Humanities & Social Sciences Communications

ARTICLE

https://doi.org/10.1057/s41599-020-00658-w OPEN

On the market for "Lemons": quality provision in markets with asymmetric information

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Akerlof's "Lemons" paper provides a seminal economic result suggesting that, in markets with asymmetric information where product quality is unobservable by consumers prior to purchase and use, the introduction of a low-quality product will drive its higher quality counterpart(s) out of the market. In this paper we identify some empirically relevant cases/conditions under which the introduction of a low-quality product does not drive its higher quality substitutes out of the market but, instead, ends-up coexisting with them.

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Introduction

The "Lemons" paper by George Akerlof (Akerlof, 1970) is the source of one of the most influential economic results of the last 50 years (The Economist, 2016). The key conclusion of the paper—known as the "Lemons Result"—is that, in markets with asymmetric information where the product quality is unobservable by consumers prior to purchase and use (as would be the case with credence and experience goods in the absence of mechanisms like warranties, certification and labeling), the introduction of an undifferentiated low-quality product will drive its higher quality counterpart(s) out of the market.[1]

However, this prediction does not always hold. Instead, new products that are inferior to existing ones can, and often do, coexist with their higher quality counterparts. A prominent example is found in the food industry where, although consumers view genetically modified (GM) products to be of lower quality than their conventional counterparts (Lusk et al., 2014),[2] the former have not completely saturated the market (Kalaitzandonakes et al., 2016).[3] Additional examples where low-quality and high-quality products and services coexist in a market with asymmetric/hidden information include: the market for used cars where low-quality and high-quality vehicles are sold at some reference price (e.g., Kelley Blue Book) by different suppliers (e.g., car dealerships with and without in-house service; private sellers); real and fake/fabricated news offered by different online sites at essentially the same price; counterfeit event tickets sold alongside real ones; and low-quality and high-quality providers of credence or experience services (like many doctors, lawyers, financial advisors, and car mechanics) coexisting and charging similar fees for the different quality services they provide.

In this paper, we identify the conditions under which the introduction of a low-quality product does not drive its high-quality counterpart out of the market but, instead, ends-up coexisting with it. Using a simple model, we show that the equilibrium quality configuration in a market depends on both the unobservability of product quality by consumers *and* the relative costs of producing the different quality products for different producers. To determine the impact of introducing a low-quality good into a market of hidden information where a high-quality product is already being sold, we consider two vertically differentiated food products supplied by heterogeneous producers that differ in their efficiency of producing these products.[4] We focus on food because the nature of its production (e.g., biotechnology, organic, fair trade, local) not only differs across producers but generates credence characteristics that are differentially valued by consumers.[5] Although we use the food example to motivate the analysis, the results are applicable to other situations where the above conditions apply.

Our analysis shows that the case in which the low-quality product drives the high-quality product out of the market is one of four possible cases that can emerge. In two other empirically relevant cases, the low-quality product coexists with its higher-quality counterpart, while in a fourth scenario the low-quality product fails to successfully enter the market.

Theoretical framework

Consumer characteristics. Consider a typical Mussa and Rosen type vertical product differentiation case (Mussa and Rosen, 1978) where consumers differ in their preferences for different food products. The utilities associated with the consumption of a high-quality product, its low-quality counterpart, and a substitute good for the consumer with differentiating attribute $\alpha \in [0,1]$ are given by:

$$\begin{aligned} U_h &= \lambda\alpha - p_h && \text{if a unit of high-quality product is consumed} \\ U_l &= \mu\alpha - p_l && \text{if a unit of low-quality product is consumed} \\ U_s &= 0 && \text{if a unit of a substitute product is consumed} \end{aligned} \tag{1}$$

where λ and μ are utility parameters associated with the consumption of high-quality and low-quality products, respectively, with $\lambda > \mu$ (with this restriction, the utility associated with the consumption of the high quality product exceeds that of its lower quality counterpart for all consumers if the prices of the two goods are equal); α reflects differences in the consumer valuation of these products; and p_h and p_l are the prices of the high-quality and low-quality products, respectively. For simplicity and without loss of generality, the utility associated with the consumption of the substitute product is normalized to zero.

Producer characteristics. Due to differences in things like age, education, experience, management skills, location and quality of land, producers differ in their costs of production and, thus, in the net returns they receive from the production of different products. The net returns associated with the production of the high-quality product, its low-quality counterpart, and an alternative good for the producer with differentiating attribute $A \in [0,1]$ are given by:

$$\begin{aligned} \Pi_h &= p_h^f - w_h - \gamma A && \text{if a unit of high-quality product is produced} \\ \Pi_l &= p_l^f - w_l - \delta A && \text{if a unit of low-quality product is produced} \\ \Pi_a &= 0 && \text{if a unit of the alternative product is produced} \end{aligned} \tag{2}$$

where p_h^f and p_l^f are the producer prices of the high-quality and low-quality products, respectively; w_h and w_l are the costs of producing these products that are *common* across producers (e.g., seed costs); and γ and δ are cost enhancement factors associated with the production of the high-quality and low-quality products, respectively. In this context, γA and δA give the *idiosyncratic* costs of producing the high-quality and the low-quality product, respectively, for the producer with differentiating attribute A. For simplicity and without loss of generality, the returns from the production of the alternative crop are normalized to zero.

