Moonlighting: Public Service and Private Practice[1]

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Abstract

We study dual job incentives with a focus on public-service physicians referring patients to their private practices. We call this moonlighting. Not all physicians moonlight; we introduce a group of dedicated doctors who in the base models behave nonstrategically in the public system. Allowing moonlighting can always enhance aggregate welfare. The equilibrium care quality in the public system may increase or decrease; in the former situation, the policy allowing moonlighting implements a Pareto improvement. Unregulated moonlighting may be detrimental to social welfare when it leads to adverse behavioral reactions such as moonlighters shirking more in the public system, and dedicated doctors abandoning their sincere behavior. Price regulation in the private market tradeoffs the efficiency gain from moonlighting against the loss due to adverse behavior in the public system and improve aggregate welfare.

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1 Introduction

Many goods are produced in both the public and private sectors. Workers who produce these goods may also work in both sectors. Perhaps health care is the prime example of the mixed, private-public provision; physicians often work in both sectors, and may self-refer patients in the public system to their private practices. We use the term moonlighting to describe dual, public-private job participation.[1] In this paper, we examine the effects of moonlighting on service quality, price, and welfare in both the public and private sectors. We also analyze when and how government regulation in the moonlighting market may enhance welfare.

Often the discussion on moonlighting revolves around its legitimacy, or the potential problem of "conflict of interests." Perhaps the issue is regarded as less critical when workers have multiple jobs all in the private sector. Presumably, private firms may suitably restrict a worker's related outside work activities to align incentives. The public sector, however, operates quite differently; for various reasons, explicit incentive mechanisms appear to be uncommon there. As a result, moonlighting may be subject to regulations or banned altogether.

Our research focuses on dual job incentives in the mixed economy, where workers may participate in both the public and private markets. Due to its importance,[2] and for clearer exposition, we primarily focus on the physician market and doctors' self-referrals from the public to the private sectors. Our research methodology is general and can be applied to situations such as public law enforcement officers working for private security firms or consumers; public school teachers offering private tutoring services or working for private test preparation firms (such as Princeton or Kaplan); academics in public (and private) universities consulting for private firms (and the government).

Why do many people believe that moonlighting should be regulated or prohibited? There seems to be a presumption that allowing the physicians to moonlight will hurt services in the public sector. Economists are usually quick to point out that allowing a market to operate generally enhances welfare. For example, if moonlighting is allowed, physicians can be expected to provide faster and

[1] According to the United Kingdom Monopolies and Mergers Commission, in 1994 more than 60% of physicians employed by the UK National Health Services also worked in the private sector. In Germany (and many other countries), physicians based in public hospitals can admit private patients, collect fees, and then reimburse the public hospital (Rickman and McGuire 1999). Workers having many jobs is of course common. Our interest here is only when one of these jobs is in the public service.

[2] A recent newsletter from the Health Economics & Financing Programme at the London School of Hygiene & Tropical Medicine reported on "moonlighting physicians." See *Exchange* Summer 2003.

higher quality services in the private sector; consumers who are willing to pay for these superior services will opt out of the public system. Critics argue, however, that moonlighters may cut back qualities for patients in the public sector and doctors that choose not to moonlight may also cut back on quality. Because of the lack of incentives in the public system, the adverse reaction presents an unmitigated problem.

Two sets of questions must be addressed in the above argument. First, for those against moonlighting, if incentives in the public sector are weak, why are the moonlighters expected to provide good services there when they are *not* allowed to moonlight? That is, why would allowing moonlighting *suddenly* make quality in the public sector worse? Second, for those on the other side of the argument, will moonlighting enhance overall welfare when there could be losses in the public sector?

Our view is that moonlighting in a mixed economy should be modelled in a satisfactory way. Besides the differences in incentives between the public and private sectors, there is also a difference between the market participants. Even when it is allowed, not every physician chooses to moonlight. We introduce a group of physicians called the "dedicated doctors." They are dedicated in the sense that they provide good qualities in the public sector despite the lack of incentives; they may also reject moonlighting opportunities.[3]

The presence of the dedicated doctors allows us to understand why healthcare qualities in public sectors are not necessarily extremely poor. Moreover, if moonlighting makes some of these dedicated doctors change their position and become moonlighters, then there will be an adverse effect on the quality in the public sector. Worrying about quality degradation in the public sector is indeed a legitimate concern, even when moonlighters provide poor quality there in the first place. A second reason for fearing quality deterioration should also be considered. Moonlighters may decide to reduce quality in the public sector even more than if they were not allowed to moonlight. In either of these two circumstances, moonlighting leads to adverse behavior in the public sector.

How is aggregate welfare affected by moonlighting? Despite the adverse behavioral reactions created by moonlighting, welfare may be enhanced when the private market is regulated. Suppose that the magnitude of these adverse reactions by physicians are positively related to the extent

[3] Robert Frank documented wage differentials among jobs that have different moral concerns. Apparently workers are willing to "trade pay or other desired working conditions in exchange for additional opportunities to help others on the job." (Frank, 1996, p2-3)

and profitability of moonlighting in the private market. More opportunities in the private market may lure more dedicated doctors to moonlight; these opportunities may also induce moonlighters to shirk more in the public system. Then restricting moonlighting will limit its negative effects; reducing the scope of moonlighting, on the other hand, limits private market efficiency. We show that a price ceiling on moonlighting in the private market enhances overall welfare. The ceiling reduces some surplus in the private market, but controls the quality deterioration in the public system by a larger order of magnitude.

These intuitions and results are derived from a basic model of moonlighting in a mixed economy. We consider a set of consumers going through the public system in order to obtain health care services. When they are matched with the dedicated doctors in the public system, they receive services there at a fixed, nominal fee. When they are matched with the moonlighters, they may be referred out of the public system if moonlighting is allowed. We use a general Nash bargaining solution to describe the outcome when a moonlighter and a consumer decide to use the private market; an outcome prescribes a quality and a price for the healthcare service.

We first compare the regimes where moonlighting is allowed and where moonlighting is not, ignoring any behavioral reactions from dedicated doctors and moonlighters. The basic model generates some expected results and some that are surprising. First, without behavioral reactions, allowing moonlighting does increase aggregate social welfare. Consumers who opt out of the public system are willing to pay a higher price for a higher quality. The quality that is implemented in the public system, however, may become higher or lower when moonlighting is allowed. The higher aggregate social welfare is due to the more efficient quality in the moonlighting market and the *option* of allowing the quality in the public system to remain the same.

Why is the quality in the public system changed if moonlighting is allowed—even when there is no behavioral reaction? The quality in the public system is based on the average consumer treated by the dedicated doctors, and there are some costs due to the use of public funds to pay for health care. As a result, there is some inefficiency. When the moonlighting market is opened up, it becomes feasible to correct for some of the inefficiency. If it is beneficial to reduce the size of the public sector (say to lower the inefficiency due to a uniform quality there), then lowering the quality there will lead to more consumers using the moonlighting market. On the other hand, when moonlighting is allowed, the public sector serves fewer consumers, and the cost of public fund is reduced. This cost saving may be used for a higher quality for consumers who remain in the public system.

