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Regulating An Experience Good In Developing Countries When Consumers Cannot Identify Producers[1]

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Abstract

In developing countries, consumers can buy many goods from either the formal sector or the informal sector and choose the sector to patronize based on the product's price there and anticipated quality. We assume that firms can produce in either sector and can adjust quality at a cost. In the long run, firms produce in the sector that is more profitable. As for the consumers, we assume they cannot assess quality prior to purchase and cannot, at a reasonable cost, identify the producer of what they are purchasing. Many products (meats, fruits, vegetables, fish, grains) sold both in formal groceries and, less formally, on the street fit this description. Using this model, we investigate how a change in regulations in the formal sector affects quality, price, aggregate production and the number of firms in each sector.

Keywords: experience good, formal sector, informal sector, quality
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1 Introduction

In his V.V. Giri Memorial Lecture, Ravi Kanbur (2009) discusses the "informality discourse" in the development literature and makes several constructive suggestions. Kanbur notes that the literature would benefit from a more precise specification of the regulations imposed in the formal sector as well as from a recognition that such regulations on firms in the formal sector may induce them to "adjust activity to move out of the ambit of the regulation."

We adopt his suggestions. We consider two regulations. For each policy, we consider (1) its "short-run" effects before firms can change sectors and (2) its "long-run" effects after firms have had an opportunity to switch sectors. We note that a government regulation need not induce firms to *flee* to the informal sector but instead might *attract* them away from that sector.

Regulation of the formal sector affects the informal sector because the two sectors are not isolated from one another. As Kanbur emphasizes, firms can choose whether to locate in one sector or the other. In addition, consumers are free to patronize one sector or the other. Finally, workers can choose a job in the formal sector or a job in the informal sector. Indeed, economic agents often participate *simultaneously* in both sectors, as Keith Hart, who introduced the term "informality" to the literature, notes in his pioneering study of Ghana's economy: "Everyone in Accra, but especially the inhabitants of the slum where I lived, tried to *combine* the two sources [from the formal and informal sectors] of income" (2006).

The economics literature on the formal and informal sectors has long recognized that regulating the formal sector will have spillover effects. Most recently, Marjit and Kar (forthcoming) consider a Hecksher-Ohlin-Samuelson (HOS) model with each good produced in both the formal and informal sectors and show that a decline in tariff rate

should increase the informal wage in a developing economy.

In the standard HOS model, however, the goods produced and traded are of uniform quality. Firms may produce guns or butter and, in the extended models, each good may be produced in both a formal and an informal sector. But all the butter is of uniform quality. Firms cannot alter this quality, and consumers are certain this quality will be provided.

We depart from these assumptions. We focus instead on experience goods—goods the quality of which cannot be determined prior to purchase. However, unlike Akerlof (1970), we assume that firms choose quality endogenously. Moreover, we focus on a class of experience goods that, although pervasive, has received relatively little attention: where the consumer cannot determine at reasonable cost who produced the good. Of course, consumers in developed countries encounter such goods every day. When we buy a Washington apple, we do not know how it will taste and we cannot ascertain what orchard produced it. Moreover, globalization has raised the frequency with which consumers in developed countries encounter such products, as we discuss elsewhere (McQuade et al. 2010). But in developing countries, consumers encounter such goods not only in stores that are subject to government regulation, but also on the street in the "informal market."

Consumers in developing countries often have concerns about the goods they purchase. Fruits, vegetables, meats, fish, grains, coffee beans, videos, and other goods are sold both in stores subject to government regulation and on the street in the informal market. The quality (both the taste and the health consequences) of consuming these goods is uncertain prior to purchase; often the purchase must be made without knowing who grew or manufactured the product. Cooking oil in India is sold both in groceries and on the street. In either case, a consumer does not know whether it has been adulterated, nor is the source of the oil easy to determine. The same is true of

maize in Kenya. A consumer can buy it in a grocery or on the street. But in either case, there is uncertainty about whether it has been stored improperly and become contaminated with aflatoxin, a fungus that cannot be detected by casual visual inspection. Panela, a sugar produced in massive quantities in Colombia and elsewhere in Latin America, is another example of a good sold in both formal and informal markets. In each case, the quality is impossible to ascertain prior to purchase, and any of a large set of households or firms might have produced it.

The problem faced by producers of such experience goods is formidable. They know the quality of the goods they produce. But they realize that there is no way for potential buyers to distinguish the quality of *their* product from the quality of the other products lumped together in the consumer's mind. They recognize, therefore, that they share a "collective reputation." Not surprisingly, a producer does not have as much incentive to make a product of high quality as he would if consumers distinguished his products from those of his competitors.

