit sector. Differences by sector are statistically significant at many points throughout the distribution, as shown in row 3 of table 7. This more detailed investigation of various quantiles shows that findings at the mean also appear throughout the distribution: differentials are larger in nonprofit hospitals than in for-profit hospitals.

[Table 7 about here]

To further strengthen this finding, I show it is also robust in most subsamples. Estimates of (9) within many relevant employment and demographic sub-samples are shown in table 6. Both union and non-union workers experience larger differentials in nonprofit hospitals than in for-profit hospitals, as shown in rows 1 and 2. Union workers experience gender differentials of -2.8% in nonprofit hospitals and -0.3% in for-profit hospitals, and those for non-union workers are -7.1% and -4.4%, respectively. Union workers experience racial differentials of -2.6% in the nonprofit sector and -3.4% in the for-profit sector, while non-union workers experience differentials of -8.2% and -5.4%, respectively.[29] The differences by sector are statistically significant for non-union workers but not for union workers.

Both full-time and part-time workers experience significantly larger differentials in the nonprofit hospitals. For full-time workers, gender differentials are -7.8% in nonprofits and -5.2% in for-profits, while for part-time workers gender differential are -2.1% and 1.0%, respectively. Racial differentials for full-time workers are -7.5% (nonprofit) and -4.9% (for-profit), while racial differentials for part-time workers are -8.8% and -6.2%, respectively. The differences by sector are significant for full-time worker, while for part-time workers the gender differential is statistically different by sector.

Married and unmarried workers both have larger differentials in nonprofit hospitals than in for-profit hospitals. Gender differentials for married workers are -8.2% in nonprofit hospitals and -6.0% in for-profit hospitals, while gender differentials for unmarried hospital workers are -4.5% and -0.8%, respectively.[30] For both married and unmarried workers, gender differentials in nonprofit hospitals are significantly larger than in for-profit hospitals. Married workers have significantly larger racial differentials in nonprofits (-9.9%) than in for-profit hospitals (-5.7%). Racial differentials for unmarried workers are larger but not significantly so in nonprofits (-6.2% versus -5.3% in for-profits). Critically, among all six of these sub-samples (based on marriage, full-time and union status), the estimated differentials are larger in nonprofit hospitals than for-profit hospitals. This confirms the study's main finding and shows that it is spread broadly across those with different workforce characteristics.

[29] Larger racial gaps among non-union workers is consistent with other recent findings in the healthcare industry (McGregory Jr., 2013).

[30] Larger gender differentials for married workers has also been found in numerous past studies (Blau, Ferber and Winkler, 2014).

[Table 8 about here]

Occupational categories also provide strong supporting evidence of the breadth of the finding. Gender and racial differentials for 8 mutually exclusive categories (Management, Professional, RN's, Other Practitioners, Service, Office, Operative and Transportation) generate 16 total race and gender differentials in each sector. In all of these, the differentials in nonprofit hospitals are larger or no different than those in for-profit hospitals. As rows 7 through 14 of table 8 show, both gender and racial differentials are larger or not statistically different in all occupational category. The gender differential for Other Practitioners is -4.5% in nonprofit hospitals and significantly smaller -1.6% in for-profit hospitals. For Office workers, gender differentials are -5.0% in nonprofit hospitals and a significantly smaller -2.0% in for-profit hospitals. The most pronounced difference for gender is among Professional Non-Practitioners where the gender differential is -12.9% in nonprofit hospitals and a significantly smaller -4.1% in for-profit hospitals. Professional Non-Practitioners also represent the largest difference for race, with a differential of -12.5% in nonprofit hospitals and a significantly smaller -3.4% in for-profit hospitals. The racial differential for Service workers are significantly larger in nonprofit hospitals (-6.7%) than in for-profits (-0.6%).[31] In summary, these findings in occupational subsamples provide a variety of estimates but broadly support the main finding that gender and racial wage differentials tend to be significantly larger in nonprofit hospitals than in for-profit hospitals.[32]

[Table 9 about here]

Race and gender sub-samples have unique benefits that warrant a closer investigation. Since gender and race are the focus of this study, these sub-samples allow us to examine one differential (say, race) within subsamples based on the other (gender). For the first time in this study, returns to all characteristics are allowed to vary by race or gender, the two focal groups. As shown in table 9,[33] Black workers have gender differentials of -4.1% in nonprofit hospitals and -1.4% in for-profit hospitals, while Non-Black workers have gender differentials of -7.0% in nonprofits and -4.4% in for-profit hospitals.[34] As shown in column 3, these

[31] A majority of Service workers are in "Health Aid" occupations: Nursing, psychiatric, and home health aides; Occupational therapist assistants and aides, Physical therapist assistants and aides, Massage therapists, Dental assistants, Medical assistants, Medical transcriptionists, Pharmacy aides, Veterinary assistants and laboratory animal caretakers, Phlebotomists; Miscellaneous healthcare support occupations, including medical equipment preparers. Dividing Service workers into Health Aids and all other Service workers does not have large effects on the findings. As shown in the last two rows of table 6, the significantly larger racial differential in nonprofit hospitals is found among the Service workers not in Health Aid occupations.

[32] In addition to these occupational categories and demographic sub-samples, I investigate 19 annual sub-samples. Patterns over the time period show no secular trends and are generally consistent with the main finding of larger differentials in the nonprofit sector. In 18 of the 19 annual sub-samples, the gender differential in nonprofit hospitals is at least as large as that in for-profit hospitals. In all 19 annual sub-samples the racial differential in nonprofit hospitals is at least as large as that in for-profit hospitals.

[33] A full table of estimates are available from the author.

[34] Larger gender gaps for Non-Black workers is consistent with patterns found in other studies (Blau et. al, 2014).

differences by sector are statistically significant for Non-Black hospital workers. Racial differentials for Males are -10.9% in nonprofit hospitals and -6.1% in for-profit hospitals, while racial differentials for Females are -6.9% and -5.1%, respectively.[35] These gender gaps are significantly larger in nonprofit hospitals for both Males and Females. Thus, these findings reveal that significantly larger racial differentials in nonprofit hospitals is attributable to both genders, while significantly larger gender differentials in nonprofit hospitals is disproportionately attributed to Non-Black workers.

2.5 Conclusion

In this study of the US hospital industry, I find that both gender and racial wage differentials are significantly larger among hospital workers in the nonprofit sector than among hospital workers in the for-profit sector. I use quantile regression to show that this pattern shows up throughout the earnings distribution, and not only at the industry mean. Consistent with past research, I find evidence of a glass ceiling for Female workers in both the nonprofit and for-profit sectors. I also show that larger differentials in nonprofit hospitals is found in a broad range of occupational categories and demographic groups. I present 36 gender and racial differentials in each sector, and show that in all of these, nonprofit hospitals have differentials larger or no smaller than those in for-profit hospitals. To provide one possible explanation for these findings, I suggest that physicians may be more able to indulge discriminatory tastes in nonprofit hospitals than in for-profit hospitals.

The nonprofit sector is often associated with weakened monitoring. Nonprofits typically are thought to maximize an objective other than profit. It is difficult for owners to know whether their firm's objective is being met because the objective is relatively difficult to observe. I argue that one implication of this weakened monitoring in nonprofit hospitals is physicians' ability to indulge in taste-based discrimination. Physicians influence production decisions in nonprofit hospitals, even though they often are not hospital employees. The greater ability to indulge discrimination in nonprofit hospitals can generate larger wage differentials. One reason that the logic used to explain my findings does not fit with past economy-wide studies may be related to the unique dual-billing nature of the hospital industry and the relationship between physicians and hospitals.

The findings that nonprofit hospitals have larger differentials than for-profit hospitals reveals an opposite pattern from what has been found in past economy-wide studies. Past researchers have found that gender and racial wage differentials are significantly smaller among workers in the nonprofit sector as compared with workers in the for-profit sector. To explain these findings, they suggest that nonprofits emphasize wage

[35] Larger racial differentials among Male relative to Female workers is consistent with commonly observed patterns (Blau et. al, 2014).

equality along race and gender lines because their employees care more about fairness. Thus, this theory is not consistent with my findings in the US hospital industry.

Finally, this study is the first modern study of racial and gender differentials that contrasts nonprofits and for-profits within a single industry. Critically, I find that one of the largest American industries demonstrates patterns inconsistent with the economy as a whole. This brings into question whether or not other industries might also demonstrate patterns more similar to those found in hospitals. Further work might investigate whether the findings in hospitals point to a wider trend or remain unique.

Table 3: Descriptive Statistics by Sector

Variable	Nonprofit Sector	For-Profit Sector
Observations	36,180	43,302
Log(Wage)	3.126 (0.479)	3.034 (0.493)
Demographics:		
Female	80.4%	82.4%
Black	7.3%	12.7%
Age	43.43 (11.71)	41.11 (11.74)
Currently Married	63.8%	62.6%
Past Married	17.6%	17.7%
Metropolitan	74.95%	80.2%
Education:		
No College	18.7%	22.8%
Some College	39.6%	41.5%
Bachelor's Degree	30.1%	27.3%
Graduate Degree	11.6%	8.4%
Occupation:		
Management	9.8%	6.9%
Professional (non-Practitioner)	6.6%	4.3%
Professional (RN)	29.7%	29.4%
Professional (Other Practitioner)	20.5%	21.1%
Service	14.6%	19.1%
Office	16.1%	16.9%
Operative	1.7%	1.1%
Transportation	1.1%	1.1%
Union	10.8%	11.9%
Part Time	28.6%	26.2%

Table 4: Log Wage Regression Coefficients

Variable	Economy-wide	Hospital Only	Non-Hospital
Nonprofit*Female	0.144***	-0.031***	0.127***
(SE)	(0.0033)	(0.0076)	(0.0037)
Nonprofit*Black	0.055***	-0.026***	0.076***
	(0.0047)	(0.0089)	(0.0054)
Nonprofit	-0.227***	0.065***	-0.268***
	(0.0029)	(0.0071)	(0.0032)
Female	-0.184***	-0.040***	-0.185***
	(0.0009)	(0.0054)	(0.0009)
Black	-0.067***	-0.053***	-0.067***
	(0.0013)	(0.0054)	(0.0013)
Some College	0.142***	0.160***	0.139***
	(0.0009)	(0.0037)	(0.0009)
Bachelor's Degree	0.367***	0.296***	0.371***
	(0.0013)	(0.0047)	(0.0014)
Graduate Degree	0.567***	0.502***	0.574***
	(0.0021)	(0.0069)	(0.0022)
Age	0.042***	0.033***	0.041***
	(0.0002)	(0.0008)	(0.0002)
$\mathrm{Age}^2/100$	-0.042***	-0.031***	-0.042***
	(0.0002)	(0.0009)	(0.0002)
Management	0.408***	0.469***	0.407***
	(0.002)	(0.0146)	(0.0016)
Professional (non-Practitioner)	0.294***	0.245***	0.302***
	(0.0017)	(0.0152)	(0.0017)
Professional (RN)	0.571***	0.550***	0.484***
	(0.0025)	(0.0137)	(0.0040)
Professional (Other Practitioner)	0.355***	0.306***	0.340***
	(0.0025)	(0.0136)	(0.0031)
Service	-0.166***	-0.066***	-0.173***
	(0.0013)	(0.0134)	(0.0013)
Office	0.092***	0.043***	0.093***
	(0.0012)	(0.0135)	(0.0012)
Operative	0.129***	0.250***	0.128***
	(0.0014)	(0.0172)	(0.0014)
Union	0.235***	0.074***	0.242***
	(0.0013)	(0.0041)	(0.0014)
Part Time	-0.134***	-0.009***	-0.137***
	(0.0009)	(0.0030)	(0.0009)
Currently Married	0.109***	0.044***	0.111***
	(0.0011)	(0.0039)	(0.0011)
Past Married	0.046***	0.0081*	0.047***
	(0.0014)	(0.0047)	(0.0014)
Metropolitan	0.109***	0.113***	0.108***
	(0.0009)	(0.0032)	(0.0010)
Constant	1.533***	1.624***	1.538***
	(0.0046)	(0.0228)	(0.0047)
N	1,666,427	79,486	1,586,941
R^2	0.482	0.585	0.478

Superscripts ***, **, and * denote coefficients are statistically different from zero at the 1%, 5% and 10% level. Sector-specific regressions also include controls for Region and Year.