Market response to the introduction of low-quality product

Consumer decisions. When the quality characteristics of a product are unobservable by consumers prior to its purchase and use (i.e., when there is asymmetric information in the form of hidden information about the quality of the products sold in the market), the introduction of an undifferentiated low-quality product creates uncertainty about the true nature of the product being sold; this uncertainty occurs because people are not sure whether the product they are considering—referred to as a pooled product—is of high or low quality. Thus, consumer utility (expected utility in the case of the pooled product) after the introduction of the undifferentiated low-quality product becomes:[6]

$$\begin{aligned} U_{pl} &= [\psi\mu + (1-\psi)\lambda]\alpha - p_{pl} && \text{if a unit of the pooled product is consumed} \\ U_s &= 0 && \text{if a unit of a substitute product is consumed} \end{aligned} \tag{3}$$

where p_{pl} is the consumer price of the pooled product[7] and ψ is the production share of the low-quality product (and, thus, the perceived probability that the pooled product is of low quality).

Assuming prices and preference parameters are such that the different products coexist in the market, the consumer with differentiating attribute:

$$\alpha_{pl} : U_{pl} = U_s \Rightarrow \alpha_{pl} = \frac{p_{pl}}{\psi\mu + (1-\psi)\lambda} \tag{4}$$

is indifferent between the pooled and substitute products. Consumers with stronger preference for quality (i.e., consumers with $\alpha \in (\alpha_{pl},1]$) prefer the pooled product, while consumers with $\alpha \in [0,\alpha_{pl}]$ consume the substitute good.

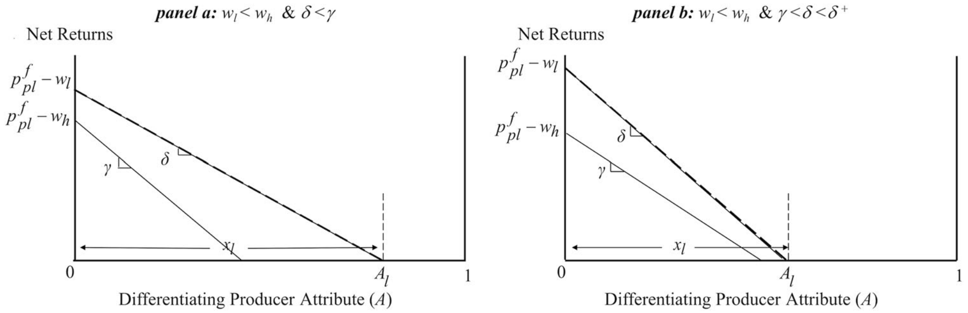

Fig. 1 Producer decisions in Scenario I. This figure graphs the producer net returns for the two cases that give rise to Scenario I. In both cases, the introduction of the low-quality product drives the high-quality product out of the market.

When consumers are uniformly distributed between the polar values of α, $1-\alpha_{pl}$ determines the consumption share of the pooled product, x_{pl}; normalizing the mass of consumers at unity, x_{pl} gives the consumer demand for the pooled product, with

$$x_{pl} = \frac{[\psi\mu + (1-\psi)\lambda] - p_{pl}}{[\psi\mu + (1-\psi)\lambda]} = \frac{[\lambda - \psi(\lambda-\mu)] - p_{pl}}{[\lambda - \psi(\lambda-\mu)]}, \qquad (5)$$

which is decreasing in ψ, and increasing in the consumer valuation of the low-quality product, μ.

Producer decisions. The producer price of the low-quality product equals that of its high-quality counterpart when the two products are marketed together as a pooled good. Thus, the producer net returns function after the introduction of the low-quality product is derived by substituting p^f_{pl} for p^f_h and p^f_l in Eq. (2), where p^f_{pl} is the producer price when the high-quality and low-quality products are marketed together as an undifferentiated good.

Before deriving the equilibrium production shares after the introduction of the low-quality product, it is important to note that, depending on the nature of the technology used to produce the low-quality product, this technology could have different effects on the common and idiosyncratic costs faced by producers. In particular, four scenarios can emerge and are examined here:

Scenario I–the production of the low-quality product results in lower total (common plus idiosyncratic) costs for all producers;

Scenario II–the technology for producing the low-quality product is cheaper to acquire (i.e., $w_l < w_h$) but increases the idiosyncratic costs (due to increased labor, fertilizer and/or weed control required for production);

Scenario III–the technology reduces the idiosyncratic costs but is more expensive to acquire (as is the case with many agricultural biotechnology innovations imbedded in seeds that are more expensive than their conventional counterparts but offer agronomic benefits to producers); and

Scenario IV–the production of the low-quality product results in increased total costs for all producers.