Klein and Leffler (1981) and Shapiro (1983) consider markets for experience goods, but their analyses are confined to packaged or branded experience goods that enable the consumer to determine the identity of the producer. In the steady state of Shapiro's model, some firms specialize in one quality and receive one price, and other firms specialize in a different quality and receive different prices. In these formulations, one firm's quality choice has no effect on another firm's future reputation for quality.

The literature on "collective reputation" investigates the situation where it is costly for firms to improve the quality of the experience goods they produce and where consumers cannot distinguish the products of different firms (or farms). As a result, all firms sell at a common price and share a common reputation for quality. The first paper in this literature was Winfree and McCluskey (2005).[1] In their model, output

[1]Tirole (1996) coined the term "collective reputation" and was the first to analyze the phenomenon.

is exogenous, entry is prohibited, and firms are constrained to offer a single quality. Under these assumptions, Winfree and McCluskey show that when firms share a collective reputation, they have an incentive in the steady state of their dynamic model to free ride and to produce low-quality goods. In a recent working paper, Rouvière and Soubeyran (2008) retain the assumption of a fixed output and the constraint that firms choose a single quality but permit entry. They show that free riding causes entry into the market to be suboptimal.

In this paper, we consider n producers of an experience good, selling to heterogeneous consumers. Firms choose whether to sell entirely in the formal market or entirely in the informal market. The firms in the formal market are subject to government regulation, whereas firms in the informal market are unregulated. Consumers may patronize either market (or neither market). Consumers cannot judge the quality of the goods prior to purchase and cannot, at reasonable expense, determine the identity of the producer. However, consumers can identify whether the good comes from the formal or the informal market. In equilibrium, the experience good sells for one price in the formal market and a possibly different price in the informal market. The reputed quality of the experience good may differ in the two markets. We consider both the short-run equilibrium and the long-run equilibrium. In the short run, firms remain in an exogenously designated market. In the long run, firms move to the more profitable market. In the short-run equilibrium, the quantity and quality choices of each firm form a Nash equilibrium. In addition, in the long run, firms migrate until profits equalize in the two sectors.[2]

However, his focus was not on the strategic interaction of firms but on the reputations of workers. In Tirole's formulation, an agent's own past behavior is imperfectly observed, and he is assessed not only on the basis of his own past actions but also on the collective past actions of others. In contrast, past behavior of our firms is not observed and they have no individual reputations, only a collective one.

[2]One can interpret the long-run equilibrium as a prior stage in a two-stage game where each of the n firms decides whether to locate in the formal or the informal sector.

In the next section, we introduce our model. In section 3 we discuss the effects of each regulation on the two sectors in the short and long run. Section 4 concludes.

2 Model

We consider a country in which there is both a formal (F) and an informal (I) market for a good. The formal market is visible to the government and is subject to the regulations imposed upon it. Conversely, the informal sector consists of firms that are invisible to the government and are not subject to any of the regulations constraining the actions of the formal sector. We suppose that there are n producers of the final good, who allocate themselves between the formal and informal sectors. We take n to be even and allow for continuous adjustment of the number of firms.[3] Each firm, denoted by i, in sector j for $j \in \{F, I\}$ sets quality $k_{ij} \in [0, \infty)$ and quantity $q_{ij} \in [0, \infty)$ simultaneously.

Consumers form independent views about the quality of the goods emanating from the formal and informal markets but cannot trace a good to a particular firm within a sector. In other words, firms in a particular sector share a collective reputation on quality with the other firms in the sector. To be precise, firms in sector j develop a reputation for quality equal to the quantity-weighted average of their qualities:

$$R^j = \sum_{i=1}^{n_j} \frac{q_{ij}}{Q^j} k_{ij} \tag{1}$$

where n_j is the number of firms in sector j and Q^j is the total quantity of the good produced by sector j. Because consumers cannot distinguish firms within sector j,

[3] We make this assumption only for tractability. Allowing for an odd number of firms or considering measure-theoretic analyses where firms are infinitesimal in size changes none of the qualitative results and serves only to add unimportant technical considerations.

every firm operating in a given market sells its experience good at the same price (P^j), and the merchandise of every firm has the same reputed quality (R^j).

We specify consumer utility to generate an inverse demand curve for each sector that is strictly increasing in that sector's reputed quality, strictly decreasing and strictly concave in the total output of the two sectors, and additively separable in the two variables. In particular, we assume that every consumer gets net utility u from purchasing one unit of the experience good of reputed quality R at price p: $u = \theta R - p$. Consumers can purchase a substitute that provides a reservation utility, and they buy the experience good if and only if it provides higher net utility than the outside option. We assume that consumers have the same θ but differ in their reservation utilities.