Table 5: Gender and Racial Differentials Economy-Wide, Hospital Only, and Non-Hospital

	Economy-wide		Hospital Only		Non-Hospital	
	Nonprofit	For-profit	Nonprofit	For-profit	Nonprofit	For-profit
Gender	-3.9	-16.8	-6.9	-3.9	-5.6	-16.9
Race	-1.2	-6.5	-7.6	-5.2	-1.0	-6.5

Table 6: Log-Wage Regression Coefficients by Sector

Hospitals Only			
Variable	Nonprofit Sector	For-Profit Sector	Difference = NP - FP
Female	-0.069***	-0.041***	-0.029***
(SE)	(0.0059)	(0.0055)	(0.0081)
Black	-0.080***	-0.054***	-0.026***
	(0.0077)	(0.0056)	(0.0095)
Some College	0.157***	0.161***	-0.003
	(0.0057)	(0.0048)	(0.0074)
Bachelor's Degree	0.296***	0.294***	0.002
	(0.0070)	(0.0064)	(0.0095)
Graduate Degree	0.490***	0.512***	-0.022
	(0.0096)	(0.0100)	(0.0139)
Age	0.037***	0.031***	0.007***
	(0.0012)	(0.0011)	(0.0016)
$\text{Age}^2/100$	-0.035***	-0.029***	-0.006***
	(0.0014)	(0.0012)	(0.0019)
Management	0.454***	0.480***	-0.026
	(0.0197)	(0.0209)	(0.0287)
Professional (non-Practitioner)	0.244***	0.241***	0.003
	(0.0205)	(0.0219)	(0.0300)
Professional (RN)	0.539***	0.558***	-0.019
	(0.0186)	(0.0194)	(0.0268)
Professional (Other Practitioner)	0.309***	0.303***	0.006
	(0.0186)	(0.0193)	(0.0268)
Service	-0.070***	-0.063***	-0.007
	(0.0182)	(0.0190)	(0.0262)
Office	0.038**	0.044**	-0.006
	(0.0183)	(0.0191)	(0.0265)
Operative	0.242***	0.255***	-0.014
	(0.0231)	(0.0251)	(0.0341)
Union	0.054***	0.088***	-0.034***
	(0.0061)	(0.0056)	(0.0083)
Part Time	-0.007*	-0.011***	0.004
	(0.0044)	(0.0041)	(0.0060)
Currently Married	0.038***	0.050***	-0.012
	(0.0057)	(0.0052)	(0.0078)
Past Married	0.001	0.013**	-0.012
	(0.0070)	(0.0064)	(0.0094)
Metropolitan	0.119***	0.108***	0.011*
	(0.0047)	(0.0045)	(0.0065)
Constant	1.607***	1.677***	-0.071
	(0.0342)	(0.0300)	(0.0455)
N	36,184	43,302	79,486
R^2	0.584	0.580	0.586

Table 7: Female and Black Coefficients at 5 Quantiles

		Quantile				
		10	25	50	75	90
Nonprofit	Female	-0.007	-0.043***	-0.058***	-0.084***	-0.134***
	(SE)	(0.0086)	(0.0072)	(0.0064)	(0.0075)	(0.0101)
	Black	-0.089***	-0.081***	-0.069***	-0.056***	-0.081***
		(0.0087)	(0.0094)	(0.0078)	(0.0073)	(0.0102)
For-Profit	Female	0.014**	0.001	-0.027***	-0.063***	-0.098***
		(0.0136)	(0.0065)	(0.0054)	(0.0073)	(0.0098)
	Black	-0.062***	-0.055***	-0.046***	-0.040***	-0.035***
		(0.0061)	(0.0069)	(0.0056)	(0.0065)	(0.0094)
Difference (NP-FP)	Female	-0.021*	-0.043***	-0.031***	-0.021**	-0.036***
		(0.0107)	(0.0095)	(0.0081)	(0.0104)	(0.0134)
	Black	-0.027**	-0.026**	-0.023**	-0.016	-0.046***
		(0.0107)	(0.0118)	(0.0095)	(0.0010)	(0.0141)

Table 8: Employment and Demographic Sub-Samples

Sub-Sample (NP obs.; FP obs.)	Variable	Nonprofit Sector	For-Profit Sector	Difference
Union (3,900; 5,173)	Female	-0.028*	-0.003	-0.025
	Black	-0.026	-0.035**	0.008
Non-Union (32,280; 38,129)	Female	-0.074***	-0.045***	-0.029***
	Black	-0.086***	-0.055***	-0.031***
Full-Time (25,826; 31,942)	Female	-0.081***	-0.053***	-0.028***
	Black	-0.078***	-0.050***	-0.028***
Part-Time (10,354; 11,361)	Female	-0.021	0.010	-0.032***
	Black	-0.092***	-0.064***	-0.028
Married (23,081; 27,118)	Female	-0.086***	-0.062***	-0.023**
	Black	-0.104***	-0.059***	-0.044***
Unmarried (13,099; 16,184)	Female	-0.046***	-0.008	-0.037***
	Black	-0.064***	-0.054***	-0.010
Management (3,526; 3,008)	Female	-0.134***	-0.158***	0.024
	Black	-0.128***	-0.094***	-0.034
Professional: Non-Practitioner (2,376; 1,867)	Female	-0.138***	-0.041*	-0.097***
	Black	-0.134***	-0.035	-0.100***
Professional: Registered Nurse (10,760; 12,730)	Female	0.011	0.021*	-0.011
	Black	-0.037*	-0.075***	0.038
Professional: Other Practitioner (7,402; 9,132)	Female	-0.045***	-0.016	-0.030*
	Black	-0.102***	-0.105***	0.003
Service (5,266; 8,292)	Female	-0.032***	-0.029***	-0.003
	Black	-0.069***	-0.006	-0.063***
Office (5,818; 7,306)	Female	-0.062***	-0.011	-0.051**
	Black	-0.036	-0.015	-0.021
Operative (604; 493)	Female	-0.193***	-0.214***	0.022
	Black	-0.249**	-0.120**	-0.129
Transportation (417; 473)	Female	-0.095***	-0.149***	0.053
	Black	-0.110**	-0.107**	-0.003
Service (Health Aids) (3,147; 5,020)	Female	-0.006	-0.009	0.003
	Black	-0.058***	-0.024**	-0.034
Service (non- Health Aid) (2,119; 3,272)	Female	-0.126***	-0.128***	0.001
	Black	-0.066***	0028*	-0.092***

Table 9: Race and Gender Sub-Samples

Sub-Sample (NP obs.; FP obs.)	Variable	Nonprofit Sector	For-Profit Sector	Difference
Black (8,123)	Female	-0.042**	-0.014	-0.029
Non-Black (71,359)	Female	-0.073***	-0.045***	-0.028***
Female (64,755)	Black	-0.072***	-0.052***	-0.020*
Male (14,727)	Black	-0.115***	-0.063***	-0.052**

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2.6 Appendix

In this section, I summarize the two links in Leete's theory explaining less wage equality in the nonprofit sector: intrinsically motivation is more common in the nonprofit sector, and wage equality stimulates workers' intrinsic motivation. I provide a few theories for why this explanation is not consistent with the findings of this study in the US hospital industry.

2.6.1 On Expectations of Wage Equality and Nonprofits

Leete's theory explains less wage equality in the nonprofit sector compared with the for-profit sector. She argues that (1) intrinsically motivated workers are more common in the nonprofit sector, and (2) wage equality stimulates workers' intrinsic motivation. Thus nonprofit are more likely to emphasize wage equality as a way of stimulating their employees. Each of these two links I summarize in turn.

Intrinsic Motivation in Nonprofits Intrinsic motivation means doing something because it is fun or interesting on its own (Deci and Ryan, 2000). For example, some people exercise simply because they enjoy it. Many others, however, exercise out of guilt or value being healthy or identify as "someone who exercises." These latter reasons are not examples of intrinsic motivation.

If a worker receives a non-monetary reward from an action, they might or might not be intrinsically motivated. There are many non-monetary motivators including prestige or altruism. However, doing something in order to improve your reputation (prestige) or in order to improve someone else's well-being (altruism) are not intrinsic motivation because the reward is not only in the action itself. Nonetheless, they are all examples of non-monetary, or non-pecuniary, rewards.

A number of theoretical economists have noted that nonprofit organizations attract workers with intrinsic motivation or, more generally, nonpecuniary preferences. Critically, some of these theories do not rely on the service being provided but simply on the organizational form. Nonprofit organizations are, by definition subject to a nondistribution constraint: profits cannot be distributed to owners, managers or other workers. Nonprofits may "[screen] selectively for a class of entrepreneurs, managers, and employees who are more interested in providing high-quality service and less interested in financial reward" (Hansmann, 1980, p. 876). These workers are more likely to be trusted to adhere to the nondistribution constraint. This explanation does not depend on the service being provided but is simply a result of the organizational form. Another feature of nonprofit organizations that has been thought to attract intrinsically motivated workers is a principal-agent problem between unpaid trustees, managers and employees (Handy and Katz, 1998). Since nonprofit trustees do not observe the day-to-day operations and want to hire workers they can trust, they are more likely to hire managers and workers who are intrinsically motivated. Again, this explanation does not depend on the service being provided but is only a result of the organizational form. Alternatively, workers with intrinsic motivation may be attracted to nonprofit organizations if they provide a unique service. If some workers value the social benefit provided by nonprofit organizations, they may be willing to work for a lower wage in that sector (Preston, 1989).

Other researchers have argued that entrepreneurs with nonpecuniary preferences are more likely to choose the nonprofit form instead of for-profit. The nonprofit form may be superior for "a person with strong beliefs about the proper way to provide a particular service" because of freedom from control of stake-holders (Rose-Ackerman, 1996, p. 719). Another reason is that if workers value their level of output in addition to profit, they are more willing to restrict their output as required by the nondistribution constraint, in exchange for more production (Lakdawalla and Philipson, 1998, 2006). In both of the explanations, the entrepreneur does not prefer the nonprofit form because of the service being provided but because of the organizational form itself. In an efficiency wage setting, entrepreneurs (principles) with nonpecuniary preferences might experience free-riding among employees (agents) who shirk knowing the benevolent entrepreneur will complete the job (Ghatak and Mueller, 2011; Francois, 2000, 2003). In this framework, the nonprofit form limits the entrepreneur's profit, reducing their incentive to complete an unfinished project, thereby eliminating shirking by employees.

All of these theories suggest reasons why workers with nonpecuniary preferences are more likely to be found in the nonprofit sector than the for-profit sector. It is possible (though not certain) that the nonpecuniary preferences in all these models are, in fact, intrinsic motivation. Indeed, Leete (2000) and Etienne and Narcy (2010) cite the above predictions by Hansmann, Handy and Katz, Preston, and Rose-Ackerman as motivation their argument that intrinsically motivated workers are disproportionately common in the nonprofit sector.

Intrinsic Motivation and Wage Inequality Intrinsic motivation is costly. Frey (1993) argues that a worker has a choice of how intrinsically motivated they will be for a given task. A high level implies the work is done because is it fun and interesting, while a low level implies it is done for other reasons. A worker's equilibrium level of intrinsic motivation for a given task is found when the marginal cost of being intrinsically motivated equals its marginal benefit.

Many factors can affect a worker's equilibrium level of intrinsic motivation by shifting the costs and benefits. Monetary rewards can affect intrinsic motivation either positively or negatively. Following Deci and Ryan (1980), Frey lays out three ways that a monetary reward can decrease workers' intrinsic motivation. A reward will decrease intrinsic motivation if (a) it causes the worker to feel less recognized by the employer, (b) the worker does not feel the employer recognizes how the task was performed, or (c) the worker feels the reward is unfair.

Leete (2000) and others have focused on this third determinant of intrinsic motivation, perceptions of fair rewards. Through this channel, employers can maintain workers' intrinsic motivation by attempting to keep monetary rewards fair. One relatively straightforward dimension of fairness is equality. Thus, she claims that if workers perceive that their employers are successful at emphasizing equality, they will be remain intrinsically motivated on the job.