As a robustness check, we consider two variations of the basic model. We extend the model to a dynamic one, and we allow for asymmetric information. Neither of these will change the basic intuition. When there are many periods in which consumers can be matched to physicians, they have a credible threat against a moonlighter who offers very low quality. As a result, moonlighters may have to offer a higher quality even if the consumer stays within the public system. Asymmetric information may limit the volume of trade. Nevertheless, consumers always have the option of remaining in the public system. Should they decide to use a moonlighter in an equilibrium, they must expect to gain from the decision. Again, the expected gain from trade drives the improvement in social welfare.

The theoretical literature on dual job incentives in the mixed economy is not extensive. Rickman and McGuire (1999) examine the optimal public reimbursement cost sharing rule when a physician can supply both public and private services and focus on the issue of whether the public and private services are complements or substitutes. Barros and Olivella (2002) analyze a model with a waiting list in the public sector to study a physicians' decision to cream-skim. Finally, Gonzalez (2002) presents a model where a physician has an incentive to provide excessive quality in the public sector in order to raise her prestige.

Other papers in the health economics literature have examined the effect of the private market on the waiting list in the public sector. Iversen (1997) considers a dynamic model of rationing by waiting lists and shows that the existence of a private sector can make the list longer. Barros and Martinez-Giralt (2002) use a Hotelling model of oligopoly to study the effect of interaction between public and private health care on quality and cost efficiency. Besley, Hall, and Preston (1998) show empirically that waiting lists in the UK National Health Services are positively associated with private insurance. These papers do not consider job incentives of physicians working in both sectors.

Moonlighting can be seen as a multi-task principal-agent problem, where the regulator sets the reimbursement rate in the public sector and may regulate prices and the ability to work in the private sector. Other research in the multi-tasking agency literature include Holmstrom and Milgrom (1994) in the theory of the firm and Ma (1994) in health care.

The regulation literature has looked at incentives when a regulator may later work in the private sector. In the "revolving door" literature (Che 1995), the issue is whether the post-tenure opportunity will motivate a regulator to invest in skill for a regulatory agency. The literature has not looked at situations where the regulator can work simultaneously at a government agency and a regulated firm, while we focus on the case where the physician simultaneously participates in two markets.

Finally, our assumptions on physician behaviors build on models originating from the psychology literature. Our hypothesis that some physicians will provide quality without being monitored adopts a behavioral approach that has received much attention recently. Rabin (1993) develops a formal game-theoretic model on fairness. Alger and Ma (2003) propose that some agents are honest and truthfully reveal information to the principal.

In the next section we present the basic model and analyze it in section 3. We consider the dynamic model and allow for private information in sections 4 and 5. In section 6, we introduce behavioral changes of moonlighters and dedicated doctors. Concluding remarks are in section 7.

2 Basic Model

There are three groups of players: one set of consumers, and two sets of doctors. Each consumer would like to receive one unit of health service. There is a public health system where each consumer initially visits to obtain health care.[4] There are two sets of doctors which we call the dedicated doctors and the moonlighters. All doctors work in the public system. While the dedicated doctors work there only, the moonlighters may also work in the private sector if they are allowed to do so. Whether the moonlighters are allowed to operate in the private market will be determined as a policy choice.

In the public system, health services are provided to consumers at a nominal cost. The public system is one where health insurance and care services are integrated. Hence, for insurance (and also equity) purposes, consumers do not bear the full marginal cost of service. For simplicity, we assume that in the public system consumers pay a constant amount, and this is normalized at zero.

A doctor chooses a quality level for the healthcare services he provides; equivalently, we can

[4] We do not include the possibility that a consumer completely opts out of the public system. This option is usually taken by very rich members of an economy. Our purpose is to study how patients who go through the public system initially may actually end up in the private system.

think of a doctor deciding on treatment intensity, or the quantity of treatment for each patient. Providing health services at high quality is costly for the doctors. While the public system strives at good care quality, an incentive mechanism in the public system is difficult to implement. Suppose that the public system aims at achieving a certain care quality, and a regulator makes such a recommendation to the doctors. The dedicated doctors and moonlighters differ in their responses to this recommendation. Dedicated doctors follow the quality recommendation as long as their disutility from doing so is compensated for. Moonlighters do not follow the recommendation, and choose a quality to maximize their utilities. Payoffs for doctors will be defined shortly.

The dedicated doctors' nonstrategic behavior is seldom assumed by economists in models, but seems to us to be important in public services. In fact, it is uncommon to find strong incentive systems in the public sector or the civil service. According to the usual assumption that each agent maximizes his utility, the lack of incentives implies poor performance or complete shirking. Yet, we often find that tasks are fulfilled and services provided even in public organizations where incentives are weak. Our assumption that there are dedicated doctors in the public sector is consistent with this empirical observation. The dedicated doctors play a key role in our model by allowing consumers some possibility of obtaining good quality in the public system.[5]

We use the following normalization: each doctor, whether a dedicated doctor or a moonlighter, can treat one and only one patient in each period. The convention of defining a unit of a doctor by the provision of a unit of health treatment has the following implication. When treatment provision is verifiable, which we assume throughout, part-time employment at the public sector is enforceable. In other words, filing false claims on treatment is impossible in the public system; the accounting system is able to track treatments so that payments to a doctor are based on the number of treatments provided, not the amount of time a doctor says he has spent or quality that he provided at a public facility.

There are D dedicated doctors, M moonlighters, and N consumers. We assume that D, M, and N are fixed parameters; the total supply of services from each kind of doctors is fixed, and so is the total demand. We assume that $N > M + D$ so that there is always an excess demand for services. In the public sector, while the provision of treatment is verifiable, the quality of treatment is not.

[5] We make no claim on the overall efficiency of a public service; nor do we attempt here to explain the apparent lack of incentives. Alger and Ma (2003) propose that weak incentive mechanisms may well be optimal when there are many honest and sincere agents.

As we have said, a dedicated doctor will provide treatment at any recommended quality level if his expected cost or disutility is compensated for. A moonlighter, however, will choose quality to maximize his utility. So, in the public sector, absent any monitoring mechanism on quality, a moonlighter will choose a minimum quality.

Let q denote the quality of care; again, we can interpret this as the intensity or quantity of care for each patient. A consumer's benefit from receiving a unit of service or treatment at quality q is vq. Here, the marginal valuation for quality, v, is the realization of a random variable distributed on the support $[\underline{v}, \bar{v}]$ with distribution and density functions $F(v)$ and $f(v)$. Each consumer is described by her marginal valuation of a unit of quality.[6] We assume that each consumer knows her own valuation of quality (but later let some consumers be uninformed). Consumers' valuations of quality are independently and identically distributed. If in the private sector a consumer has to pay a fee p for the service with quality q, then her utility is $vq - p$. A consumer's utility is zero if she does not receive any treatment.