Consumers observe the reputations for quality of the formal and informal sector, respectively. The price they pay depends on the aggregate supply of the experience good in the two sectors. Suppose that, given the distribution of reservation utilities, a utility of $U(Q)$ must be offered to attract Q customers to the experience good. We assume that $U(Q)$ is strictly increasing, strictly convex, and twice differentiable and that $U(0) = 0$. $U(Q)$ is not the utility function of a single consumer, but rather reflects the distribution of the reservation utilities of the heterogeneous consumers.[4] Price adjusts in each sector such that consumers are indifferent about whether they purchase the experience good on either the formal or informal market. Every purchaser receives the same net utility $U(Q)$. Inframarginal buyers strictly prefer the experience good to their outside option while the marginal buyer is indifferent between the experience good and the outside option since both yield net utility $U(Q)$. More formally, let the

[4]Formally, let μ be a σ-finite measure on $[0, \infty)$. Define $Q(U) = \int_0^U d\mu$. We assume that $Q(0) = 0$ and that $Q(U)$ is twice differentiable, strictly increasing, and strictly concave. Let $U(Q) \equiv Q^{-1}(U)$.

inverse demand of sector j $(j = F, I)$ be given by

$$P^j(Q, R^j) = \begin{cases} \theta R^j - U(Q); \text{ if } Q < U^{-1}(\theta R^j) \\ 0; \qquad\qquad \text{if } Q \geq U^{-1}(\theta R^j) \end{cases} \tag{2}$$

Hence, we can see that the inverse demand curve is additively separable over the set $\{(Q, R^j)|Q < U^{-1}(\theta R^j)\}$.

Suppose *ex-ante* there are n_F firms registered in the formal market and n_I firms participating in the informal market. Also suppose for the moment that no regulations have been placed on firms in the formal sector. Consider the game where each firm i $(i = 1, \ldots, n_j)$ in sector j $(j = F, I)$ simultaneously chooses its output and quality to maximize the following payoff function:

$$q_{ij}[P(q_{ij} + Q_{-ij}, R^j) - c(k_{ij})] \tag{3}$$

where $c(\cdot)$ is a strictly increasing, convex cost function for $k_{ij} > 0$; in addition, $c(0) = c'(0) = 0$.

When the other firms in sector j are producing $(Q_{-ij} > 0)$, then the reputed quality of sector j is well defined whether or not firm i is producing. Hence, equation (3) is well defined. When no firm in sector j is producing, however, the reputed quality of that sector is ambiguous, and we *define* the profit of firm i, given in equation (3), as zero. This assignment never conflicts with (3), as that equation, evaluated at $q_{ij} = 0$, gives the same result when $Q_{-ij} > 0$ and is undefined when $Q_{-ij} = 0$.

Because firm i maximizes profits, its decisions must satisfy the following pair of complementary slackness (denoted c.s.) conditions for $Q_{-ij} > 0$:

$$q_{ij} \geq 0, \ \theta R^j - U(Q) - c(k_{ij}) - q_{ij}U'(Q) + q_{ij}\theta\frac{\partial R^j}{\partial q_{ij}} \leq 0, \text{ c.s.} \tag{4}$$

$$k_{ij} \geq 0,\ q_{ij}[\theta \frac{\partial R^j}{\partial k_{ij}} - c'(k_{ij})] \leq 0,\ \text{c.s.} \tag{5}$$

where, from (1), $\frac{\partial R^j}{\partial k_{ij}} = q_{ij}/Q^j$ and $\frac{\partial R^j}{\partial q_{ij}} = (k_{ij} - R^j)/Q^j$. We assume that the profit function of each firm, given the other firms' strategies, is pseudoconcave.[5] We can establish the following result:

Theorem 2.1 *There exist nontrivial Nash equilibria.*[6] *Each includes at least one active sector, and across all equilibria the same sectors are active. Finally, in each active sector j, every producer of the experience good sells the same unique, strictly positive amount ($q_{ij} = q_j > 0$, for all i) at the same unique, strictly positive quality ($k_{ij} = k_j > 0$, for all i).*

Proof See Appendix A.