There are many ways that monetary rewards can be perceived as fair or unfair. Wage dispersion across or within various groups of workers has the potential to be perceived as unfair. Other monetary non-wage rewards like fringe benefits and bonuses are also ways that organizations can fail or succeed at compensating workers equally. The effect of bonuses on perceived fairness could work in either direction. Some workers might think that it is only fair for workers to be paid bonuses based on their performance, tenure or other inputs. Alternatively, bonuses tend to increase wage dispersion among similar workers and so might be considered unfair. Leete (2000) and others have focused on wage differentials based on gender, and to a lesser extent, race, as measures of fair monetary reward. They argue that wage equality reflected in smaller gender and racial differentials help to maintain workers' intrinsic motivation.

Discussion: Findings from the Hospital Industry There are at least four possible reasons why Leete's theory falls short of explaining my findings in the hospital industry. First, gender and racial wage differentials are only two of many measures of unequal compensation. For example, wage dispersion, firm-wide or within occupation or education level, could be emphasized. Non-wage rewards like bonuses, fringe benefits or job related perquisites are also ways of measuring equality of compensation among workers. It is possible that while nonprofit hospitals do no emphasize wage equality along race and gender lines, they emphasize equality in other areas. Bonuses, which typically increase wage dispersion, have been found to be less commonly used by nonprofit hospitals than for-profit hospitals to compensate executives (Ballou and Weisbrod, 2003; Roomkin and Weisbrod, 1999). Therefore, not using bonuses seem to be another way that nonprofit hospital emphasize equitable compensation.

Second, equality is not the only measure of fairness. Nonprofit hospitals may attempt to be fair to their workers in ways other than equitable compensation. Performance based pay may not generate equal pay to similar workers, but it might still be considered fair.

Third, perceived fairness may not be the relevant stimulator of workers' intrinsic motivation. Frey (1993) reference organizational psychologists Deci and Ryan (1980) who lay out three main factors. In addition to perceived fairness, recognition by the employer and their appreciation of how the task was performed also boost workers' intrinsic motivation. If these motivators are substitutes for perceived fairness, nonprofit hospitals might use them to motivate their employees instead of reducing race and gender wage differentials.

Fourth, it could be that hospitals are different and nonprofit hospitals simply do not attract more intrinsically motivated workers than for-profit hospitals. This might make sense if the services are essentially the same. If nonprofit hospital workers are willing to work for less, all else equal, then it is possible they are more intrinsically motivated (Etienne and Narcy, 2010). Schumacher (2008) uses CPS data from 1995 - 2006 to study relative wage levels of US hospital workers in various occupation groups. After controlling for unobserved heterogeneity in a fixed-effects model, he finds no significant difference in wage levels between the two sectors. These findings casts doubt on the notion that hospital workers in the nonprofit sector, as compared to those in the for-profit sector, are more intrinsically motivated. Roomkin and Weisbrod (1999) compare earnings of upper-level managers in nonprofit and for-profit hospitals. They find that nonprofit hospital executives are paid significantly lower salaries than executives in for-profit hospitals. It is possible that this pattern reflects more intrinsically motivated executives in nonprofit hospitals.

3 Nonprofit Status Choice in a Duopoly

3.1 Introduction

Important industries such as healthcare, education and the arts involve mixed markets where both nonprofits and for-profits provide services. Economists interested in these markets have given substantial attention to at least two common observations: (1) markets involving nonprofits are often imperfectly competitive (for hospitals, e.g., see Cutler et. al 2013) and so are modeled as Cournot, and (2) nonprofit status is voluntary and constrains profit to zero (Lakdawalla and Philipson 1998, 2006). Yet, surprisingly, these observations have not been studied together.

While economists have modeled a Cournot duopoly between a nonprofit and a for-profit firm, they have taken nonprofit status to be exogenous (Sansing 2000, Lien 2002, Goering 2007, 2008a, Ferreira 2009, Skak 2006 2011, Unfried 2012). Meanwhile, others model endogenous nonprofit status without incorporating the strategic rivalry between firms (Glaeser and Schleifer 2001, Francois 2003, Lakdawalla and Philipson 1998 2006, Ghatak and Mueller 2011, Bubb and Kaufman 2013). For the first time, I model a Cournot duopoly in which firms choose nonprofit status in the face of its accompanying zero profit constraint.

When both firms maximize a weighted average of profit and consumer surplus, outputs can be strategic compliments. A firm deciding to adopt nonprofit status will increase output to meet the constraint of zero profits and is rewarded by a further increase in output by the for-profit rival. This can result in an endogenously chosen mixed market despite identical objective functions of the two firms and so provides an explanation for the presence of such markets.

This research adds to the literature seeking to explain the emergence of mixed markets. Lakdawalla and Philipson (1998, 2006) argue that one explanation for the emergence of a mixed market is that firms choose different status because they have different objective functions. In their model, nonprofit status involves a zero profit constraint and lower production costs than a for-profit firm. They show that profit-maximizing firms gain nothing from nonprofit status since the reduced cost cannot be used to increase profit. However, a firm that places value on output is rewarded with more output by adopting nonprofit status. While they focus on perfect competition, they argue, but do not show, that the same logic can be applied to imperfectly competitive markets. Whereas they focus on the incentive from reduced production cost, I allow both costs and objective functions to remain the same regardless of nonprofit status choice.

In this paper, I assume firms maximize a weighted average of consumer surplus and profit. This assumption is common in the literature on corporate social responsibility (Lambertini and Tampieri 2010, Kopel and Brand 2012, Nakamura 2013 2014, Kopel 2015). Firms have identical weights and identical increasing marginal cost curves. Firms simultaneously choose between nonprofit and for-profit status, where nonprofit status requires a zero profit constraint, and then engage in Cournot competition.

When the weight on consumer surplus is large enough output levels become strategic compliments. In this case, when a firm chooses nonprofit status and increases output to satisfy the zero profit constraint, the for-profit rival responds by also increasing output. This response can be large enough to offset the nonprofit's reduced profit thus incentivizing the nonprofit choice. For its part, the for-profit firm has no incentive to become a second nonprofit firm. If it were to increase output to satisfy the zero profit constraint, the first nonprofit would *reduce* output to continue accommodating its own zero profit constraint. Thus, the incentive to choose nonprofit status exists for one firm while being absent for the other. In this way, an endogenously chosen mixed market emerges even among firms with identical weights on consumer surplus.

The endogenous mixed market is never socially superior to both the for-profit market and the nonprofit market. The social welfare function need not equally weight producer surplus and consumer surplus. When the weight on consumer surplus is relatively high, the nonprofit market is socially optimal, and when the weight on consumer surplus is low, the for-profit market is socially optimal.

Following this presentation, I consider the effect of incorporating a nonprofit tax-exemption. I assume the government takes a lump-sum tax from for-profit firms but not from nonprofits. I identify the range of tax-exemption levels that generate an endogenous mixed market. I show that such a tax policy can expand the range of parameter values in which an endogenous mixed market emerges.

Finally, I endogenize the nonprofit tax-exemption. When the government chooses the socially optimal level of tax-exemption, the mixed market can arise endogenously and be the socially optimal market type. Tax revenue can benefit society if it is potentially transferred to consumers. I show that tax revenue in the mixed market can be greater than the other market types. Thus, while welfare in the mixed market ranks second or third without a tax-exemption, it can rank first with a tax-exemption because of the additional benefit from tax revenue. This result provides an explanation for the presence of mixed markets in US market such as the arts, education and healthcare.

The underlying assumption of firms with positive weights on consumer surplus is consistent with a large and growing literature on corporate social responsibility (CSR). Many researchers assume that for-profit CSR firms maximize a combination of profit and consumer surplus (Lambertini and Tampieri 2010, Kopel and Brand 2012, Nakamura 2013 2014, Kopel 2015).[36] For example, CSR is a key ingredient of hospital governance (Brandão et. al 2013, Russo 2016) and has been shown to increase both hospital quality and

[36] Equilibrium capacity choices have been found to depend on the degree of substitutability and the CSR firm's weight on consumer surplus (Nakamura 2014). Allowing for endogenous mode of competition, either price or quantity competition can arise depending on the CSR weight on consumer surplus and the degree of competition (Kopel 2015). The welfare implications of competition mode depends on the CSR's weight on consumer surplus (Nakamura 2013). Both the profit-maximizing and CSR firms have incentive to delegate decisions to managers (Kopel and Brand 2012). If production involves a negative externality, a CSR firm that internalizes the externality earns higher profit than the profit-maximizing rival and can improve social welfare (Lambertini and Tampieri 2010).

social welfare (Xu 2014). Goering (2008b) shows that a CSR firm chooses to produce less durable goods than its profit-maximizing rival.

Firms may take on CSR strategies for a variety of reasons. These include socially concerned shareholders, managers or consumers (Baron 2008). A recent surge in research has examined the theoretical conditions that cause Cournot competitors to adopt objective functions based on both profitability and consumer surplus (Hino and Zennyo 2017, Fanti and Boccella 2016 2017a 2017b 2017c, Manasakis et al 2014, Planer-Friedrich and Marco 2017).

More generally, philanthropy performed by for-profit firms is widespread. Google has created its own philanthropy division (Reiser 2009). Some states have passed legislation granting tax-exemption to socially-oriented for-profit enterprises called Low-Profit Limited Liability Companies (L3C) (Hines, Horwitz and Nichols 2010). This blurs the lines characterizing nonprofit and for-profit firms. Yet a defining feature is the zero profit constraint that nonprofits must adhere to. This paper examines the effect of such a constraint on the choice of organizational form in a duopoly. I follow the CSR literature and model firms that value consumer surplus. I find that for a range of weights on consumer surplus one firm chooses nonprofit status and the other remains for-profit.

In what follows, I first summarize the related literature. In Section 3, I present the model and solution. In Section 4, I discuss welfare implications. Section 5 analyzes the effect of a nonprofit tax-exemption. In Section 6, I endogenize the nonprofit tax-exemption. Section 7 concludes.

3.2 Related Literature

This paper models nonprofit status choice in a Cournot duopoly and derives conditions under which an endogenous mixed market can occur. Reviewing the literature shows why this contribution is unique. One strand of literature studies nonprofit status choice without considering the strategic interaction of firms. Another strand studies imperfectly competitive markets involving nonprofit firms, but takes status to be exogenous. I summarize both of these strands in turn.

Nonprofit status choice has long been a focal point for researchers. The hospital industry often motivates the literature on nonprofit organization. Expenditures on hospital services are 5.6% of GDP (American Health Association 2014a), and as early as Long (1964) nonprofit hospitals were seen as maximizing quantity subject to a quality and budget constraint.[37] Such research continues with Herbst and Prüfer (2016) modeling a nonprofit where a group of owners value quality and profit but are subject to a zero profit constraint and an efficiency-wage contract with the employed manager. The manager chooses price to maximize its efficiency

[37] Alternatively, Newhouse (1970) models a nonprofit hospital as maximizing a function of output and quality subject to a zero profit constraint.

wage and a small share of profit (the rest of which is donated) minus effort cost. They find a nonprofit can be socially preferred to a for-profit firm.[38]

Theories of nonprofit status choice have often focused on nonprofit status overcoming market failures from non-contractable product quality or non-contractible worker decisions. Hansmann's (1980) canonical paper argues that nonprofits overcome non-contractible quality. Formalized in a model by Glaeser and Schleifer (2001), nonprofit status softens profit incentives. This assures consumers and donors that quality will not be sacrificed for profit. The nonprofit firm owner benefits from more revenue and donations while consumers benefit from better quality. In a similar vein, Bubb and Kaufman (2013) argue that nonprofit firms have less incentive to take advantage of consumer when setting contract terms.

Hansmann (1981) focuses on performing arts companies that rely on both donations and ticket sales. Philanthropic patrons that value production by more than the ticket price are willing to donate (something he calls "voluntary price discrimination"). Being a nonprofit elicits more donations because of the tax-exemption donors receive, and so benefits the firm.