A physician incurs a cost or disutility $c(q)$, which is a strictly increasing and convex function, when he provides a treatment to a consumer at quality q. A regulator in the public system decides on payments to physicians and recommends a quality of service. Let q^r be the quality recommended to the doctors at the public sector. The regulator offers a payment equal to the cost of the recommended quality: for each provided treatment, a doctor is paid $c(q^r)$.[7] A dedicated doctor will follow the quality recommended by the regulator, and the payment will compensate for his disutility. A moonlighter will choose a minimum quality, denoted by $\underline{q} \leq q^r$, but still receive the payment $c(q^r)$.

Our basic model is a static one with complete information, and with the behavior of dedicated and moonlighters as defined above. We will progressively make the model more complex (and realistic). In subsequent sections, we consider a dynamic model, and also incorporate asymmetric information between doctors and consumers. Furthermore, in a later section, we will change the assumptions on the behavior of dedicated doctors and moonlighters; each type of doctors will be allowed more strategies while price regulation will be considered. These modifications will be defined in later sections. Our goal is to determine the welfare properties of equilibria as the assumptions

[6] It is likely that the marginal valuation is positively correlated with income.

[7] Our main qualitative results would not change if payments in the public sector are contingent on whether a physician moonlights.

of the basic model are relaxed.

We now define the extensive form of the basic moonlighting model. At the beginning, a consumer is matched with a dedicated doctor with probability D/N, or with a moonlighter with probability M/N; otherwise the consumer does not receive any medical service. This matching process is typical of public health systems in many developing countries; consumers often do not get to choose their own doctors when they seek services from the public sector.

If a consumer is matched with a dedicated doctor, she receives a treatment at quality q^r at zero cost. If a consumer is matched with a moonlighter, the consumer's valuation parameter v becomes common knowledge among the moonlighter and the consumer. A moonlighter then either treats the consumer in the public facility or offers to treat the consumer at his private practice. On hearing the recommendation, a consumer must decide whether to accept the offer, or insist on being treated by the moonlighter in the public system.

If the consumer refuses the moonlighting offer—the disagreement outcome—she is treated in the public system by the moonlighter. Here, the consumer pays 0, and the moonlighter provides the service at minimum quality $\underline{q}$. If the consumer accepts the moonlighting offer, she receives treatment at the moonlighter's private practice. There, the outcome is a generalized Nash bargaining solution, (p, q), where p is the price the consumer pays the moonlighter, and q is the quality of care provided by the moonlighter to the consumer. The consumer and the moonlighter divide the surplus over the disagreement outcome in the ratio α and $1 - \alpha$, respectively,.

Our use of the Nash bargaining solution says that the price-quality agreement between the moonlighter and the consumer is enforceable. This is different from our assumption that treatment quality in the public sector is nonverifiable. Our belief is that the moonlighter's private practice is subject to forces different from the public sector. Whereas the government may be unable to verify quality, the marketplace is able to do so.[8] Our modelling method builds in a potential gain when consumers opt out of the public system—Nash bargaining generates an efficient outcome. Later, we allow for either consumers or doctors to have private information about the valuation parameter v. These assumptions generate a game of incomplete information where outcomes may be inefficient.

[8] In case where higher quality of care means more timely service, enforcement of quality in the private sector is straightforward: the patient only need to pay the physician after the treatment.

2.1 Welfare and Quality when Moonlighting is disallowed

Moonlighting is a policy choice. First, we determine the benchmark where moonlighting is disallowed. The regulator weighs consumer surplus and doctor profits equally, but there is a cost for the use of public funds. If the regulator spends a dollar, the social welfare cost of this transfer is $\lambda > 0$. For a recommendation of quality q^r the regulator pays each doctor $c(q^r)$. The moonlighter will always choose the minimum quality $\underline{q}$ while the dedicated doctors will choose q^r. The dedicated doctor earns 0; each moonlighter earns $c(q^r) - c(\underline{q})$. The regulator incurs a total social cost of $(1+\lambda)(D+M)c(q^r)$. Thus, the social welfare without moonlighting is

$$D \int_{\underline{v}}^{\overline{v}} v q^r f(v) dv + M \int_{\underline{v}}^{\overline{v}} v \underline{q} f(v) dv + M[c(q^r) - c(\underline{q})] - (1+\lambda)(D+M)c(q^r). \tag{1}$$

In this expression, the two integrals are the sum of consumers' benefit when they are matched, respectively, with the dedicated doctors and moonlighters. The remaining terms are the sum of the payoffs of dedicated doctors (each obtaining zero) and moonlighters (each obtaining $c(q^r) - c(\underline{q})$), as well as the total cost of funds used by the regulator. Given our assumptions, the social welfare function (1) is strictly concave in q^r. Using the first-order condition, we find that the optimal recommended quality q^r when moonlighting is disallowed satisfies

$$D \int_{\underline{v}}^{\overline{v}} v f(v) dv = (1+\lambda) D c'(q^r) + \lambda M c'(q^r), \tag{2}$$

which simplifies to

$$\int_{\underline{v}}^{\overline{v}} v f(v) dv = \left(1 + \lambda \frac{D+M}{D}\right) c'(q^r). \tag{3}$$

The optimal level of the recommended quality equates the average valuation of quality to the marginal cost of providing quality adjusted by the cost of social fund as well as the ratio of moonlighters to dedicated doctors. The left-hand side of (2) is the marginal gain of raising the recommended quality: only D consumers will receive services at the recommended quality level, and the assignment of consumers to dedicated doctors is random, hence the average valuation term $\int_{\underline{v}}^{\overline{v}} v f(v) dv$. The right-hand side of (2) is the social marginal cost of raising the recommended quality. To raise the recommended quality by one unit, all D dedicated doctors have to be compensated for, which costs $(1+\lambda)Dc'(q^r)$. Nevertheless, the moonlighters also receive the higher payment, but the moonlighter's rent $c(q^r) - c(\underline{q})$ also counts towards social welfare. So the remaining part of the social marginal cost is just the cost of public fund $\lambda M c'(q^r)$.

The optimal level of quality when moonlighting is disallowed reveals two kinds of inefficiency. First, the cost of public fund tends to reduce the quality level. Second, paying moonlighters only results in giving them rents, not higher quality. If moonlighters were following the regulator's recommendation, the optimal quality would be given by

$$\int_{\underline{v}}^{\overline{v}} vf(v)dv = (1+\lambda)c'(q^r).$$

Comparing with (3), we see that the optimal quality with strategic moonlighters is lower, the magnitude of this distortion being related to the ratio between the numbers of dedicated doctors and moonlighters.

3 Moonlighting Equilibrium Quality and Welfare

We now consider equilibria when moonlighting is allowed. When a consumer with valuation v is matched with a moonlighter, they will consider whether to use the moonlighter's private service. The moonlighter's decision is whether to offer the consumer that option, and the consumer's decision is whether to accept it. If they agree on opting out, the outcome is a price-quality pair agreement (p, q) determined by the Nash bargaining solution.