It follows from Theorem 3.1 that $\frac{dR^j}{dk_{ij}} = \frac{1}{n_j}$ and $\frac{dR_j}{dq_{ij}} = 0$. We will focus on the case in which both the formal and informal markets are operating.[7]

We can rewrite the first-order conditions (4) and (5) as follows:

$$\theta R^j - U(Q) - c(k_j) - q_j U'(Q) = 0 \tag{6}$$

and

$$\theta \frac{1}{n_j} - c'(k_j) = 0 \tag{7}$$

Equation (6) is a familiar Cournot first-order condition. It indicates that the firm should increase production until its per-unit profit from expanding output by another unit ($\theta R^j - U(Q) - c(k_j)$) just equals the losses ($q_j U'(Q)$) this expansion would impose

[5] Although we have assumed a specific functional form for the profit function, the set of functions that are pseudoconcave is nonempty. The condition should be satisfied as long as $U(Q)$ and $c(k)$ are sufficiently convex.

[6] Trivial equilibria are those in which firms receive a price of zero for the product.

[7] This will be the case as long as the policies we subsequently consider do not drive every firm to the same sector.

because of the induced price reduction on the other units the firm was selling. Equation (7) indicates that each firm in a given sector raises the quality of its product until the marginal cost of a further expansion ($c'(k_j)$), equals the marginal benefit of that expansion ($\frac{\theta}{n_j}$), which reflects the fact that the only firm raising quality produces $1/n_j$ of sector j's output. Equation (7) implies that the sector with the larger number of firms will offer lower-quality experience goods. Because prices adjust so that consumers are indifferent about the source of the good, the products of the larger sector must sell for lower prices. This in turn ensures that every firm operating in the larger sector has lower profit and output, as the following argument shows. In the equilibrium, any firm offering quality k earns profit per unit of $\theta k - U(Q) - c(k)$. As this function is strictly concave in quality and peaks at k^*, the implicit solution to $\theta = c'(k^*)$, equation (7) implies that in equilibrium, every firm will choose a quality $k_j < k^*$. Therefore, the profit per unit at each firm in a group rises if the common quality of every firm in that group increases. It follows that firms in the larger sector will have lower profit per unit than firms in the smaller sector. But equation (6) implies that any firm with a lower profit per unit produces less output and hence earns lower total profit.[8] In the limiting case where each sector has the same number of firms, quality, price, output, and profit are the same at every firm regardless of its sector.

If it is costless for a firm to move between the formal and informal markets, then in the long run, profits must equalize in the two sectors. Moreover, under *laissez-faire* and under the two policies we will investigate, firms in each sector are free to adjust their output until the *per-unit profit* of expanding output equals the losses that would be imposed on the inframarginal units sold by a firm. Consequently, profits

[8]In this model, it is assumed that firms producing in one sector cannot disguise their products as originating in the other sector in which firms may have a better reputation and earn higher profits. Presumably, this implicitly requires that the government identify and prohibit such deceptions as they would be profitable. Likewise, purchasing a good in the sector with the lower price and reselling it in the sector with the higher price is prohibited.

at a firm in sector j will equal $q_j^2 U'(Q)$ for $j = F, I$. It follows that in the long-run equilibrium, output will equalize among firms in the two sectors, and so will profit per unit. Hence, in the long-run equilibrium, only price, quality, and the number of firms can differ between the two sectors. Moreover, the sector with the higher quality must always have the higher price; otherwise, no consumer would buy the other sector's merchandise. As we shall see, under *laissez faire* these variables equalize in the long-run equilibrium. Under a subsidy (respectively, tax), quality and price are strictly higher (resp., strictly lower) in the informal sector, while the number of firms is strictly lower (resp., higher) in the informal sector. Under a minimum quality standard, price and quality equalize across sectors, and the formal sector has more firms.

This discussion suggests the following proposition:

Theorem 2.2 *Suppose that moving between the formal market and informal market is costless. In the absence of any regulation on the formal market, in the long-run equilibrium the number of firms operating in each market will be equalized. Moreover, all firms will produce the same output at the same quality. Profits will be equalized across sectors and across all firms.*

Proof In long-run equilibrium, because switching between sectors is costless, firms will reallocate themselves until the profits earned in the formal market are equal to the profits earned in the informal sector. By the discussion above, the only way for profits to be equalized is for the number of firms across sectors to be equalized. If the number of firms in each sector is equal, then outputs and quality choices will be equalized across sectors as well. ∎

3 Consequences of Two Policies

Suppose now that the formal market and informal market are in long-run equilibrium, i.e., the number of firms operating in each market is equal, and profits, output, and qualities are equalized across sectors, when the government chooses to enact regulations directed at the formal market. In particular, we will first consider the impact of the government instituting a constant per-unit subsidy τ on firms operating in the formal sector. We have the following result:

Theorem 3.1 *If an equal number of firms are initially located in each sector, then in the short run, the imposition of a per-unit subsidy ($\tau < 0$) on the formal sector will raise the profits of the formal sector relative to the informal sector.*

In the long run, the formal market will be larger than the informal market and will offer lower qualities and lower prices than the informal market.