Pauly and Redisch (1973) suggest nonprofit status incentivizes efficient provision of quality when a few workers possess an overwhelming share of the human capital needed for production. They consider physicians working in a nonprofit hospital. Physicians possess a majority of the information needed to produce quality hospital services. Further, the efficient use of this information cannot be monitored by the hospital. They argue the hospital may benefit from giving full control of hospital service to the physicians. In this case, one way to incentivize physicians to act efficiently is for the hospital to choose nonprofit status and make physicians the residual claimant.

Francois (2003) shows that a manager can choose nonprofit status because it elicits higher effort from an intrinsically motivated worker. Nonprofit status assures the worker that extra effort increases output rather than profit. The zero profit constraint reduces the manager's incentive to let worker effort crowd out other costly inputs. Ghatak and Mueller (2011) adopt a similar model and show that nonprofit status weakly (and, in some cases, strictly) reduces social welfare.

However, these models do not consider the strategic interaction of firms. Many nonprofits operate in imperfectly competitive markets. Hospitals are no exception. In 2010, 150 of the 306 hospital referral regions in the US were considered "highly concentrated" with a Herfindahl-Herschman Index over 2,500 (Cutler et. al 2013). Additionally, 98 regions are considered "moderately concentrated" (1,500 $<$ HHI $<$ 2,500).[39] Prüfer (2011) models a duopoly between nonprofit firm owners who maximize quality subject to

[38] Alternatively, nonprofits have been modeled as maximizing the level and distribution of consumer surplus with the ability to price discriminate across various types of consumers (Steinberg and Weisbrod 2005). They show that the nonprofit firm's distributional concerns affect the prices they set and the amount they sell to various groups of buyers. Sometimes highly valued consumers are given the good for free while others are excluded from the market.

[39] A large literature models the quality choice of hospitals in a spatial duopoly (see e.g. Montefiori 2005, Brekke et. al 2006,

a zero profit constraint. He finds that merger to monopoly can either increase or decrease social welfare depending on how much value the owners' put on quality. Philipson and Posner (2009) model Cournot competition between nonprofit firms that value both profit and own output. They show that a merger typically reduces social welfare because of reduced output and higher prices.[40] They show their results apply in long-run competition between nonprofit and for-profit firms.

Studies of rivalry between nonprofits and for-profits in mixed markets are also motivated by the hospital industry. Of the 4,999 private US hospitals, 2894 are nonprofit, while the remaining 2,105 are for-profit (American Hospital Association, 2014b). A large and growing literature models Cournot duopoly between a nonprofit firm and for-profit firm. In these models, nonprofit status is taken exogenously and does not require a zero profit constraint. Instead, the main difference between nonprofit and for-profit firms is their objective functions. Most have assumed that the nonprofit firm maximizes a combination of profit and consumer surplus and the for-profit firm maximizes profit (Sansing 2000, Lien 2002, Goering 2007 2008a, Ferreira 2009).[41] However, this does not acknowledge the assumption common in the CSR literature that for-profit firms can also value consumer surplus. I assume that both firms value consumer surplus. In contrast to these models, I follow the literature on nonprofit status choice by taking nonprofit status to be endogenous and assuming that nonprofit status involves a zero profit constraint.

In summary there are two broad tracks of research on nonprofits: those that consider endogenous nonprofit status choice and those that model nonprofits in imperfectly competitive markets. This paper models two firms that value consumer surplus and allows them both to choose nonprofit status. I show that an endogenous mixed market can emerge despite identical objectives firms and in the absence of a tax-exemption. This abandons the assumption common in the literature on mixed markets that only nonprofits value consumer surplus and for-profits value profit. It demonstrates for the first time that the interaction of two firms that value consumer surplus can, on its own, generate an incentive for one firm to choose nonprofit status.

3.3 Model and Solution

In this section, I model duopoly where firms value both profit and consumer surplus. I consider firms' choice of nonprofit status, where nonprofit status involves the limit of zero profit. Two firms produce total output

$$Q = q_i + q_j \tag{58}$$

Gravelle and Sivey 2010, Andree and Schwan 2014).

[40] They extend the analysis to show that merger can increase welfare in some cases when firms value total output or consumer surplus rather than own output.

[41] A few others have assumed a nonprofit objective that includes own output instead of consumer surplus (Skak 2006, 2011, Unfried 2012).

and serve a market with the linear inverse demand function

$$P = a - Q \tag{59}$$

where P is the market price and a is the reservation price. Firms have increasing marginal costs with identical slope k, so profit is

$$\pi_i = Pq_i - \frac{1}{2}kq_i^2. \tag{60}$$

Both firms maximize a weighted average of their own profit and consumer surplus (CS), where $CS = \frac{1}{2}Q^2$ given the linear demand. Nonprofit status involves a *nondistribution constraint*: profits cannot be distributed to the owner. Any profit must remain within the firm and thus is not enjoyed by the owner. Utility is given by

$$u^1(d_i, d_j) = (1-\alpha)\pi_i + \frac{\alpha}{2}Q^2 \tag{61}$$

$$u^0(d_i, d_j) = (1-\alpha)\pi_i + \frac{\alpha}{2}Q^2 \text{ subject to } \pi_i \leq 0 \tag{62}$$

where superscript 1 denotes for-profit status and 0 denotes nonprofit status. Each firm's utility is a function both firms' status, where

$$d_i = \begin{cases} 0, & \text{if firm } i \text{ chooses nonprofit status} \\ 1, & \text{if firm } i \text{ chooses for-profit status} \end{cases}$$

and $0 < \alpha \leq 1$ is identical across firms. The weight on profit is taken as exogenous and the cost structure remains the same even if a firm changes status.

The game is played in two stages. In stage 1, each firm chooses between nonprofit and for-profit status. In stage 2, firms engage in Cournot competition by simultaneously choosing output to maximize utility, given their nonprofit or for-profit status. The game is solved using backward induction.

3.3.1 Stage 2: Production Choice

In stage 2, firms simultaneously choose output to maximize their own utility. Finding equilibrium production levels requires simultaneously solving the firms' best response functions. There are three possible status combinations: two for-profits, a mixed market, and two nonprofits. Each of these is considered in turn.

Two For-profits The best-response function of a for-profit is found by setting the derivative of (61) with respect to q_i equal to zero and solving for q_i yielding

$$q_i^{BR,1} = \frac{a - q_j\left(1 - \frac{\alpha}{1-\alpha}\right)}{k + 2 - \frac{\alpha}{1-\alpha}}. \tag{63}$$

This best-response function collapses to the profit-maximizing best-response function of $\frac{a-q_j}{k+2}$ when $\alpha = 0$.[42] A for-profit firm's output is a strategic compliment to its rival's if and only if (iff) $\alpha > \frac{1}{2}$. Differentiating (63) with respect to q_j yields $\frac{\partial q_i^{BR1}}{\partial q_j} = -\left(\frac{1-\frac{\alpha}{1-\alpha}}{k+2-\frac{\alpha}{1-\alpha}}\right)$ which is positive when $\alpha > \frac{1}{2}$.

Simultaneously solving the best-response functions for the two firms yields equilibrium output, which can be returned to (58), (59), (60) and (61) yielding equilibrium total output, price, profit and utility:

$$q^1(1,1) = \frac{a}{k + 3 - \frac{2\alpha}{1-\alpha}} \tag{64}$$

$$Q^*(1,1) = \frac{2a}{k + 3 - \frac{2\alpha}{1-\alpha}} \tag{65}$$

$$P^*(1,1) = \frac{a\left(k + 1 - 2\frac{\alpha}{1-\alpha}\right)}{k + 3 - \frac{2\alpha}{1-\alpha}} \tag{66}$$

$$\pi^1(1,1) = \frac{a^2(k + 2 - \frac{4\alpha}{1-\alpha})}{2(k + 3 - \frac{2\alpha}{1-\alpha})^2} \tag{67}$$

$$u^1(1,1) = (1-\alpha)\left[\frac{a^2(k+2)}{2(k + 3 - \frac{2\alpha}{1-\alpha})^2}\right] \tag{68}$$

where $(1,1)$ reflects the for-profit status of both firms. Positive output requires $\alpha < \frac{k+2}{k+3}$.

As the weight on consumer surplus α increases, output and utility increase and price decreases. Equilibrium profit first increases and then decreases in α. Profit can be negative if the firms' weight on consumer surplus is large enough. Assuming firms do not have access to outside funding restricts attention to the cases of non-negative profit, $\alpha \leq \frac{k+2}{k+6}$ (equation (67) shows that $\pi \geq 0 \iff \alpha \leq \frac{k+2}{k+6}$).

A Mixed Market In a mixed market, one firm has nonprofit status and the other has for-profit status. The for-profit's best-response function remains (63), while the nonprofit firm sets its output q_j such that its profit (60) is zero.[43] Solving for q_j yields firm j's best-response function

$$q_j^{BR,0} = \frac{2\left(a - q_i\right)}{k + 2}. \tag{69}$$

[42] The second order condition holds as long as $\alpha < \frac{k+2}{k+3}$.

[43] Alternatively, the firm owner could, but never would, produce at a level that earns positive profit and retain the profit within the firm.

The nonprofit's best-response function differs dramatically from that of a for-profit firm. Unlike the for-profit firm, it does not depend on the firm's weight on consumer surplus. The nondistribution constraint requires profit to remain at zero regardless of firms' preferences. A nonprofit firm's output is always a strategic substitute to its rival's. Differentiating (69) with respect to q_i yields $-\left(\frac{2}{k+2}\right)$ which is negative for all $k > 0$.

Solving (69) and (63) simultaneously for q_i and q_j yield equilibrium output, which can be returned to (58), (59), (60), (61) and (62) yielding equilibrium total output, price, profit and utility:

$$q^0(0,1) = \frac{2a(k+1-\frac{\alpha}{1-\alpha})}{k^2+4k+2-k\frac{\alpha}{1-\alpha}} \tag{70}$$

$$q^1(0,1) = \frac{a(k+\frac{2\alpha}{1-\alpha})}{k^2+4k+2-k\frac{\alpha}{1-\alpha}} \tag{71}$$

$$Q^*(0,1) = \frac{a(3k+2)}{k^2+4k+2-k\frac{\alpha}{1-\alpha}} \tag{72}$$

$$P^*(0,1) = \frac{ak(k+1-\frac{\alpha}{1-\alpha})}{k^2+4k+2-k\frac{\alpha}{1-\alpha}} \tag{73}$$

$$\pi^0(0,1) = 0 \tag{74}$$

$$\pi^1(0,1) = \frac{a^2k\left(k+\frac{2\alpha}{1-\alpha}\right)(k+2-\frac{4\alpha}{1-\alpha})}{2(k^2+4k+2-k\frac{\alpha}{1-\alpha})^2} \tag{75}$$

$$u^0(0,1) = \left[\frac{a^2\alpha(3k+2)^2}{2(k^2+4k+2-k\frac{\alpha}{1-\alpha})^2}\right] \tag{76}$$

$$u^1(0,1) = (1-\alpha)\left\{\frac{a^2k\left[\left(k+\frac{2\alpha}{1-\alpha}\right)(k+2-\frac{4\alpha}{1-\alpha})+\frac{\alpha}{1-\alpha}k\left(k+1-\frac{\alpha}{1-\alpha}\right)^2\right]}{2\left(k^2+4k+2-k\frac{\alpha}{1-\alpha}\right)^2}\right\}. \tag{77}$$

The nonprofit firm produces more than the for-profit firm and the for-profit always earns higher profit than the nonprofit. Since the firms have identical weights on consumer surplus, their only utility difference is profit. Thus, utility of the for-profit always exceeds that of the nonprofit, given that a mixed market has arisen. Total output in the mixed market is always greater than total output in the for-profit market.

Two Nonprofits If both firms choose nonprofit status they both have best-response function (69). Solving these simultaneously yields equilibrium output which can be returned to (58), (59), (60) and (62) yielding equilibrium total output, price, profit and utility:

$$q^0(0,0) = \frac{2a}{k+4}. \tag{78}$$
$$Q^*(0,0) = \frac{4a}{k+4} \tag{79}$$
$$P^*(0,0) = \frac{ak}{k+4} \tag{80}$$
$$\pi^0(0,0) = 0 \tag{81}$$
$$u^0(0,0) = \alpha\left(\frac{4a}{k+4}\right)^2. \tag{82}$$

Since the firms' weight on consumer surplus, α, is absent from both best-response functions, it does not affect any market outcomes other than utility levels. Total output in the nonprofit market is always greater than total output in the mixed market and the for-profit market.