To derive the Nash bargaining solution, we begin with the disagreement point. If the moonlighter and the consumer fail to reach an agreement, the moonlighter will provide treatment at minimum quality to the consumer in the public facility; the consumer's utility is $v\underline{q}$ whereas the moonlighter's utility is $c(q^r) - c(\underline{q})$. The total surplus for the service in the public system is $v\underline{q} - c(\underline{q}) + c(q^r)$, which, with respect to v, increases at the rate $\underline{q}$.

Next, let $q(v)$ be the efficient quality for consumer type v, and $S(v)$ the surplus when the efficient quality is provided to this consumer. That is,

$$q(v) \equiv \text{argmax}_q \; vq - c(q) \quad \text{and} \quad S(v) \equiv vq(v) - c(q(v)). \tag{4}$$

This surplus is increasing in v, and at a rate $q(v)$ by the Envelope Theorem. Define a valuation threshold $\widehat{v}$ by

$$S(\widehat{v}) \equiv \widehat{v}\underline{q} - c(\underline{q}) + c(q^r). \tag{5}$$

The surplus from moonlighting will be higher than the public sector when $v > \widehat{v}$. This is because the derivative of S with respect to v is always higher than that of $v\underline{q} - c(\underline{q}) + c(q^r)$. For future use, we note that from the definition of $\widehat{v}$:

$$\frac{d\widehat{v}}{dq^r} = \frac{c'(q^r)}{q(\widehat{v}) - \underline{q}} > 0. \tag{6}$$

In words, if the recommended quality increases, the total surplus in the public sector increases and thus more consumers stay in the public system.

For $v > \widehat{v}$ Nash bargaining yields the efficient quality $q(v)$ and a price $p(v)$. The consumer's utility is $vq(v) - p(v)$, and the moonlighter's utility is $p(v) - c(q(v))$. The price $p(v)$ determines the split of the surplus above the threat point utilities in the ratio α to $1-\alpha$ for the consumer and the moonlighter.

To summarize, if a consumer is matched with a dedicated doctor, she obtains service with quality q^r at the public facility. If a consumer with valuation v below $\widehat{v}$ is matched with a moonlighter, she is not offered the private practice option, and receives treatment at quality $\underline{q}$. If her valuation is above $\widehat{v}$, the moonlighter offers the private practice option, and she accepts it. In this case, the consumer obtains the service at quality $q(v)$ and pays the moonlighter $p(v)$. The price-quality pair $(p(v), q(v))$ is determined by the Nash bargaining solution described above.

We can now write down the social welfare under moonlighting:

$$D\int_{\underline{v}}^{\overline{v}} (vq^r - c(q^r))f(v)dv + M\int_{\underline{v}}^{\widehat{v}} (v\underline{q} - c(\underline{q}))f(v)dv + M\int_{\widehat{v}}^{\overline{v}} S(v)f(v)dv - \lambda c(q^r)\left[D + MF(\widehat{v})\right] \tag{7}$$

where $\widehat{v}$ satisfies (5). Because the price $p(v)$ is a transfer between the consumer and the moonlighter, it does not appear in the social welfare expression above. The three integrals describe respectively the social surplus for the consumers who are matched with dedicated doctors, consumers matched with moonlighters and obtaining services in the public sector, and consumers obtaining services in the moonlighters' private practices. The last term is the cost of public funds; because those moonlighters who match with consumers with $v > \widehat{v}$ opt out of the public sector, only $F(\widehat{v})$ of the moonlighters receive funds from the regulator.

Maximizing (7) with respect to q^r, we have the first-order condition

$$D\int_{\underline{v}}^{\overline{v}} vf(v)dv = (1+\lambda)Dc'(q^r) + \lambda MF(\widehat{v})c'(q^r) + Mf(\widehat{v})\frac{d\widehat{v}}{dq^r}\left[S(\widehat{v}) - \widehat{v}(\underline{q}) + c(\underline{q}) + \lambda c(q^r)\right]$$

and using the definition of $\widehat{v}$, we write the first-order condition as

$$D\int_{\underline{v}}^{\overline{v}} vf(v)dv = (1+\lambda)Dc'(q^r) + \lambda MF(\widehat{v})c'(q^r) + (1+\lambda)Mf(\widehat{v})\frac{d\widehat{v}}{dq^r}c(q^r) \tag{8}$$

To compare the equilibria across the two regimes (where moonlighting is and is not allowed), we use the corresponding first-order conditions (2) and (8). In general, when moonlighting is allowed, the equilibrium recommended quality level can become lower or higher than when moonlighting is disallowed. Once moonlighting is allowed, only a fraction of moonlighters are being paid by the regulator: so the term $\lambda M c'(q^r)$ in (2) is reduced to $\lambda M F(\widehat{v}) c'(q^r)$ in (8). Nevertheless, a new and positive term $M f(\widehat{v}) \frac{d\widehat{v}}{dq^r}(1+\lambda)c(q^r)$ appears in (8).

We now explain the new tradeoff for the determination of the equilibrium recommended quality under the moonlighting regime. There are two effects under moonlighting. First, and perhaps the obvious one, is the departure of some consumers from the public sector. The regulator saves some cost of social funds because the moonlighters are treating these consumers in the private sector. This is the reduction of the term $\lambda M c'(q^r)$ in (2) to $\lambda M F(\widehat{v}) c'(q^r)$ in (8): only $F(\widehat{v})$ of the moonlighters will be paid by the regulator when moonlighting is allowed. This *cost saving* effect reduces the cost of implementing a given level of the recommended quality, and tends to raise the recommended quality in the public sector.

There is, however, a second effect when moonlighting is allowed. The public sector provides services to consumers free of charge (or at a low nominal fee) so every consumer demands some service. Yet, the quality q^r costs resource $c(q^r)$, with a total social cost of $(1+\lambda)c(q^r)$. Without the moonlighting option, the regulator cannot avoid this consumer *moral hazard effect*, which acts opposite to the cost saving effect. Nevertheless, with moonlighting, consumer moral hazard may be avoided. A consumer opting out of the public system will pay a price to the moonlighter, and the quality is supplied efficiently. The last term of (8) measures the marginal social cost of raising recommended quality q^r: increasing the recommended quality by one unit increases the number of consumers being serviced in the public sector by $M f(\widehat{v}) \frac{d\widehat{v}}{dq^r}$, and this costs $(1+\lambda)c(q^r)$. This new and extra marginal cost tends to reduce the recommended quality q^r.

Clearly, whether moonlighting leads to a lower recommended quality in the public sector depends on the balance of the cost saving and moral hazard effects. When $\lambda = 0$, there is no cost in the use of public funds, and the cost saving effect vanishes; in this case, the equilibrium recommended quality decreases when moonlighting is allowed. As λ grows, then the cost of public funds becomes more important, and it is possible that the recommended quality level becomes higher when moonlighting is allowed.

Allowing moonlighting always improves aggregate welfare. In fact, it is always possible to implement a Pareto improvement. That is, it is always possible to switch to moonlighting and increase each player's expected utility evaluated before a consumer is matched with any doctor. The regulator can simply leave the recommended quality level unchanged when moonlighting is allowed. Then all consumers who are treated in the public sector get the same surplus as when there is no moonlighting, the moonlighters and dedicated doctors get the same utility for services provided in the public sector, and moonlighters and consumers who opt out of the public system are both strictly better off. Finally, since less treatments are conducted in the public system, less public funds are needed for care. We should note that we have assumed that the regulator pays the same fee to a doctor whether they have or do not have a private practice. If the regulator had the possibility of paying a moonlighter a lower fee for the right to have a private practice, welfare would improve even more.