If a per-unit tax ($\tau > 0$), is imposed every qualitative statement about the short-run and long-run equilibrium is reversed.

Proof When the regulations are imposed, each sector has an equal number of firms: $n_F = n_I = n/2$. Given the imposition of the subsidy, we can write the first-order conditions of the firms in the formal market as

$$\theta R^F - U(Q) - (c(k_F) + \tau) - q_F U'(Q) = 0 \tag{8}$$

$$\theta \frac{1}{n_F} - c'(k_F) = 0 \tag{9}$$

The first-order conditions of firms in the informal market are unchanged. From this, one can immediately see that in the short run, the imposition of the subsidy has no

impact on the quality choices of the firms. We can show that

$$\frac{dq_F}{d\tau} = \frac{-(U'(Q)+q_F U''(Q))\frac{dQ}{d\tau}-1}{U'(Q)} < 0 \tag{10}$$

$$\frac{dq_I}{d\tau} = \frac{-(U'(Q)+q_I U''(Q))\frac{dQ}{d\tau}}{U'(Q)} > 0 \tag{11}$$

Using the fact that $\frac{dQ}{d\tau} = n_F\frac{dq_F}{d\tau} + n_I\frac{dq_I}{d\tau}$, we get that

$$\frac{dQ}{d\tau} = \frac{-n_F}{(1+n_F+n_I)U'(Q)+(n_F q_F + n_I q_I)U''(Q)} < 0 \tag{12}$$

As (12) indicates, the subsidy must increase aggregate production; every term in the denominator of (12) is strictly positive. Given this induced aggregate expansion, the subsidy must cause every firm in the informal sector to contract (as the previous inequality indicates). As for firms in the formal sector, the subsidy must cause them to expand as (10) reflects, because otherwise every firm would contract, contradicting the result established above that aggregate production expands. Because both factors in the last term of equation (8) increase, profit per unit in the formal market increases as well. Thus, profits in the formal sector increase. Profits must decrease in the informal sector. This follows because the subsidy lowers output per firm in the informal sector and—because consumer utility increases—must result in a lower price and profit per unit.

In the long run, firms operating in the informal market will move to the formal market to take advantage of the subsidy. In other words, n_F will increase and n_I will decrease. From the first-order conditions, it is easy to see that the reputed quality will decrease in the formal market and will increase in the informal market. In particular, we have

$$\frac{dk_F}{dn_F} = \frac{-c'(k_F)}{n_F c''(k_F)} < 0, \qquad \frac{dk_I}{dn_F} = \frac{c'(k_I)}{n_I c''(k_I)} > 0 \tag{13}$$

We can also calculate that

$$\frac{dq_F}{dn_F} = \frac{(\theta - c'(k_F))\frac{dk_F}{dn_F} - (U'(Q) + q_F U''(Q))\frac{dQ}{dn_F}}{U'(Q)} \tag{14}$$

$$\frac{dq_I}{dn_F} = \frac{(\theta - c'(k_I))\frac{dk_I}{dn_F} - (U'(Q) + q_I U''(Q))\frac{dQ}{dn_F}}{U'(Q)} \tag{15}$$

Aggregate output may either expand or contract in response to the reallocation of firms across the two sectors. However, in both cases, output per firm contracts in the formal sector and expands in the informal sector.[9] Firms will continue to move from the informal sector to the formal sector until profits are equalized. In long-run equilibrium, the formal market will be larger and will offer lower quality goods at lower price relative to the informal market. ∎

This result illustrates the surprising effects of the ability of firms to move in and out of the formal and informal sectors. Due to the additive separability of the inverse demand function, in the short run a subsidy has no impact on the qualities of goods produced in both the formal market and the informal market. If the goal of the government is strictly to improve quality, then in the short run subsidies are a completely ineffective form of regulation. However, they still do increase the profits of firms operating in the formal market, which in the long run incentivizes firms operating in the informal market to move to the formal sector to take advantage of the subsidies. This then has the effect of lowering the quality in the formal market and raising the quality in the formal market. Thus, in the long run, subsidies actually degrade the quality of goods *within* the ambit of regulation and effectively raise the quality of goods *outside* the ambit of regulation.

[9] To see this, suppose that aggregate output decreases. Since $\theta \geq c'(k_I) \geq 0$, $\frac{dk_I}{dn_F} > 0$, and $U(Q)$ is strictly increasing and convex, it is clear from equation (15) that output expands in the informal sector. But then if aggregate output decreases, it must be that output contracts in the formal sector. Similarly, if aggregate output increases, one can show from equation (14) that output decreases in the formal sector, which implies that output increases in the informal sector.