3.3.2 Stage 1: Status Choice

In stage 1, the firms simultaneously choose whether to take on nonprofit or for-profit status. In making this choice the firm must consider the status of the rival. For status choices to be an equilibrium, neither firm can have incentive to switch status, given the status of the rival. Equilibrium status choices are summarized in Proposition 10.

Proposition 10: A mixed market arises endogenously when $\alpha^* < \alpha < \frac{k+2}{k+6}$, where

$$\alpha^* = \frac{2k^4 + 23k^3 + 72k^2 + 65k + 18 - (k+1)\sqrt{13k^4 + 86k^3 + 181k^2 + 140k + 36}}{2k^4 + 30k^3 + 122k^2 + 122k + 36}.$$

Both firms choose for-profit status otherwise, when $0 < \alpha < \alpha^*$.

Proof: See Appendix.

When the firms' weight on consumer surplus is relatively large ($\alpha > \alpha^*$), one firm chooses nonprofit status while the other chooses for-profit status. Figure 4 plots the critical α^* and $\frac{k+2}{k+6}$ in (k, α)-space. As k and α increase, the mixed market range increases in size. For low levels of α (below α^*), both firms choose for-profit status.

[Figure 4 about here]

For intuition behind Proposition 10, return to the firms' best-response functions (63) and (69). Recall that a for-profit firm's output is a strategic compliment to its rival's only if $\alpha > \frac{1}{2}$. In this case, when a firm chooses nonprofit status and increases its output to accommodate the nondistribution constraint, the for-profit rival responds by also increasing its output. For the firm that has just chosen nonprofit status, this response directly increases its utility through greater consumer surplus. This reward mitigates the lost profit from choosing nonprofit status. When the gain in utility from the for-profit rival's response outweighs the lost utility from lower profit, there is incentive to choose nonprofit status.

Conversely, a nonprofit firm's output is a strategic substitute to its rival's. Thus, if the second firm chooses nonprofit status and increases its output to accommodate the nondistribution constraint, the nonprofit rival responds by reducing its output. This response directly lowers the utility of the second nonprofit firm as it reduces consumer surplus. There is no reward to mitigate the lost profit from nonprofit status when the rival is also nonprofit.

3.4 Social Welfare

In this section, I consider the effect of endogenous status choice on social welfare. I assume that the government's social welfare function is a weighted average of total firms' profit and consumer surplus:

$$W = (1-\beta)\left(\pi_i + \pi_j\right) + \frac{\beta}{2}Q^2. \tag{83}$$

I focus on cases where the government values consumer surplus at least as much as producer surplus, or $\beta \geq \frac{1}{2}$.[44] This function has a form similar to the firms' utility functions in that it is the weighted average of consumer surplus and profit. While the second term is identical to the firms', the first term includes the profit of both firms rather than just one. Under a mixed market, a nonprofit and a for-profit market, respectively, (83) becomes

$$\begin{aligned}
W(0,1) &= (1-\beta)\left(\frac{a^2k\left(k+\frac{2\alpha}{1-\alpha}\right)(k+2-\frac{4\alpha}{1-\alpha})}{2(k^2+4k+2-\frac{\alpha}{1-\alpha})^2}\right) + \frac{\beta}{2}\left(\frac{a(3k+2)}{k^2+4k+2-k\frac{\alpha}{1-\alpha}}\right)^2 && (84)\\
W(0,0) &= \frac{8a^2\beta}{k^2+8k+16} && (85)\\
W(1,1) &= (1-\beta)\left(\frac{2a^2(k+2-\frac{4\alpha}{1-\alpha})}{2(k+3-\frac{2\alpha}{1-\alpha})^2}\right) + \frac{\beta}{2}\left(\frac{2a}{k+3-\frac{2\alpha}{1-\alpha}}\right)^2 && (86)
\end{aligned}$$

Under all three market types a^2 can be factored out leaving functions of α and k only. Thus a change in the reservation price a never affects the rankings of the three market types. Proposition 11 ranks social welfare in the three market types for various weights β.

[44]When $\beta = \frac{1}{2}$, the function collapses to $W = \frac{1}{2}\left(\pi_i + \pi_j + \frac{1}{2}Q^2\right)$. This function is a monotonic transformation of the common $W = \pi_i + \pi_j + \frac{1}{2}Q^2$ which has been used to analyze welfare even when firms do not maximize profit (Hansmann 1981, Kato and Tomaru 2007).

Proposition 11: A mixed market is never the first-best market type for any $0 \leq \beta \leq 1$. For $\beta < \beta^*$ the for-profit market is the socially optimal market type, for $\beta \geq \beta^*$ the nonprofit market is the socially optimal one, where

$$\beta^* = \frac{(1-\alpha)\,k^2 + 8\,(1-\alpha)\,k + 16\,(1-\alpha)}{(1-\alpha)\,k^2 + 14\,(1-\alpha)\,k + 36 - 44\alpha}.$$

Proof: See Appendix.

When the government's weight on consumer surplus is relatively high ($\beta \geq \beta^*$), the nonprofit market is socially superior to both the for-profit and the mixed market. The consumer surplus gained from two nonprofit firms outweighs the lost profits. The tradeoff of consumer surplus for profit is always greater with two nonprofits than with one. When the government's weight is relatively low ($\beta < \beta^*$), the for-profit market is socially superior to both the nonprofit and the mixed market. The profits gained from two for-profits firms outweighs the lost consumer surplus. This tradeoff of profit for consumer surplus is always greater with two for-profits than with one. Thus, welfare in the mixed market never ranks first.

For example, consider the common case of equal weights in the social welfare function, $\beta = \frac{1}{2}$. When $k = 2$ and $\alpha = \frac{1}{2}$, the for-profit market is socially optimal since β is less than the critical $\beta^* = \frac{6}{10}$. Alternatively, if $k = 1$ and $\alpha = \frac{1}{10}$, the nonprofit market is socially optimal since β is greater than the critical $\beta^* = 0.499$.[45]

In general, the critical β^* increases in k and α ($\frac{\partial \beta^*}{\partial \alpha}, \frac{\partial \beta^*}{\partial k} > 0$) and β^* is greater than α, for all k.[46] Additionally, $0 \leq \beta^* \leq 1$ for all $0 < \alpha < 1$ and $k > 0$. Thus there is always a β for which the nonprofit market is first-best, and there is always a β for which the for-profit market is first-best. Meanwhile, the mixed market is never the first-best market type.

3.5 Nonprofit Tax-Exemption

Until now, the focus has been on nonprofit status choice independent of a subsidy or tax-exemption. However, grants and other subsidies are often conditional on nonprofit status. In the U.S., 501(c)(3) nonprofit status involves exemption of property, sales and corporate income taxes. Lakdawalla and Philipson (1998, 2006) show that this nonprofit subsidy can generate a nonprofit status choice for firms that value output as well as profit. Hansmann (1987) uses state-level industry and tax-exemption data to show that larger nonprofit tax-exemptions correlate with a larger share of nonprofits relative to for-profit firms. This section explores the consequence of a nonprofit tax-exemption on firms' nonprofit status choice in duopoly.

I focus on the exemption of a lump-sum tax. Assume that for-profit firms are subject to a lump-sum tax

[45] Setting $\beta^* = \frac{1}{2}$ and solving for α yields $\alpha = \frac{k^2+2k-4}{k^2+2k-12}$. Values of α below (above) this level yield β^* below (above) $\frac{1}{2}$.

[46] To see this, $\beta^* > 0$ when $\alpha = 0$, and $\frac{\partial \beta^*}{\partial \alpha} > 1$, for all k.

F, while the nonprofits are exempt from the tax. Thus, utility is now

$$u^1(d_i, d_j) = (1-\alpha)(\pi_i - F) + \frac{\alpha}{2}Q^2 \tag{87}$$

$$u^0(d_i, d_j) = (1-\alpha)\pi_i + \frac{\alpha}{2}Q^2 \text{ subject to } \pi_i \leq 0. \tag{88}$$

The only difference from (61) and (62) is that a fixed cost enters the for-profit utility function (87) weighted by $(1-\alpha)$. Since a fixed cost does not affect the firms' output choices, a for-profit firm's best-response function remains (63). A nonprofit firm's best-response function is also unchanged since utility is unchanged.

Equilibrium output and prices in the three possible market structures (for-profit, mixed and nonprofit) are, thus, the same as without the nonprofit tax-exemption. Equilibrium utility for a nonprofit is unaffected by F, while utility for the for-profit is reduced by $(1-\alpha)F$:

$$u^1(1,1) = (1-\alpha)\left[\frac{a^2(k+2)}{2(k+3-\frac{2\alpha}{1-\alpha})^2} - F\right] \tag{89}$$

$$u^0(0,1) = \left[\frac{a^2\alpha(3k+2)^2}{2(k^2+4k+2-k\frac{\alpha}{1-\alpha})^2}\right] \tag{90}$$

$$\begin{aligned} u^1(0,1) &= (1-\alpha)\left\{\frac{a^2k\left[\left(k+\frac{2\alpha}{1-\alpha}\right)(k+2-\frac{4\alpha}{1-\alpha})\right]}{2\left(k^2+4k+2-k\frac{\alpha}{1-\alpha}\right)^2}+\right. \\ &\quad \left. +\frac{a^2k\left[\frac{\alpha}{1-\alpha}k\left(k+1-\frac{\alpha}{1-\alpha}\right)^2\right]}{2\left(k^2+4k+2-k\frac{\alpha}{1-\alpha}\right)^2} - F\right\} \end{aligned} \tag{91}$$

$$u^0(0,0) = \alpha\left(\frac{4a}{k+4}\right)^2. \tag{92}$$

Nonprofit status choices are affected by the tax-exemption since F affects for-profit utility but not nonprofit utility. Proposition 12 describes the parameter range generating the endogenous mixed market under a nonprofit tax-exemption.

Proposition 12: An endogenous mixed market occurs if $\underline{F} \leq F \leq \overline{F}$, where

$$\underline{F} = \begin{cases} 0 \text{ if} & \alpha^* < \alpha < \frac{k+2}{k+6} \\ \frac{Ca^2}{D} & \text{if } 0 < \alpha < \alpha^* \end{cases}$$

$$\overline{F} = \frac{Ea^2}{F}$$

and C, D, E and F are functions of α and k found in the Appendix.

Proof: As proven in Proposition 1, when $F = 0$ a firm prefers to choose nonprofit status when $\alpha^* \leq \alpha \leq \frac{k+2}{k+6}$. Equating (89) and (90) and solving for F yields $\underline{F}$. When $F > \underline{F}$, a firm with a for-profit rival prefers nonprofit status to for-profit status. Equating (91) and (92) and solving for F yields $\overline{F}$. When $F < \overline{F}$, a firm with a nonprofit rival prefers for-profit status to nonprofit status.

When the nonprofit tax-exemption is small ($F < \underline{F}, \overline{F}$) both firms choose for-profit status. As F increases beyond $\underline{F}$ and remains below $\overline{F}$, the mixed market becomes the endogenous choice. Alternatively, in cases where F is greater than $\overline{F}$ but remains less than $\underline{F}$, it becomes a coordination game where both the nonprofit market and the for-profit market are SGPNE. When the tax-exemption is large ($F > \underline{F}, \overline{F}$) both firms choose nonprofit status. The k and α parameter range that can generate the endogenous mixed market under a nonprofit tax-exemption is summarized in the following result.

Result 1: A nonprofit tax-exemption expands the parameter range of k and α generating an endogenous mixed market. Identifying this range requires identifying where $\overline{F} - \underline{F} > 0$. While the equality $\overline{F} - \underline{F} = 0$ cannot be solved for α explicitly, the roots of $\overline{F} - \underline{F}$ can be found for any k. Figure 5 plots and connects these roots revealing that they are less than α^*. For α values above these roots (the shaded area in Figure 5) $\overline{F} - \underline{F} > 0$. Thus the parameter range capable of generating an endogenous mixed market is expanded under a tax-exemption.