The regulator actually will *not* leave the recommended quality level unchanged. The level will be adjusted according to the magnitudes of the cost saving and moral hazard effects. Again, the first effect favors a higher recommended quality since less social costs are incurred in the public system, while the second favors a lower recommended quality since there is an efficiency gain when consumers opt out of the public system. Allowing moonlighting is a Pareto improvement if the equilibrium recommended quality increases from the equilibrium in the regime when moonlighting is disallowed. Nevertheless, moonlighting may result in a fall of the recommended quality, which hurts those consumers who are treated at the public system by a dedicated doctor. We now collect the above results in the following proposition.

Proposition 1 *Allowing moonlighting has the following consequences:*

1. *Aggregate welfare improves.*
2. *The equilibrium recommended quality level in the public sector may increase or decrease.*
3. *If the recommended quality increases, moonlighting is a Pareto improvement: all consumers and all moonlighters enjoy higher expected utilities.*
4. *If the recommended quality decreases, consumers who continue to use the public sector become worse off, while consumers who have sufficiently high valuation are better off.*
5. *If the cost of public funds is zero, the recommended quality always falls.*

We have used a static model and the Nash bargaining solution to describe the moonlighting outcome. In the next two sections we consider alternative assumptions, and demonstrate that in fact the welfare properties of moonlighting rely on very weak requirements.

4 Dynamic Model

Presently, we investigate a dynamic model. There are now potentially an unlimited number of periods during which a consumer may receive medical treatment; the static model in the previous section describes a typical period. A doctor is matched with one and only one consumer in a period. A consumer who is not matched with any doctor, or who refuses treatment after being matched may wait until the following period. If a consumer is treated, she leaves the market, and another consumer replaces her in the next period. There is a common discount factor δ. We examine steady state equilibria in which all consumers receive treatment in the period that they are first matched.

4.1 Equilibrium when Moonlighting is disallowed

First, we derive the equilibrium when moonlighting is not permitted. If the consumer is matched with a moonlighter, the moonlighter is free to offer any quality to her.[9] Consider an equilibrium in which the recommended quality is q^r and the moonlighter offers quality q^m, where the quality may depend on the consumer's valuation of quality. Because a moonlighter is assumed to be matched with only one consumer each period, his offer will be the minimum quality to keep the consumer from waiting till the next period.

Let $U(v)$ be the equilibrium expected utility of a consumer with valuation v at the beginning of a period before she is matched with any doctor. The value function $U(v)$ is

$$U(v) = \frac{Dvq^r}{N} + \frac{M}{N}\delta U(v) + \left[1 - \frac{D+M}{N}\right]\delta U(v).$$

The first term is the consumer's utility if she is matched with a dedicated doctor, who provides treatment at quality q^r. The second term is her utility if she is matched with a moonlighter, who offers her a treatment quality so that she is indifferent between staying and seeking care again next period; the final term represents no match this period. Each of these terms is weighted by the probability of the respective event.

[9] If we restricted the moonlighter to only offering qualities at least $\overline{q}$, then all our results would still hold. We use this formulation for expositional ease.

Solving for the value function, we obtain

$$U(v) = \frac{vq^r D}{(1-\delta)N + \delta D}.$$

From this, and the fact that the moonlighter's quality must be given by $vq^m = \delta U(v)$, we obtain

$$q^m = \left[\frac{\delta D}{(1-\delta)N + \delta D}\right] q^r \tag{9}$$

which is less than q^r and turns out to be independent of consumer valuations. A moonlighter must offer a consumer a fraction of the recommended quality q^r to retain her.

The welfare in the dynamic model without moonlighting is

$$D \int_{\underline{v}}^{\overline{v}} [vq^r - c(q^r)] f(v) dv + M \int_{\underline{v}}^{\overline{v}} [vq^m - c(q^m)] f(v) dv - \lambda [D + M] c(q^r)$$

Maximizing this with respect to q^r under the constraint (9), we obtain the first-order condition

$$D \int_{\underline{v}}^{\overline{v}} v f(v) dv = (1+\lambda) D c'(q^r) + \lambda M c'(q^r) - \frac{\delta M D}{(1-\delta)N + \delta D} \int_{\underline{v}}^{\overline{v}} \left[v - c'(q^m)\right] f(v) dv. \tag{10}$$

The main difference compared to the static model, equation (2), is the moonlighter's improved quality, which leads to the last term in the first-order condition in (10).

4.2 Equilibrium Moonlighting

Next, we study moonlighting in the dynamic model. We begin by describing the bargaining between a consumer and a moonlighter. If there is no agreement between the moonlighter and a consumer for treatment in his private market, the moonlighter will offer to treat the consumer in the public system at a quality q^m. This gives the consumer a utility vq^m. She agrees to the treatment if and only if vq^m is at least equal to the discounted expected utility of waiting for one more period ($\delta U(v)$). If the consumer accepts this, the physician obtains $c(q^r) - c(q^m)$. Obviously, we only need to consider $q^m \leq q^r$; the moonlighter will not supply quality above q^r to keep the consumer in the public sector, since his payment would be less than his disutility of effort. For any service in the public system, the moonlighter will choose the lowest quality level to keep the consumer: $vq^m(v) = \delta U(v)$. If bargaining for treatment in the private sector breaks down, the consumer's (continuation) payoff is thus $\delta U(v)$, while the moonlighter's payoff is $c(q^r) - c(q^m(v))$, where $vq^m(v) = \delta U(v)$.

The total surplus in the public system available to the moonlighter and a consumer with valuation v is $\delta U(v) + c(q^r) - c(q^m(v))$. From Nash bargaining, if $S(v)$ is bigger than the surplus in the public system, the consumer will agree to receiving private treatment at quality $q(v)$, and paying a price to the moonlighter. Again, we assume that Nash bargaining splits the surplus above the disagreement-point utilities in the ratio α and $1-\alpha$ between the consumer and the moonlighter.

Consumers with lower values of v will not be offered the private practice option when they meet a moonlighter. Define this set of consumers as $v \in [\underline{v}, \widehat{v}]$. The value function for these types of consumers is exactly the same as that in the regime when moonlighting is disallowed:

$$U(v) = \frac{vq^r D}{(1-\delta)N + \delta D} \tag{11}$$

and the quality offered to them is given by (9).