We now analyze the case where the government decides to regulate the quality of the product in the formal market in the form of a minimum quality standard. We assume that the standard ($\bar{k}$) is binding on firms in the formal sector but is not set higher than firm would choose if it were the only domestic producer, and hence its products could be readily identified by consumers.

That is, we assume $\bar{k} \leq k^*$, where k^* solves $\theta = c'(k^*)$.[10] We establish the following:

Theorem 3.2 *In the short run, the imposition of a minimum quality standard on the formal sector raises the output and profits of firms in the formal market while lowering the output and profits of unregulated firms in the informal market. Overall, aggregate output expands. Quality rises in the formal sector and remains unchanged elsewhere.*

In the long run, firms move from the informal sector to the formal sector, and profits, profit per unit, output, and quality equalize across sectors.

Proof The imposition of the standard must strictly increase aggregate production of the experience good. For, suppose the contrary. Suppose aggregate quantity falls or remains constant. Then the utility that consumers get from the experience good must weakly decrease. In the informal sector, firms would maintain quality, as equation (7) still holds. So if their goods provide weakly less net utility, the prices of their goods ($P^j = \theta k_j - U(Q)$) must weakly increase. Because the per-unit profit ($P^j - c(k_j)$) would then weakly increase, equation (6) implies that output at each unregulated firm must weakly increase. As for the *regulated* firms in the formal market, their per-unit profit must *strictly* increase, because the standard raised quality and, by assumption, was not excessive ($\bar{k} < k^*$). Equation (6) then implies that output at each regulated firm strictly increases. But then we have a contradiction: aggregate output cannot weakly decrease as we hypothesized, as this implies that the sum of the individual firm outputs would strictly increase.

[10] This is also the socially optimal quality chosen by a social planner to maximize welfare.

So the imposition of a minimum quality standard in one market must cause aggregate output of the experience good to strictly increase and hence must cause the net utility of every consumer of the good to increase. As the quality of the unregulated firms in the informal sector does not change, their prices, profit per unit, output, and total profits must fall. Because aggregate output expands despite the contraction at every unregulated firm, output at every *regulated* firm must increase. But, as equation (6) implies, regulated firms would expand output only if their profit per unit also increased. Hence, their total profits would also increase. Because profit per unit increases at each regulated firm, its price per unit must increase by more than enough to offset the increased cost per unit of producing the higher quality mandated by the minimum quality standard.

In the long run, firms will abandon the informal market and join the formal market. This will raise the quality of the product in the informal market, while the quality in the formal market remains fixed at the level imposed by the minimum quality standard. Note that equation (6) implies that if profit per unit is higher in one sector, then output is higher in that sector, which implies profit is higher. Thus, in long-run equilibrium, profit per unit and output must be equalized across sectors. Because profit per unit $(\theta k_j - U(Q) - c(k_j),\ \text{for } j = F, I)$ is equalized across sectors, this implies that quality must also be equalized across sectors. ∎

This result is quite interesting. It demonstrates that given the lack of firm traceability with regard to quality, the government can indirectly, yet effectively, regulate the entire market for a good through regulations on only the formal sector. Intuitively, the minimum quality standard actually creates a comparative advantage for the formal sector, which leads firms to move out of the informal market. As firms leave the informal market, the collective reputation problem is ameliorated, which endogenously raises the quality of goods in this sector. This process continues until the quality of

good in the informal market is exactly equal to the quality specified by the standard.

4 Conclusion

This paper assumes that consumers can purchase a product from either the formal or informal sector and can assess the quality of that product only from the collective reputation of the sector where it is purchased. In this circumstance, firms will free ride on quality efforts of others in that sector, and as a result, quality provision in each sector will be suboptimal. If a per-unit subsidy is imposed on firms in the formal sector, many will eventually migrate to it from the informal sector, exacerbating the free riding there and lowering quality. If, on the other hand, regulators implement a minimum quality standard in the formal sector, then again firms have an incentive to migrate to the regulated sector. However, under this policy, there is less free riding in the informal sector because fewer firms remain in it *and* less free riding in the formal sector as a result of the quality standard. Therefore, a minimum quality standard imposed on firms in the formal sector will increase quality in both sectors.

The idea of a government intervention in one area *benefiting* agents in another area despite the absence of any intervention in that area has other applications. For example, if a fixed number of motorists commute from the same origin to the same destination on two congestible roads, then expanding one road so that commute time for any given number of cars is reduced will attract motorists from the other road and will therefore reduce the commute time on that other road, even though the government has made no improvements to that road. Similarly, suppose a fixed number of fishermen must choose which of two lakes to patronize, and there is a common property congestion externality on each lake. Without any regulation, both lakes would be overfished in comparison with the social optimum. However, if one lake is

regulated so that the payoff per fisherman is increased for any number of fishermen, then in the long run, this would draw fishermen away from the unregulated lake, reducing congestion there. Migration would continue until the payoffs on the two lakes equalized. One can think of other examples where everyone is helped although regulators confine their intervention to a subset of firms or people.