[Figure 5 about here]

Admittedly, there still exist many cases where the endogenous mixed market cannot occur. Contrasting Figure 5 with Figure 4 demonstrates the difference in parameter ranges with and without a nonprofit tax-exemption. For example suppose $k = 3$. Without a tax-exemption, a mixed market emerges for $0.55 < \alpha < 0.56$. With a tax-exemption $\underline{F} \leq F \leq \overline{F}$ a mixed market emerges for the much larger range of $0.47 < \alpha < 0.56$. Additionally, with the exemption, the endogenous mixed market now includes cases where $k < 2$ and $\alpha < \frac{1}{2}$. The firms no longer need to value consumer surplus more than profit for a mixed market to emerge.

[Table 11 about here]

Table 11 presents the critical $\underline{F}$ and $\overline{F}$ for various k and α. For a given k, $\underline{F}$ and $\overline{F}$ increase (weakly) as α decreases. For example, suppose that $k = 3$. When $\alpha = 0.555$, $\underline{F} = \overline{F} = 0$. The mixed market emerges endogenously without any tax-exemption, but with any positive F both firms choose nonprofit status. As α decreases to 0.545, $\underline{F} = 0$ and $\overline{F} = 0.0013a^2$. The mixed market can still emerge without a tax-exemption.

However, the mixed market can also emerge with positive tax-exemptions. As α decreases to 0.473, both $\underline{F}$ and $\overline{F}$ increase to $\underline{F} = \overline{F} = 0.0097a^2$.

3.6 Social Welfare: Endogenous Nonprofit Tax-Exemption

In this section, I investigate social welfare under an endogenous nonprofit tax-exemption. I focus on the cases where the optimal choice of F generates a mixed market.[47] The game now proceeds in three stages. In stage 1, the government chooses F, the lump-sum tax taken from each for-profit firm but not from a nonprofit firm. Stages 2 and 3 proceed as before with nonprofit status choice in stage 2 and then quantity choices in stage 3, taking F as given.

Stage 3 outputs and the resulting prices are the same as without a nonprofit tax-exemption since a fixed cost does not affect production choices. These equilibrium values are presented in Section 3. Utility for a for-profit firm is reduced by $F(1-\alpha)$ while utility for a nonprofit firm is unaffected by F, as presented in equations (89), (90), (91), (92).

Stage 2 status choices as a function of F are summarized in Proposition 3. The endogenous mixed market is generated for a range of F (between $\underline{F}$ and $\overline{F}$). Alternatively, low levels of F (less than or equal to $\underline{F}$) generate a for-profit market and high levels (greater than $\overline{F}$) generate a nonprofit market.

In stage 1, the government chooses F to maximize social welfare. I assume that when the government collects F from each for-profit firm the tax revenue is valued as if it were distributed directly to consumers:[48]

$$W = (1-\beta)\left(\pi_i + \pi_j - F\left(d_i + d_j\right)\right) + \beta\left(\frac{Q^2}{2} + F\left(d_i + d_j\right)\right) \tag{93}$$

where d_i is zero when firm i is nonprofit and is unity when firm i is for-profit. The government's optimal choice of F is summarized in Proposition 13.

Proposition 13: The government chooses $F^* = \overline{F}$ and the mixed market arises, when $\beta_1^* < \beta < \beta_2^*$, where

$$\begin{aligned}
\beta_1^* &= \frac{4\alpha^2 k - \alpha(1-\alpha)\left(7k^2 + 30k + 16\right)}{\left(k^3 - 16\right)(1-\alpha)^2 + (13\alpha^2 - 14\alpha + 1)k^2 + (34\alpha^2 - 12\alpha - 14)k} \\
\beta_2^* &= \frac{G}{H}
\end{aligned}$$

and G and H are functions of α and k found in the Appendix.

[47]This is both the interesting case and it simplifies analysis. In the other case, the government's choice of F can generate three possible outcomes: a nonprofit market, a for-profit market, or a coordination game where both the nonprofit market and the for-profit market are equilibria.

[48]This reflects the government's potential ability to redistribute tax revenue to the benefit of consumers.

Proof: Since $\beta \geq \frac{1}{2}$, the government chooses $\underline{F}$ in the for-profit market, $\overline{F}$ in the mixed market and $\overline{F}$ (weakly) in the nonprofit market. Returning these to their respective welfare functions yield

$$
\begin{aligned}
W(1,1) &= (1-\beta)\left(\frac{2a^2(k+2-\frac{4\alpha}{1-\alpha})}{2(k+3-\frac{2\alpha}{1-\alpha})^2}\right)+\beta\left[\frac{1}{2}\left(\frac{2a}{k+3-\frac{2\alpha}{1-\alpha}}\right)^2\right]+ && (94)\\
&\quad +2\underline{F}(2\beta-1)\\
W(0,1) &= (1-\beta)\left(\frac{a^2k\left(k+\frac{2\alpha}{1-\alpha}\right)(k+2-\frac{4\alpha}{1-\alpha})}{2(k^2+4k+2-\frac{\alpha}{1-\alpha})^2}\right)+\beta\left[\frac{1}{2}\left(\frac{a(3k+2)}{k^2+4k+2-k\frac{\alpha}{1-\alpha}}\right)^2\right]+\\
&\quad +\overline{F}(2\beta-1) && (95)\\
W(0,0) &= \frac{8a^2\beta}{k^2+8k+16}. && (96)
\end{aligned}
$$

Setting (94) equal to (95) and solving for β yields β_2^*. When $\beta < \beta_2^*$, $W\left(0,1 \mid \overline{F}\right) > W\left(0,0 \mid \overline{F}\right)$. Similarly, setting (94) equal to (96) and solving for β yields β_1^*. When $\beta > \beta_1^*$, $W\left(0,1 \mid \overline{F}\right) > W\left(1,1 \mid \underline{F}\right)$. The result follows.

Since the government values consumer surplus over producer surplus, tax revenue benefits society and the government chooses the largest F that generates a given market type. From stage 2, the largest F that generates a for-profit market is $\underline{F}$ and the largest level that generates a nonprofit market is $\overline{F}$. If the government wants to generate a nonprofit market it must set F above $\overline{F}$ and the level does not directly affect welfare (since there are no for-profit firms).

Proposition 13 demonstrates that with a tax-exemption the mixed market can become the socially optimal market type. The intuition can be found in the social welfare functions (94), (95) and (96). In the for-profit market, tax revenue $\underline{F}$ is collected from the for-profit firms for a total tax revenue of $2\underline{F}$. In the mixed market, the total tax revenue $\overline{F}$ is collected from the one for-profit firm. In the nonprofit market, no taxes are collected.

Thus, total tax revenue in the mixed market can be greater than both of the other markets. This occurs when $0 \leq 2\underline{F} < \overline{F}$. In this case, welfare in the mixed market can go from ranking third (without the nonprofit tax-exemption) to first (with the tax-exemption). For example suppose $k = 3$, $\alpha = 0.545$ and $\beta = 0.633$. Without the tax-exemption, the mixed market welfare ranks third.[49] With the endogenous nonprofit tax-exemption, each firm in a for-profit market is taxed $\underline{F} = 0$, while the for-profit firm in a mixed market is taxed $\overline{F} = 0.0013a^2$. The tax revenue collected in the mixed market sends its welfare above the welfare of both of the other two markets types.[50]

[49] Returning α and k to β_1 and β_2 in the proof for Proposition 2, the mixed market ranks third when $0.631 < \beta < 0.634$.
[50] Returning α and k to β_1^* and β_2^* in Proposition 4, the mixed market ranks first when $0.62 < \beta < 0.71$.

Alternatively, total tax revenue in the mixed market can be less than in for-profit market but greater than in the nonprofit market. This occurs when $0 < \overline{F} < 2\underline{F}$. In this case, welfare in the mixed market can go from ranking second behind the nonprofit market (without a tax-exemption) to first (with the tax-exemption). For example, suppose $k = 3$ and $\alpha = \frac{1}{2}$ and $\beta = 0.65$. Without the tax-exemption, the mixed market welfare ranks second to the nonprofit market.[51] With the endogenous nonprofit tax-exemption, each firm in the for-profit market is taxed $\underline{F} = 0.005a^2$, for a total tax revenue of $2\underline{F} = 0.010a^2$, while the for-profit firm in the mixed market is taxed $\overline{F} = 0.0067a^2$. The tax revenue collected in the mixed market sends its welfare above the welfare in the nonprofit market and it also remains socially superior to the for-profit market.

The parameter range of k and α where the endogenous mixed market can be the socially optimal market type is summarized in the following result.

> *Result 2*: When the endogenous mixed market is *possible* for some F, it is almost always *optimal* for some β, as shown in Figure 2. Identifying this range requires finding where $\beta_2^* - \beta_1^* > 0$ (since Proposition 4 requires that $\beta_1^* < \beta_2^*$). While the equality $\beta_2^* - \beta_1^* = 0$ cannot be solved for α explicitly, the roots of $\beta_2^* - \beta_1^*$ can be found for various k. Figure 2 plots and connects these roots, separating the lightly shaded and the darkly shaded areas. In the darkly shaded area the mixed market is both possible and is potentially optimal. In the much smaller lightly shaded area the mixed market is possible but is never optimal.

Table 12 gives β_1^* and β_2^* for various values of k and α combinations. For example, when $k = 3$ and $\alpha = 0.545$, the mixed market is optimal if $0.62 < \beta < 0.71$.

[Table 12 about here]

For $\beta < \beta_1^*$ the for-profit market is the optimal market type and for $\beta > \beta_2^*$ the nonprofit market is the optimal market type. For larger k (given α), β_1^* and β_2^* increase. For all but one of these k and α combinations $\beta_1^* > \alpha$. Admittedly, the critical range of β can be small. Nonetheless, the result that a mixed market can be the socially optimal market type for some values of β provides a possible explanation for the presence of mixed markets under a nonprofit tax-exemption policy.

3.7 Conclusion

This paper provides the first examination of nonprofit status choice in a Cournot duopoly. It demonstrates that a mixed market can emerge endogenously even when firms have identical costs and objective functions.

[51] Returning α and k to β_2 in the proof for Proposition 2, the mixed market ranks second to the nonprofit market when $0.625 < \beta$.

When firms value both profit and consumer surplus, they can treat output as strategic compliments. Thus, when a firm chooses nonprofit status and increases output to accommodate the zero profit condition, it is rewarded by the additional output of its for-profit rival. For its part, the for-profit firm has no incentive to become a second nonprofit. If it were to increase output to satisfy the zero profit constraint, the first nonprofit would *reduce* output to continue accommodating its own constraint. Thus, the incentive to choose nonprofit status exists for one firm while being absent for the other. In this way, an endogenously chosen mixed market emerges even among firms with identical weights on consumer surplus.

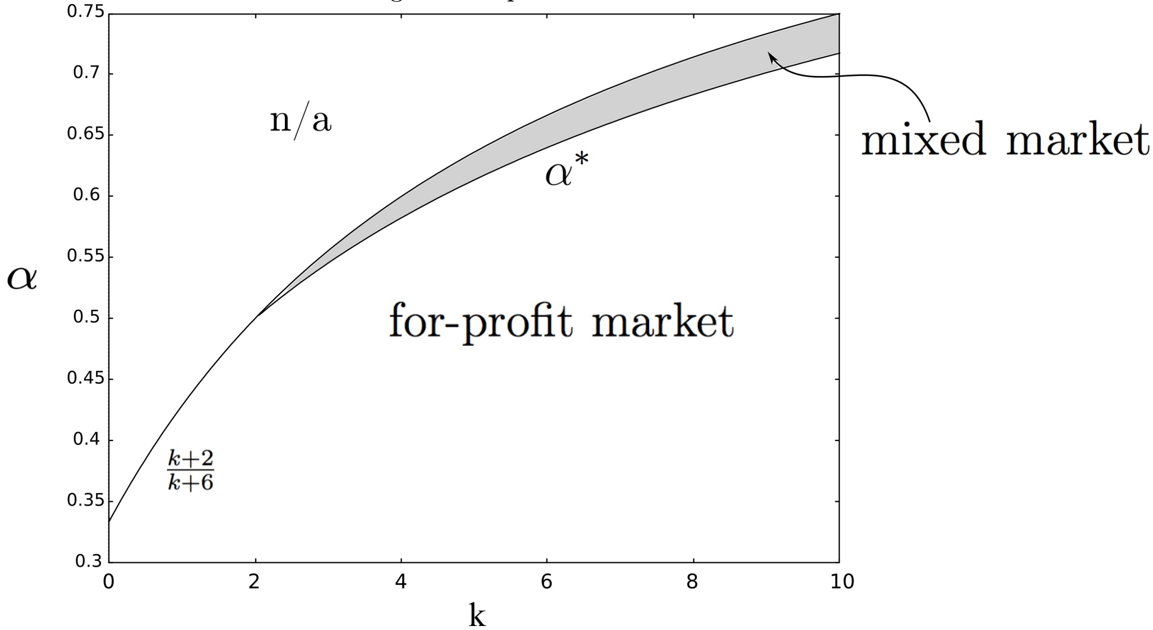
Yet, without a tax-exemption, the endogenous mixed market is shown to never be the socially superior market type. The government prefers either the nonprofit market or the for-profit market, as determined by the weight on consumer surplus in its social welfare function. For weights on consumer surplus above (below) a threshold, the nonprofit (for-profit) market is the socially superior one.