The value function for those consumers who will agree with a moonlighter to use his private practice (those with $v \in [\widehat{v}, \overline{v}]$), is

$$U_H(v) = \frac{Dvq^r}{N} + \frac{M}{N}\left\{\delta U_H(v) + \alpha\left[S(v) - \delta U_H(v) - c(q^r) + c(q^m(v))\right]\right\} + \left[1 - \frac{D+M}{N}\right]\delta U_H(v). \tag{12}$$

The first term is the consumer's utility if she meets a dedicated doctor,[10] the second if she meets a moonlighter and opts out of the public system, and the last term the consumer's expected utility if she is not matched. Each utility is weighted by the probability of the corresponding event. We can rewrite (12) as

$$U_H(v) = \frac{vq^r D + \alpha[S(v) - c(q^r) + c(q^m(v))]M}{(1-\delta)N + \delta(\alpha M + D)}. \tag{13}$$

To determine $\widehat{v}$ we set (11) equal to (13), and after simplification, we get

$$\frac{\delta q^r D}{(1-\delta)N + \delta D} = \frac{[S(\widehat{v}) - c(q^r) + c(q^m(\widehat{v}))]}{\widehat{v}}, \tag{14}$$

where $q^m(\widehat{v})$ is given by (9). It then follows that there is a unique value for $\widehat{v}$ that is independent of the split of the surplus in a steady state equilibrium.

The welfare function with moonlighting in a steady-state equilibrium is

$$D\int_{\underline{v}}^{\overline{v}} [vq^r - c(q^r)]\, f(v)dv + M\int_{\underline{v}}^{\widehat{v}} [vq^m - c(q^m)]\, f(v)dv + M\int_{\widehat{v}}^{\overline{v}} S(v)f(v)dv - \lambda c(q^r)\left[D + MF(\widehat{v})\right],$$

where $\widehat{v}$ is determined implicitly by (14). The first-order condition with respect to q^r characterizes the optimal choice of the recommended quality. Compared with the static model, we find that

[10] We assume that the recommended quality is sufficiently high. This implies that those consumers with very high valuations would not prefer to be matched with a moonlighter in a future period.

there is an additional effect. Besides those that have been identified in the static model, (reduced cost of public fund, and the moral hazard effects), a choice of the recommended quality affects a consumer's decision to accept a moonlighter's offer or wait another period. The welfare results, and the reasoning behind them, are similar in the dynamic and static models. In particular, welfare is always higher and the recommended quality may be higher or lower when moonlighting is allowed. Welfare is higher since the regulator can always maintain the same quality as without moonlighting and consumers and moonlighters will only agree to use the private clinic if it is mutually beneficial.

5 Private Information and Moonlighting

We have assumed that when the consumer meets with a moonlighter, both share the same information. Nevertheless, when a moonlighter and a consumer negotiate under asymmetric information, must moonlighting increase welfare? We consider two alternative asymmetric information situations. First, only the consumers know their true valuations of quality. Second, a moonlighter knows the consumer's valuation, and only a fraction of the consumers are informed of their own valuations. Both are plausible assumptions and can be motivated readily. In the first case, consumers' valuations may be related to incomes which moonlighters may not know. In the second scenario, doctors have expert knowledge and information about consumers' illness; through diagnosis, they gain private information about the value of treatment. Although consumers also learn about the diagnosis, some patients may not fully understand and do not know their valuations

We now define the extensive form. Under each of the informational assumptions, the moonlighter makes an offer of a price-quality pair (or a menu of such pairs), which the consumer may accept or reject. If there is an acceptance, the treatment is provided by the moonlighter in the private sector under the terms of the offer. If there is a rejection, the moonlighter treats the consumer in the public system at the minimum quality $\underline{q}$, while the consumer incurs no cost.

We now argue that aggregate welfare becomes higher when moonlighting is allowed. The key of the argument is a consumer's option of rejecting the moonlighter's offer. Suppose that consumers' valuations are their own private information. A moonlighter's offer of price and quality will lead to either acceptance or rejection. A higher price leads to a higher profit but lower likelihood of acceptance; conversely, a higher quality leads to a lower profit but higher likelihood of acceptance. The moonlighter finds the optimal tradeoff to maximize his expected profit. Reacting against any moonlighter's offer optimally, a consumer must be better off accepting the moonlighter's offer than staying in the public system

Next, suppose that the moonlighter learns a consumer's valuation, but the consumer may be uninformed. Consider an equilibrium.[11] Here, an uninformed consumer must infer the moonlighter's private information given the moonlighter's price-quality offer (or menu of offers). In an equilibrium, the consumer must not be mistaken about the moonlighter's strategy. For example, in an equilibrium a moonlighter may make some offer of price and quality if and only if the consumer's valuation is above a certain threshold. Assuming this moonlighter strategy, the consumer infers that her valuation must be above the threshold, compares the expected utilities of remaining in the public system and opting out, and chooses among them optimally. If the consumer participates in moonlighting in an equilibrium, she must become better off.

To see that moonlighting must raise aggregate welfare under either of these informational regimes, again use the fact that the regulator can maintain the same equilibrium q^r as when moonlighting is banned. Whenever a consumer and a moonlighter mutually agree to opt out of the public system, there must be some mutually beneficial gain, and both must be better off. When the recommended quality remains unchanged, those consumers who remain in the public system are not made worse off. Welfare must increase in any equilibrium.

6 Physician Reactions and Price Regulation

We now enrich the model by considering other strategies that moonlighters and dedicated doctors may use. We have depicted moonlighting simply as permitting a physician in a public facility to refer a consumer for treatment in a private setting. Nevertheless, moonlighting may bring more complex effects, a worry that appears in policy discussions. In this section, we consider two such effects: shirking by moonlighters and adverse reactions by dedicated doctors. We then introduce price regulation in the private market as a policy counteracting these effects.

[11] There may be multiple equilibria. Our argument applies to each of them. There may also be trivial equilibria in which the moonlighting market is inactive, but our point is not to rank all equilibria when moonlighting is allowed.

6.1 Shirking by Moonlighters

In the basic model, the moonlighters always chose the minimum quality level when treating a consumer in the public system. We may interpret the moonlighter's quality in the public sector as the minimally acceptable level of care quality. We may reasonably argue that a moonlighter would be willing to subscribe to this care quality if moonlighting was infeasible. Nevertheless, when a doctor moonlights in the private market, he provides a higher quality there, and this may result in a "crowding-out" effect. To save time and energy for the private market, a moonlighter may decide to reduce the quality in the public sector below the acceptable level. Permitting moonlighting leads to a deterioration of quality in the public sector. Formally, this effect can be studied by lowering the level of $\underline{q}$ once moonlighting is allowed; we call this shirking in the public sector by moonlighters.

Our concern is not to measure the extent of shirking so that moonlighting becomes undesirable. Nor do we find it very important to install another margin for a moonlighter's choice of shirking which reflects precisely his cost-benefit tradeoff. Rather, we are interested in exploring the use of price regulation in the private market to limit shirking in the public sector. It is enough for our purpose to assume that the extent of shirking is directly related to the amount of potential profit a moonlighter can earn in the private sector. In other words, when moonlighting is permitted, a moonlighter will work harder in the private market when profit opportunities there are higher. As a result, he will shirk more in the public sector, hurting consumers there.