In the case of the highway expansion, it is quite plausible that commute time will improve on both roads to exactly the same extent. In the case of a minimum quality standard in the formal market, quality is likely to rise in the regulated market. Whether it rises to the same extent in the informal market as our model predicts depends on factors from which we have abstracted. Although a standard might in reality affect quality in the informal market less than in the formal market, the movement of quality in the same direction in the two markets might make identifying empirically the full effects of the regulation a challenge.

A Proof of Theorem 2.1

Lemma A.1 *There exists a nontrivial equilibrium in which in each sector j, every producer of the experience good is either active or inactive. If a sector is active, each firm sells the same unique strictly positive amount ($q_j > 0$) with the same unique strictly positive quality ($k_j > 0$). There is at least one active sector.*

Proof Given the symmetry we are considering, we can write the Kuhn-Tucker conditions as

$$q_j \geq 0,\ P^j(Q, k_j) + q_j P_1^j(Q, k_j) - c(k_j) \leq 0,\ \text{c.s.} \tag{16}$$

$$Q = \sum_{j=1}^{N} n_j q_j \tag{17}$$

and

$$k_j \geq 0,\ q_j[P_2^j(Q, k_j) - n_j c'(k_j)] \leq 0,\ \text{c.s.} \tag{18}$$

where $R^j = k_j$.

To begin, consider the solution to equation (18) given a particular Q and q_j. If the firm is inactive ($q_j = 0$), then any quality choice will solve the equation. Now let $\tilde{k}_j = (c')^{-1}(\theta/n_j)$. If the firm is active, it is clear that for all $0 \leq Q < \bar{Q}(\tilde{k}_j)$, $\tilde{k}_j$ is the unique nonzero solution to equation (18). For $Q \geq \bar{Q}(\tilde{k}_j)$, there is no nonzero solution.

Let us now consider the system of equations given by (16) and (17) when $k_j = \tilde{k}_j$ for all j. Note that $P^j(0, \tilde{k}_j) - c(\tilde{k}_j) = \theta\tilde{k}_j - c(\tilde{k}_j) > 0$ for all j.[11] Next, define $\hat{Q}(\tilde{k}_j) < \bar{Q}(\tilde{k}_j)$ such that $P(\hat{Q}(\tilde{k}_j), \tilde{k}_j) = c(\tilde{k}_j)$. Then the solution to (16) is $q_j = 0$ for all $Q \geq \hat{Q}(\tilde{k}_j)$. By totally differentiating equation (16) with respect to Q, we find that

[11] Let $\hat{k} = (c')^{-1}(\theta)$. Then since $c(0) = 0$ and the cost function is convex, we know $k - c(k)$ is maximized at $\hat{k}$. Since $\tilde{k}_j \leq \hat{k}$ for all j, it follows that $\theta\tilde{k}_j - c(\tilde{k}_j) > 0$ for all j.

for $Q < \hat{Q}(\tilde{k}_j)$

$$\frac{dq_j}{dQ} = -\frac{P_1^j(Q,\tilde{k}_j) + q_j P_{11}^j(Q,\tilde{k}_j)}{P_1^j(Q\tilde{k}_j)} = -\frac{U'(Q) + q_j U''(Q)}{U'(Q)} < 0 \tag{19}$$

Now let $f(Q) = \sum_{j=F,I} n_j q_j(Q)$ and $Q^H = \max\{\hat{Q}(\tilde{k}_F), \hat{Q}(\tilde{k}_I)\}$. Then $f(Q)$ is continuous and strictly decreases from $f(0) > 0$ to $f(Q^H) = 0$ and $f(Q) = 0$ for all $Q \geq Q^H$. Thus, the curve will cross the 45^o line exactly once at some $0 < Q^\star < Q^H$. Let $k_j^\star = \tilde{k}_j$ and $q_j^\star = q_j(Q^\star)$ for all j. If $Q^\star < \hat{Q}(\tilde{k}_j) < \bar{Q}(\tilde{k}_j)$, then $q_j^\star > 0$, and if $Q^\star \geq \hat{Q}(\tilde{k}_j)$, then $q_j^\star = 0$. The profile $((k_j^\star)_{j=F,I}, (q_j^\star)_{j=F,I}, Q^\star)$ satisfies the Kuhn-Tucker necessary conditions. Note that at least one market will be active, since $Q^\star < Q^H$.