With a tax-exemption, the endogenous mixed market can be the socially superior market type and is generated by a larger parameter range. When the government's weight on consumer surplus is within a critical range, its optimal choice of a nonprofit tax-exemption generates the mixed market. Tax revenue can sometimes be larger in the mixed market than in the other market types. This additional tax revenue can improves welfare if it is potentially passed to consumers. Thus, welfare in the mixed market can go from ranking second or third without the tax-exemption, to first with the tax-exemption.

These results provide an explanation for the presence of mixed market under a nonprofit tax-exemption policy. Additionally, they take a logical next step in the literature on mixed market. Models of mixed markets in Cournot duopoly have taken nonprofit status choice to be exogenous. Research on nonprofit status choice has largely ignored imperfect competition. I incorporate both features, nonprofit status choice and Cournot duopoly, into a single model for the first time.

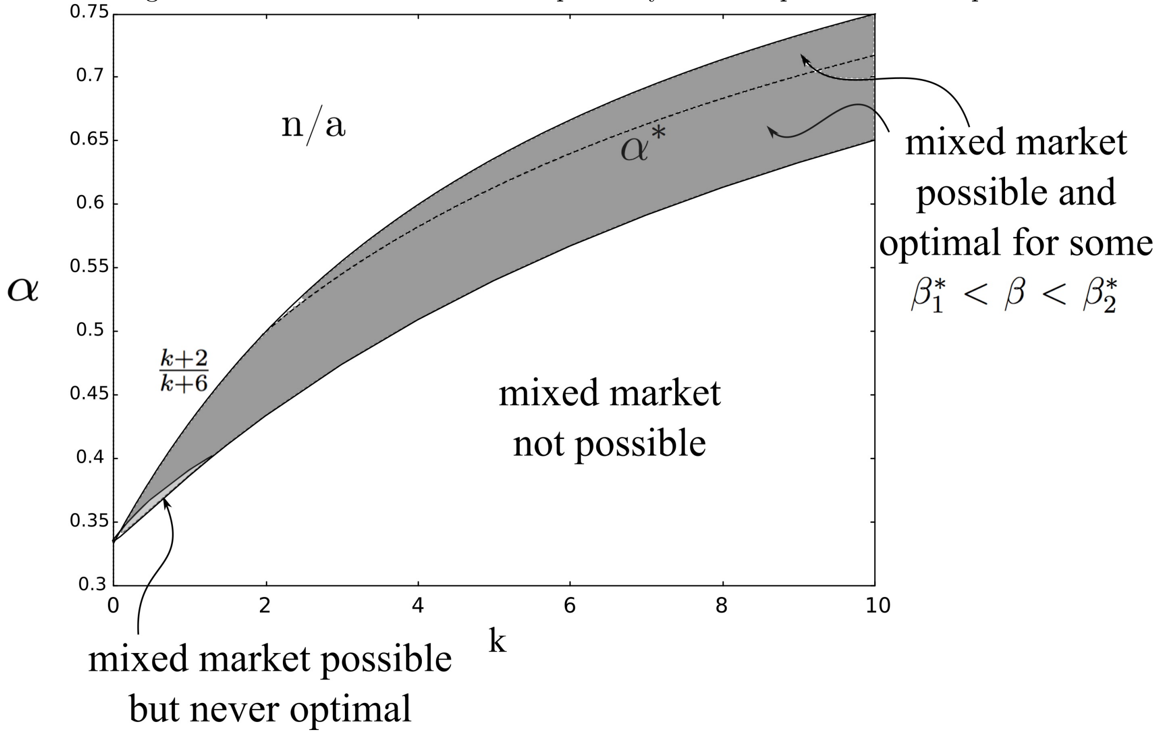
Mixed markets are common in important industries such as healthcare, education and the arts. However, economists have not provided very many strong explanations for why or how such markets arise. The fact that nonprofits tend to compete in industries involving a public good suggests all firms are likely to value objectives other than only profit. This paper demonstrates that when two firms, identical in their value of consumer surplus, compete in an imperfectly competitive market, a mixed can arise and be the socially optimal market type.

Figure 4: Equilibrium status choices



A mixed market is chosen endogenously for certain values of k (the slope of the marginal cost curves) and α (the weight on consumer surplus in the firms' utility functions) as shown by the shaded area. For other values of k and α, a for-profit market arises endogenously. Irrelevant cases (because of negative profits) are denoted by "n/a."

Figure 5: Status Choice and Social Optimality with Nonprofit Tax-Exemption



A nonprofit tax-exemption $0 < \underline{F} < F < \overline{F}$ expands the parameter range where a mixed market is chosen endogenously, as shown by the shaded areas. The unshaded area "n/a" denotes irrelevant cases where profits are negative. The other unshaded area denotes cases where the mixed market cannot occur for any F. When the government's welfare function has a weight on consumer surplus, In the darkly shaded area, if $\beta_1^* < \beta < \beta_2^*$ the socially optimal tax-exemption is $F^* = \overline{F}$ and the mixed market is generated. Conversely, in the smaller lightly shaded area, the mixed market is possible but is never optimal.

Table 10: Nash equilibria in status choices when $\alpha^* < \alpha < \frac{k+2}{k+6}$

		Firm j	
		Nonprofit ($d_j = 0$)	For-profit ($d_j = 1$)
Firm i	Nonprofit ($d_i = 0$)	$u_i^0(0,0)$ $u_j^0(0,0)$	$\underline{u_i^0(0,1)}$ $\underline{u_j^1(0,1)}$
	For-profit ($d_i = 1$)	$\underline{u_i^1(0,1)}$ $\underline{u_j^0(0,1)}$	$u_i^1(1,1)$ $u_j^1(1,1)$

When firm j is nonprofit, firm i prefers for-profit to nonprofit status, denoted by underlined $u_i^1(0,1)$ in the bottom left cell (and, by symmetry, $u_j^1(0,1)$ in the upper right cell). When firm j is for-profit, firm i prefers nonprofit to for-profit since $\alpha^* < \alpha < \frac{k+2}{k+6}$, denoted by underlined $u_i^0(0,1)$ in the top right cell (and, by symmetry, $u_j^0(0,1)$ in the bottom left cell). There are two simultaneous best-responses, each with one firm choosing nonprofit status and the other choosing for-profit status.

Table 11: Critical $\underline{F}$ and $\overline{F}$ (scaled by $\frac{100}{a^2}$) for an endogenous mixed market

α	$k = 0.5$	$k = 1$	$k = 2$	$k = 3$	$k = 5$	$k = 10$
0.750	Irrelevant (negative profits)					$(0, 0)$
0.717						$(0, 0.22)$
0.700						$(0.16, 0.35)$
0.650						$(0.72, 0.72)$
0.627					$(0, 0)$	
0.614					$(0, 0.22)$	
0.556				$(0, 0)$	$(0.70, 0.80)$	
0.545				$(0, 0.13)$	$(0.85, 0.89)$	
0.539				$(0.03, 0.21)$	$(0.94, 0.94)$	
0.500			$(0, 0)$	$(0.5, 0.67)$		
0.473			$(0.19, 0.38)$	$(0.97, 0.97)$		
0.433			$(0.89, 0.89)$			
0.429		$(0, 0)$				
0.400		$(0.32, 0.41)$	A mixed market cannot emerge for any F			
0.385	$(0, 0)$	$(0.60, 0.60)$				
0.375	$(0.08, 0.12)$					
0.359	$(0.31, 0.31)$					

When $\underline{F} < F < \overline{F}$ the mixed market arises endogenously. When F is greater (less) than both critical values both firms choose nonprofit (for-profit) status.

Table 12: Critical β_1^* and β_2^* for a socially optimal mixed market

α	$k = 0.5$	$k = 1$	$k = 2$	$k = 3$	$k = 5$	$k = 10$
0.750						$(0.68, 0.86)$
0.717						$(0.73, 0.89)$
0.700						$(0.76, 0.91)$
0.650		Irrelevant (negative profits)				$(0.89, 1.00)$
0.627					$(0.65, 0.78)$	
0.614					$(0.66, 0.78)$	
0.556				$(0.61, 0.71)$	$(0.71, 0.79)$	
0.545				$(0.62, 0.71)$	$(0.73, 0.80)$	
0.539				$(0.62, 0.71)$	$(0.74, 0.80)$	
0.500			$(0.59, 0.67)$	$(0.64, 0.69)$		
0.473			$(0.59, 0.65)$	$(0.66, 0.69)$		
0.433			$(0.61, 0.62)$			
0.429		$(0.55, 0.60)$				
0.400		$(0.55, 0.57)$				
0.39		$(0.55, 0.55)$				
0.385	$(0.53, 0.56)$			A mixed market cannot emerge for any F		
0.375	$(0.53, 0.54)$					
0.366	$(0.53, 0.53)$					
0.359						

When $\beta_1^* < \beta < \beta_2^*$, the government chooses $F^* = \overline{F}$. The mixed market arises as the socially optimal market type. When $\beta > \beta_2^*$, the nonprofit market is the socially optimal market type, which the government can generate with any $F \geq \overline{F}$. When $\beta < \beta_1^*$, the government chooses $F^* = \underline{F}$, and the for-profit market is the socially optimal market type.

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3.8 Appendix

3.8.1 Proof of Proposition 1

Endogenous mixed market requires that status combination ($d_i = 0$, $d_j = 1$) or ($d_i = 1$, $d_j = 0$) is a subgame perfect Nash equilibrium (SGPNE). A SGPNE in status means that both firms' status choices are simultaneous best-responses to each other. Finding a best-response requires comparing a firms utility levels under the two status options, holding the rival's status constant.

First, if firm j is for-profit, then firm i earns utility (76) under nonprofit status and (68) under for-profit status. Equating these two values and solving for α yields four roots. However, the only relevant roots are $\frac{k+2}{k+6}$ and

$$\alpha^* = \frac{2k^4 + 23k^3 + 72k^2 + 65k + 18 - (k+1)\sqrt{13k^4 + 86k^3 + 181k^2 + 140k + 36}}{2k^4 + 30k^3 + 122k^2 + 122k + 36}.$$

Plugging in various values of α and k reveals that

$$\begin{aligned} u_i^0(0,1) &> u_i^1(0,0) \text{ if } \alpha^* < \alpha < \frac{k+2}{k+6} \\ u_i^0(0,1) &\leq u_i^1(0,0) \text{ if } 0 < \alpha < \alpha^*. \end{aligned}$$

Thus, firm i's best-response to $d_j = 1$ is $d_i = 0$ when $\alpha^* < \alpha < \frac{k+2}{k+6}$. Otherwise, its best-response is $d_i = 1$ when $0 < \alpha < \alpha^*$.

Second, if firm j is nonprofit, firm i earns utility (82) under nonprofit status and (77) with for-profit status. Equating these two values and solving for α yields three roots. However, the only relevant root is $\frac{k+2}{k+6}$ where

$$u_i^0(0,0) < u_i^1(0,1) \text{ if } 0 < \alpha < \frac{k+2}{k+6}.$$

Thus, firm i's best-response to $d_j = 0$ is $d_i = 1$. Since firms i and j are identical, the above inequalities apply to both firms' status choices.