We consider a price-ceiling regulation: let $\overline{p}$ be the maximum price for health treatment in the private sector. When a moonlighter and a consumer agree to a treatment in the private market, they agree on the quality and the price, but the latter cannot be higher than $\overline{p}$. The price ceiling is a natural way to model the extent of the moonlighting-private market. If the ceiling is very low, the private market cannot be very active; alternatively, if the ceiling is high, moonlighters (and consumers) have more freedom to contract for private services.

We assume that a moonlighter shirks by an amount $\sigma(\overline{p})$ when the price ceiling is $\overline{p}$, where the shirking function σ is strictly increasing.[12] So given a price ceiling $\overline{p}$ in the private sector, a moonlighter provides services at the public sector at quality $\underline{q}-\sigma(\overline{p})$.[13] The higher the price ceiling,

[12]It may also be convex, but our analysis does not rely on this.

[13]For a sufficiently low price, the shirking is assumed to be zero. For what follows, we will assume that the price ceiling is higher than this value.

the more flexibility there is for private contracting, and the higher the moonlighter's opportunity cost of providing services in the public sector.

Now we study moonlighting equilibria when prices in the private market must not exceed the ceiling. We begin by modifying the Nash bargaining solution. As before, if a moonlighter and a consumer fail to agree on a contract for private service, the moonlighter will provide service in the public sector. Now the quality of this service will be $\underline{q} - \sigma(\overline{p})$. At the disagreement point, the moonlighter's payoff is $c(q^r) - c(\underline{q} - \sigma(\overline{p})) \equiv D_m$, while the consumer's is $v(\underline{q} - \sigma(\overline{p})) \equiv D_c$. If there is an agreement, the moonlighter provides treatment at quality q at a price $p \leq \overline{p}$. The Nash bargaining outcome (p, q) is characterized by the solution of the following maximization program:

$$\max_{p,q} \ \alpha \ln (vq - p - D_c) + (1 - \alpha) \ln \{p - c(q) - D_m\} \tag{15}$$

subject to $p \leq \overline{p}$. The following presents the Nash bargaining outcomes.[14]

Lemma 1 *For low values of v, the price ceiling does not bind, and the quality is efficient: $v = c'(q)$; the quality is increasing in v. For those values of v higher than a threshold, the price ceiling binds, and the quality becomes inefficiently low: $v > c'(q)$; the quality is decreasing in v beyond the threshold.*

Proof. The properties of the Nash bargaining solution for low values of v follow directly from those properties of the solution when there is no price ceiling. To derive the properties when the ceiling binds, consider now the Kuhn-Tucker conditions with respect to p and q respectively:

$$\frac{-\alpha}{vq - \overline{p} - D_c} + \frac{1 - \alpha}{\overline{p} - c(q) - D_m} > 0 \tag{16}$$

$$\frac{\alpha v}{vq - \overline{p} - D_c} - \frac{(1 - \alpha)c'(q)}{\overline{p} - c(q) - D_m} = 0. \tag{17}$$

The inequality (16) comes from the binding price ceiling $\overline{p}$; the equality (17) describes the Nash bargaining solution for q. Combining these two yields the inequality $v > c'(q)$. To see that the Nash bargaining solution prescribes a q decreasing in v in this range, observe that the cross partial derivative of the objective function (15) with respect to q and v is negative. This can be confirmed by differentiating the left-hand side of (17) (which is the derivative of (15) with respect to q) with respect to v to obtain:

$$\frac{-\alpha(\overline{p} + D_c)}{(vq - \overline{p} - D_c)^2} < 0.$$

[14] Lemma 1 and Proposition 2 hold for any q^r as long as some patients are referred by the moonlighter.

So an increase in v will decrease q. ■

When the value of v is low, consumers and moonlighters will not be restricted by the price ceiling $\overline{p}$. They will be able to agree on an efficient quality level ($v = c'(q)$), and the corresponding price to split the surplus among themselves will be below $\overline{p}$. As the value of v increases, the efficient quality and the price both rise. Beyond some threshold, the price ceiling becomes binding: the price must not rise above $\overline{p}$ even for higher values of v. Nevertheless, a higher value of v implies a bigger surplus—even when q remains constant. The Nash bargaining solution insists on splitting the surplus (above the disagreement point) in a fixed ratio. So the value of q in the agreement must begin to fall so that the moonlighter's utility, $\overline{p} - c(q)$, may increase.[15]

Once the price ceiling binds, the extent of inefficiency is increasing in v. The lower the ceiling, the more likely that moonlighter will supply inefficient quality to consumers in the private market. On the other hand, a lower price ceiling implies less shirking in the public market. This is the tradeoff that a price ceiling introduces.

We can describe the aggregate welfare given a price ceiling $\overline{p}$. There will be two consumer thresholds, $\widehat{v}$ and $\widetilde{v}$ with $\widehat{v} \geq \widetilde{v}$. Consumers will be offered a private practice option if and only if their valuations satisfy $v \geq \widehat{v}$. For those consumers with $v \geq \widehat{v}$, there are two possibilities. If their valuations are not very high, $v < \widetilde{v}$, the price ceiling does not bind, and they receive the efficient quality from the moonlighters in the private market. If their valuations are high, $v > \widetilde{v}$, they receive an inefficient quality from the moonlighters given by (17). We will use $S^{\dagger}(v)$ to denote the total surplus generated in the private market when the price ceiling binds. The social welfare under moonlighting is:

$$D\int_{\underline{v}}^{\overline{v}} (vq^r - c(q^r))f(v)dv + M\int_{\underline{v}}^{\widehat{v}} (v\underline{q} - c(\underline{q} - \sigma(\overline{p})))f(v)dv +$$
$$M\left[\int_{\widehat{v}}^{\widetilde{v}} S(v)f(v)dv + \int_{\widetilde{v}}^{\overline{v}} S^{\dagger}(v)f(v)dv\right] - \lambda c(q^r)\left[D + MF(\widehat{v})\right].$$

Clearly, from the above, the imposition of the price ceiling represents an intermediate institution of the two polar regimes where the moonlighting practice is completely banned, and where it is uncontrolled. If the price ceiling is high, moonlighters freely contract with consumers in the private market, resulting in high efficiency there, but this implies a high level of shirking by moonlighters

[15] Consumers with high v will not prefer to forgo the private market opportunity even when they receive inefficient quality from moonlighters. The reason is that the total surplus is increasing in v and the moonlighters receive only a fraction of the incremental surplus.

in the public sector. If the price ceiling is low, moonlighters do not find it very worthwhile to participate in the private market, but the level of shirking in the public system will be minimal. An optimal choice of the price ceiling balances the inefficiency in the quality for consumers with high valuations against the lower quality received by consumers with lower valuations who are treated by moonlighters in the public sector. To see why a price ceiling will be imposed, take the highest price when it is binding. This will only effect the highest type consumers and will be a second order loss. On the other hand, since the amount of reduction in shirking is a first order gain, due to it affecting all consumers below $\widehat{v}$ times the reduction in shirking, welfare is improved.[16] Thus, we have the following result

Proposition 2 *Suppose moonlighters may shirk by lowering quality below $\underline{q}$, and the amount of shirking is directly related to the maximum price they can charge in the private sector. There exists a price ceiling $\overline{p}$ in the private market such that social welfare is higher than when either moonlighting is banned or when moonlighting is allowed without any price restriction.*

6.2 Adverse Reaction by Dedicated Doctors

Moonlighting may affect dedicated doctors' behavior. Seeing that some colleagues earn more money from private practice, a dedicated doctor may feel unappreciated. The dissatisfaction may lead him to refuse to perform the recommended quality. We model the adverse reaction by postulating that a fraction γ of the dedicated doctors become moonlighters; they provide quality $\underline{q}$ in the public sector, and self-refer consumers to the private sector.[17] As in the previous subsection, we consider price regulation and assume that the dedicated doctors' defection rate γ depends positively on the price ceiling $\overline{p}$ in the private market. This assumption can be motivated similarly: profit opportunities in the private sector are "temptations" that lure dedicated doctors to consider moonlighting.