Because by assumption the profit function of each firm is pseudoconcave, the specified solution constitutes a Nash equilibrium.[12] ∎

The following two lemmas demonstrate that in any non-trivial equilibrium, active firms do not produce the minimum quality and active countries cannot have inactive firms.

Lemma A.2 *There can be no nontrivial equilibrium (symmetric or otherwise) in which a firm produces a positive quantity of the minimum quality.*

Proof If it is optimal to produce at minimum quality ($k_{ij} = 0$), then since $c'(0) = 0$, condition (5) requires that $P_2(Q, R^j)\frac{q_{ij}}{Q^j} \leq 0$. But each of the factors to the left of this inequality is strictly positive since, by hypothesis, $q_{ij} > 0$ and we are considering nontrivial equilibria. So the inequality can never hold. Therefore, every firm with $q_{ij} > 0$ must have $k_{ij} > 0$. ∎

[12] If pseudoconcavity does not hold, there may be nonlocal deviations that are optimal for a given firm. If this is the case, then one can use an iterative process to solve for the Nash equilibrium. In equilibrium, a sector may flood the market with goods, thereby achieving zero price. See McQuade et al. (2010) for a much fuller and detailed discussion of this issue within the context of collective reputations in international markets.

Intuitively, because the cost function is flat at the origin but inverse demand is strictly increasing in quality when the price is nonzero, an active firm producing a minimal quality can always increase its profit by marginally increasing its quality choice. At the margin, costs will remain the same but the price will increase.

Lemma A.3 *There can be no nontrivial equilibrium (symmetric or otherwise) in which an active market can have an inactive firm.*

Proof Suppose that $q_{ij} = 0$ and $Q^j > 0$. In that case, one or more of the rival firms is producing a strictly positive amount. Label as firm i' the active firm with the smallest quality. Hence, $k_{i'j} - R^j \leq 0$. Because firm i' produces a strictly positive amount, its first-order condition in (4) must hold with equality. Because the terms $q_{i'j}P_1^j(Q, R^j)$ and $q_{i'j}P_2^j(Q, R^j)(k_{i'j} - R^j)/Q$ are respectively strictly and weakly negative, (4) implies $P^j(Q, R^j) - c(k_{i'j}) > 0$. But because the cost function is strictly increasing, $P(Q, R^j) - c(0) > 0$, and this same complementary slackness condition, which must hold for firm i as well, implies that $q_{ij} > 0$, contradicting the hypothesis that $q_{ij} = 0$. ∎

Given the previous results, we have the following lemma:

Lemma A.4 *There exist no nontrivial pure strategy Nash equilibria in which firms in active markets produce different qualities and/or outputs.*

Proof Consider an active sector j. By the two previous lemmas, the first-order conditions of each firm in this sector must hold with equality. That is, the following equation must hold in equilibrium:

$$[k_{ij} - (R^j - \frac{QU'(Q)}{\theta R^j})]c'(k_{ij}) + \{\theta R^j - U(Q) - c(k_{ij})\} = 0 \tag{20}$$

Define the left-hand side as $\Gamma^j(k_{ij}; Q, R^j)$. In equilibrium, every firm ($i = 1, \ldots, n_j$) will have $\Gamma^j(k_{ij}; Q, R^j) = 0$. However, this equation cannot have more than one root.

We see that $\frac{\partial \Gamma^j}{\partial k_{ij}}(k_{ij}; Q, R^j) = [k_{ij} - (R^j - \frac{QU'(Q)}{\theta R^j})]c''(k_{ij})$, and (20) requires that at any root, the first factor in $\frac{\partial \Gamma^j}{\partial k_{ij}}(k_{ij}; Q, R^j)$ must be strictly negative.[13]

Hence, there can be no more than one root. So for any given equilibrium with its (Q, R^j), a unique k_{ij} satisfies equation (20). But because equation (20) must hold for *every* firm, each firm must choose the same quality in this equilibrium. Denote it $k_j(Q, R^j)$. Moreover, as every firm will be active and reputed quality will equal $R^j = k_j(Q, R^j)$, equation (4) implies that $q_{ij} = \frac{\theta R^j - U(Q) - c(k_j(Q,R^j))}{-U'(Q)}$. Because the right-hand side of this equation is independent of i, every firm will produce the same quantity in this equilibrium. Denote it $q_j(Q, R^j)$. ∎

[13]The term in braces in (20) must be strictly positive, since $q_{ij} > 0$ (from Lemma A.3); condition (16) therefore holds with equality, and $P_1 < 0$ by assumption.

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