Table 10 illustrates these incentives in a bi-matrix for the case when $\alpha^* < \alpha < \frac{k+2}{k+6}$. The mixed market is a SGP Nash equilibrium since one for-profit and one nonprofit involves simultaneous best-responses in nonprofit status. Two symmetric equilibria exist, each with one of the two firms choosing each status.

Alternatively, if $0 < \alpha < \alpha^*$ for-profit status is a dominant strategy (a best-response regardless of the rival's status). In this case, the SGP Nash equilibrium has both firms choosing for-profit status. This bi-matrix can be constructed following a similar process as for Table 10. The result in Proposition 1 follows.

3.8.2 Proof of Proposition 2

Equating (84) and (85) and solving for β yields β_1. Similarly using (85) and (86) yields β^*, and using (84) and (86) yields β_2 where

$$
\begin{aligned}
\beta_1 &= \frac{(1-\alpha)k^3 + (8-6\alpha)k^2 + 16k + 32\alpha}{(1-\alpha)k^3 + (15-13\alpha)k^2 + (46-34\alpha)k + 16 + 16\alpha} \\
\beta^* &= \frac{(1-\alpha)k^2 + 8(1-\alpha)k + 16(1-\alpha)}{(1-\alpha)k^2 + 14(1-\alpha)k + 36 - 44\alpha} \\
\beta_2 &= \frac{A}{B}
\end{aligned}
$$

$$0 < \beta_1 < \beta^* < \beta_2 < 1$$

and

$$
\begin{aligned}
A &= \left(\alpha^3 - 3\alpha^2 + 3\alpha - 1\right)k^4 + \left(12\alpha^3 - 34\alpha^2 + 32\alpha - 10\right)k^3 + \\
&\quad + \left(53\alpha^3 - 131\alpha^2 + 109\alpha - 31\right)k^2 + \left(90\alpha^3 - 172\alpha^2 + 122\alpha - 33\right)k + \\
&\quad + 8\alpha^3 - 24\alpha^2 + 24\alpha - 8 \\
B &= \left(\alpha^3 - 3\alpha^2 + 3\alpha - 1\right)k^4 + \left(17\alpha^3 - 49\alpha^2 + 47\alpha - 15\right)k^3 + \\
&\quad + \left(85\alpha^3 - 219\alpha^2 + 189\alpha - 55\right)k^2 + \left(131\alpha^3 - 283\alpha^2 + 221\alpha - 61\right)k + \\
&\quad + 22\alpha^3 - 62\alpha^2 + 58\alpha - 18.
\end{aligned}
$$

Values of β between these critical values generate the following welfare inequalities:

$$
\begin{aligned}
W(0,0) &\lesseqgtr W(0,1) \text{ iff } \beta \lesseqgtr \beta_1 \\
W(0,0) &\lesseqgtr W(1,1) \text{ iff } \beta \lesseqgtr \beta^* \\
W(0,1) &\lesseqgtr W(1,1) \text{ iff } \beta \lesseqgtr \beta_2
\end{aligned}
$$

Combining the three welfare inequalities yields the following social welfare rankings:

(a). For-profit > Mixed > Nonprofit if $0 \leq \beta < \beta_1$

(b). For-profit > Nonprofit $\geq$ Mixed if $\beta_1 \leq \beta < \beta^*$

(c). Nonprofit $\geq$ For-profit > Mixed if $\beta^* \leq \beta < \beta_2$

(d). Nonprofit > Mixed $\geq$ For-profit if $\beta_2 \leq \beta \leq 1$.

Thus, the mixed market is never the socially optimal market type for any $0 \leq \beta \leq 1$.

3.8.3 Critical Nonprofit Tax-exemption Levels

$$
\begin{aligned}
\underline{F} &= \begin{cases} 0 \text{ if} & \alpha^* < \alpha < \frac{k+2}{k+6} \\ \frac{Ca^2}{D} & \text{if } 0 < \alpha < \alpha^* \end{cases} \\
\overline{F} &= \frac{Ea^2}{F}
\end{aligned}
$$

where

$$
\begin{aligned}
C &= (\alpha^4 - 4\alpha^3 + 6\alpha^2 - 4\alpha + 1)k^5 + (21\alpha^4 - 73\alpha^3 + 93\alpha^2 - 51\alpha + 10)k^4 + \\
&\quad +(151\alpha^4 - 452\alpha^3 + 487\alpha^2 - 222\alpha + 36)k^3 + (427\alpha^4 - 1107\alpha^3 + 1025\alpha^2 - 401\alpha + 56)k^2 + \\
&\quad +(384\alpha^4 - 932\alpha^3 + 796\alpha^2 - 284\alpha + 36)k + 108\alpha^4 - 252\alpha^3 + 204\alpha^2 - 68\alpha + 8 \\
D &= (2\alpha^4 - 8\alpha^3 + 12\alpha^2 - 8\alpha + 2)k^6 + (40\alpha^4 - 148\alpha^3 + 204\alpha^2 - 124\alpha + 28)k^5 + \\
&\quad +(308\alpha^4 - 1052\alpha^3 + 1334\alpha^2 - 744\alpha + 154)k^4 + (1120\alpha^4 - 3540\alpha^3 + \\
&\quad +4160\alpha^2 - 2156\alpha + 416)k^3 + +(1858\alpha^4 - 5532\alpha^3 + 6162\alpha^2 - 3040\alpha + 560)k^2 + \\
&\quad +(1080\alpha^4 - 3288\alpha^3 + 3704\alpha^2 - 1832\alpha + 336)k + +200\alpha^4 - 640\alpha^3 + 752\alpha^2 - 384\alpha + 72 \\
E &= (\alpha^3 - 3\alpha^2 + 3\alpha - 1)k^5 + (19\alpha^3 - 48\alpha^2 + 39\alpha - 10)k^4 + (112\alpha^3 - 232\alpha^2 + 152\alpha - 32)k^3 + \\
&\quad +(188\alpha^3 - 312\alpha^2 + 172\alpha - 32)k^2 + (-96\alpha^3 + 128\alpha^2 - 32\alpha)k \\
F &= (2\alpha^3 - 6\alpha^2 + 6\alpha - 2)k^6 + (36\alpha^3 - 104\alpha^2 + 100\alpha - 32)k^5 + (250\alpha^3 - 698\alpha^2 + \\
&\quad +648\alpha - 200)k^4 + (824\alpha^3 - 2240\alpha^2 + 2024\alpha - 608)k^3 + +(1256\alpha^3 - 3384\alpha^2 + \\
&\quad +3032\alpha - 904)k^2 + (704\alpha^3 - 1984\alpha^2 + 1856\alpha - 576)k + 128\alpha^3 - 384\alpha^2 + 384\alpha - 128.
\end{aligned}
$$

3.8.4 Critical Weights in the Welfare Function

$$
\begin{aligned}
\beta_1^* &= \frac{(7\alpha^2 - 7\alpha)k^2 + (34\alpha^2 - 30\alpha)k + 16\alpha^2 - 16\alpha}{(\alpha^2 - 2\alpha + 1)k^3 + (13\alpha^2 - 14\alpha + 1)k^2 + (34\alpha^2 - 12\alpha - 14)k - 16\alpha^2 + 32\alpha - 16} \\
\beta_2^* &= \frac{G}{H}
\end{aligned}
$$

and

$$
\begin{aligned}
G &= (3\alpha^4 - 9\alpha^3 + 9\alpha^2 - 3\alpha)k^5 + (40\alpha^4 - 136\alpha^3 + 152\alpha^2 - 56\alpha)k^4 + \\
&+(223\alpha^4 - 833\alpha^3 + 953\alpha^2 - 343\alpha)k^3 + (698\alpha^4 - 2482\alpha^3 + 2654\alpha^2 - 886\alpha)k^2 + \\
&+(1136\alpha^4 - 3280\alpha^3 + 3088\alpha^2 - 944\alpha)k + 448\alpha^4 - 1216\alpha^3 + 1088\alpha^2 - 320\alpha \\
H &= (\alpha^4 - 4\alpha^3 + 6\alpha^2 - 4\alpha + 1)k^6 + (21\alpha^4 - 76\alpha^3 + 102\alpha^2 - 60\alpha + 13)k^5 + \\
&+(173\alpha^4 - 608\alpha^3 + 760\alpha^2 - 388\alpha + 63)k^4 + (775\alpha^4 - 2704\alpha^3 + 3142\alpha^2 - 1352\alpha + 139)k^3 + \\
&+(2118\alpha^4 - 6848\alpha^3 + 7108\alpha^2 - 2544\alpha + 134)k^2 + (3008\alpha^4 - 8160\alpha^3 + 7328\alpha^2 - 2208\alpha + 32)k + \\
&+800\alpha^4 - 2112\alpha^3 + 1792\alpha^2 - 448\alpha - 32.
\end{aligned}
$$

Gabriel Courey

April 2018

Economics Department
University of Wisconsin-Milwaukee
3210 N. Maryland Ave.
Milwaukee, WI 53201

Education and Awards

Ph.D., Economics, 2018 (expected) – University of Wisconsin-Milwaukee (UWM)

Dissertation: "Market Power and the Nonprofit Sector" (advisor: John S. Heywood)

Richard Perlman Prize for Outstanding Paper in Labor Economics, 2016
Chancellor's Graduate Student Award, 2013 – 2014

B.A., Economics with Mathematics Minor, 2010 (*cum laude)* – Hope College, Holland, MI

Presidential Scholarship, 2006 – 2010

Teaching Appointments

Lecturer — University of Wisconsin-Whitewater (UWW) 2016-current
Principles of Microeconomics (4 sections), Business Statistics (8)
University Honors Program Advisor

Graduate Instructor — UWM 2012-2016
Principles of Microeconomics (6, with 2 online), Labor Economics,
Survey of Economics Discussion Section

Adjunct Instructor — Madison College, Madison, WI 2014
Survey of Economics

Publication and Research

"Spatial Price Discrimination, Monopoly Upstream and Convex Costs Downstream," *Letters in Spatial and Resource Sciences* (2016), 9: 137-144.

Gabriel Courey

“Spatial Price Discrimination, Sequential Location and Convex Production Costs,” revised and resubmitted to *Letters in Spatial and Resource Sciences.*

“Gender Wage Gap Trends Among Information Science Workers” (with John S. Heywood), revised and resubmitted to *Social Science Quarterly.*

“Nonprofit Status Choice in a Duopoly” (working)

“Gender and Racial Wage Differentials in the Nonprofit Sector: Are Hospitals Different?” (working)

“Nonprofit Status Choice in Cournot: the N-Firm Case” (work in progress)

“Asymmetric Objectives and Nonprofit Status Choice in a Duopoly” (work in progress)

“Nonprofit Status as a Prisoner’s Dilemma: A Note” (work in progress)

Conference and Seminar Presentations

“Nonprofit Status Choice in a Duopoly”
Wisconsin Economics Association (WEA) 2017 Meeting

“Gender and Racial Wage Differentials in Nonprofits: Are Hospitals Different?”
Midwest Economics Association 2016 Meeting, UWW (Fall 2016), UWM (Fall 2015, 2016), WEA 2015 Meeting

Other Work Experience

Research Assistant— UWM 2016-2017
Racial composition of public schools (Owen Thompson)
Ph.D. Microeconomic Theory curriculum development (Matt McGinty)

Research Assistant — Capital Policy Analytics, Consulting, Washington, DC 2016
Grant proposal contribution, “Literature on the Jones Act”: Summer 2016

Grader— UWM 2012-2016
Economics of Discrimination (4 semesters), Principles of Microeconomics (online), Intermediate Microeconomics

Gabriel Courey

Personal

Happily married father, active in church and small group Bible study.

References

John S. Heywood
Distinguished Professor of Economics, University of Wisconsin-Milwaukee
heywood@uwm.edu

Matthew McGinty
Associate Professor of Economics, University of Wisconsin-Milwaukee
mmcginty@uwm.edu

Owen Thompson
Assistant Professor of Economics, University of Wisconsin-Milwaukee
thompsoo@uwm.edu