Allowing moonlighting changes the total number of physicians participating in the private market. Suppose that under the price ceiling $\overline{p}$, a fraction $\gamma(\overline{p}) > 0$ of dedicated doctors offer only

[16] A sufficient condition for an effective price ceiling is that $F(\widehat{v})\sigma'(\overline{p}) > f(\overline{v})[S^*(\overline{v}) - S^\dagger(\overline{v})]$ at the price at which the ceiling begins to bind. This condition is satisfied, since $S^*(\overline{v}) - S^\dagger(\overline{v})$ is infintesimal at the highest effective price ceiling.

[17] An alternative assumption is that a fraction of the dedicated doctors choose to act like moonlighters in the public system but they do not practice in the private sector. The qualitative results are the same as with the approach that we use.

quality $\underline{q}$ to consumers in the public sector. Social welfare in this case is

$$[1-\gamma(\overline{p})]D\int_{\underline{v}}^{\overline{v}}(vq^r-c(q^r))f(v)dv+[M+\gamma(\overline{p})D]\int_{\underline{v}}^{\widehat{v}}(v\underline{q}-c(\underline{q}))f(v)dv+$$

$$[M+\gamma(\overline{p})D]\left[\int_{\widehat{v}}^{\widetilde{v}}S(v)f(v)dv+\int_{\widetilde{v}}^{\overline{v}}S^{\dagger}(v)f(v)dv\right]-\lambda c(q^r)\left\{[1-\gamma(\overline{p})]D+[M+\gamma(\overline{p})D]F(\widehat{v})\right\}.$$

In this expression, only $1-\gamma(\overline{p})$ of the dedicated doctors provide services at the recommended quality level; this accounts for the first term. The next two terms are the welfare generated by the moonlighters and those dedicated doctors who have become moonlighters. The last term is the social cost of public funds: the first part is due to the payment to the dedicated doctors, while the second part accounts for the total payment for services provided by moonlighters and those dedicated doctors who provide minimal quality at the public sector.

An intermediate price ceiling dominates either uncontrolled or banned moonlighting regimes. At a very high price ceiling, the moonlighting market is unrestricted. Suppose that γ has reached its maximum at this price ceiling. Now lower the price ceiling so that the private market is constrained, and at the same time the number of dedicated doctors who defect begins to decrease (that is γ begins to fall). There is a welfare loss in the private market because of the binding price ceiling. This, however, is a second-order loss because the quality has been chosen efficiently when the price ceiling begins to bind. The increase of the quality in the public sector by dedicated doctors who have decided not to moonlight is a discrete increase from $\underline{q}$ to q^r, a first-order gain. Welfare must improve with the decrease of the price ceiling.

Our arguments apply directly under less restrictive assumptions on dedicated doctors' adverse reaction. For example, they may choose to provide quality in the public sector strictly above the minimum $\underline{q}$ (but strictly less than q^r). In summary, we have the following:

Proposition 3 *Suppose that dedicated doctors may react to moonlighting adversely by reducing quality in their public service and by participating in moonlighting, and that the percentage of dedicated doctors who react adversely is directly related to the price ceiling in the private market. Moonlighting under a price ceiling results in a higher social welfare than when either moonlighting is banned, or when moonlighting is allowed without any price restriction.*

7 Concluding remarks

We have analyzed a model where some physicians may refer a patient in the public system to their private practice. These moonlighters provide minimal quality when they treat patients in the public system. Not all physicians moonlight, however; some dedicated doctors provide good services in the public system. We showed that absent behavioral reactions, unregulated moonlighting raises social welfare. Moonlighting may have an ambiguous effect on qualities in the public system; some consumers may become worse off when they are treated in the public system due to physician moonlighting. Our results are based on the gains from trade in the private market. Multiperiod and asymmetric information considerations do not alter these results. If there are adverse behavioral reactions by physicians, setting a price ceiling in the private sector improves welfare by mitigating these reactions, even though it reduces the efficiency of the moonlighting option.

Physicians in our model exhibit various behaviors; in reality, the range of these behaviors can be even wider. For example, when moonlighting is allowed, some dedicated doctors may choose not to moonlight, but still reduce the quality in the public sector; or they may moonlight but continue to provide good quality in the public system. Our main qualitative features would hold under each of these reactions.

We can use the model as a framework to study creaming problems. While we have concentrated on quality efficiency issues, cost variations have been ignored. Physicians referring less costly patients to their private clinics may well be among the consequences of moonlighting. Referrals can also occur in the opposite direction. A moonlighter who sees a patient in his private practice may refer her to the public system because her treatment cost is too high. Selection of patients and the distribution of their costs across the public and private sectors can be examined.

There are other directions that our framework can be used to study moonlighting. First, moonlighting may also change the total physician supply; some doctors may quit the public service altogether. We may also consider how moonlighters compete with other physicians who only work in the private sector. Our modelling approach can accommodate these considerations. It would be interesting to analyze such a model with simultaneous market clearing. Second, while we have considered price ceilings in the private sector, moonlighting restrictions may come from maximum quantities of private services that can be performed over a period of time. Alternatively, physicians may be limited by a maximum income they can earn through moonlighting. Finally, we have not considered complementary inputs (such as nurses and medical supplies) and technologies. In some countries, technology in the public sector is thought to be superior than the private sector; complementary inputs may also be better there. On the other hand, waiting time in the public system is longer. Opting out of the private market may result in shorter waiting time, but treatment protocols with less complementary services. Moonlighting lets consumers and physicians explore tradeoffs in different dimensions.

Although we have given some motivation for the role of the public sector (such as risk sharing, social insurance and equity), the paper does not offer a foundation for why the public and private sectors must coexist. Our idea here highlights the incentive perspective when the public and private sectors interact.[18] It also hints at a potential role for the public sector as a workplace to attract dedicated workers. Integrating these ideas in a model for the public sector may be interesting.

As we have commented in the introduction, the theoretical literature on dual job incentives in the mixed economy is small. We have studied referral and quality questions. We hope that other researchers will find our model useful for thinking about other questions concerning moonlighting in the mixed economy.

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[18] Ma (2004) considers how public rationing may increase private incentives for cost efficiency.

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