Since $p^f_l = p^f_h = p^f_{pl}$, Scenarios I and IV will generate corner solutions with all producers opting for the (less costly) low-quality and high-quality products, respectively. In particular, Scenario I is consistent with the "Lemons Result", since all producers find it more profitable to produce the low-quality product ($w_h + \gamma A > w_l + \delta A \Rightarrow \prod_l > \prod_h \geq 0$) and the low-quality product drives the high-quality product out of the market. Scenario IV captures the case of an unsuccessful product introduction with the low quality failing to enter the market ($\prod_h > \prod_l \geq 0$). The empirically relevant Scenarios II and III, however, generate interior solutions involving the coexistence of high-quality and low-quality products, and are the focus of the rest of this paper.

Before proceeding with the analysis of Scenarios II and III, note that, while the reduction of both common and idiosyncratic production costs (i.e., $w_l < w_h$ and $\delta < \gamma$) is sufficient for Scenario I to emerge, the reduction in the idiosyncratic costs is not necessary for the low-quality product to drive the high-quality product out of the market. Instead, the necessary conditions for $\prod_l > \prod_h \geq 0$, is for $w_l < w_h$ and δ to be less than a critical value $\delta^+ = \frac{\gamma(p^f_{pl} - w_l)}{p^f_{pl} - w_h}$. This critical value δ^+ depends on both the demand and supply effects of the introduction of the low-quality product—the lower the production costs and consumer valuation of the low-quality product, the lower are w_l and p^f_{pl}, the greater is δ^+ and the greater is the likelihood the introduction of the low-quality product will drive its high-quality counterpart out of the market.

Figure 1 graphs the net returns that result in the introduction of the low quality driving the high quality out of the market (Scenario I), while Fig. 2 depicts the relevant demand and supply schedules (and equilibrium conditions) after the introduction of the undifferentiated low-quality product in the market. As Fig. 2 illustrates, Scenario I occurs when the low quality product is sufficiently less costly to produce than the high quality product—i.e., the supply curve of the low quality product, S_l, lies below the supply curve of the high quality product, S_h, at the quantity and price that clear the market if only the low quality product is produced.

For simplicity and without loss of generality, Fig. 2 and the rest of the figures depicting the equilibrium conditions under the different scenarios are drawn on the assumption of perfect competition in the supply channels of interest. While the presence of imperfectly competitive middlemen would reduce the equilibrium quantities and create a wedge between consumer and producer prices, the qualitative results of our study would remain unaffected. The complete derivation of the mathematical expressions for the equilibrium quantities and prices under perfectly and imperfectly competitive market structures for all four scenarios is provided in the Supplementary Information/Appendix.

Scenario II ($w_l < w_h$ & $\delta > \delta^+$). Consider now the scenario in which the technology used to produce the low-quality product is cheaper to acquire but increases the idiosyncratic cost of production above the threshold level δ^+—i.e., $w_l < w_h$ and $\delta > \delta^+$. As noted earlier, the increase in the idiosyncratic costs might be due to increased requirements for things like labor, fertilizer and pesticide inputs when producing the low-quality product, while the reduction in common costs is associated with a lower cost of purchasing the seed or the technology required to produce this product.

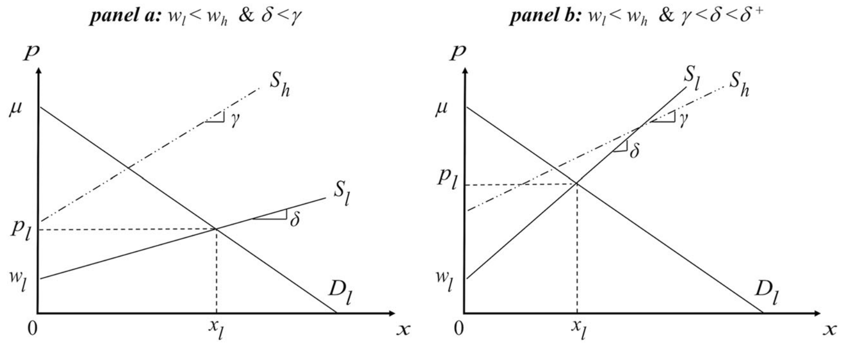

Fig. 2 Equilibrium conditions in Scenario I. This figure depicts the demand and supply schedules (and equilibrium conditions) for the two cases that give rise to Scenario I. In both cases, the supply curve for the low-quality product lies below the supply curve for the high-quality product (throughout the relevant range of the demand curve) and the introduction of the undifferentiated low-quality product drives its higher quality counterpart out of the market.

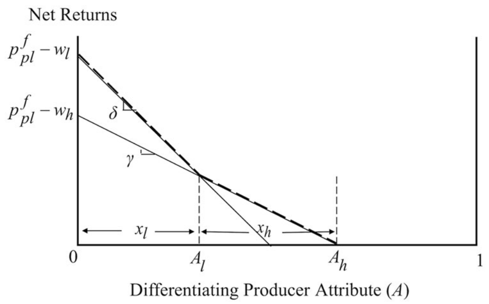

Fig. 3 Producer decisions in Scenario II. This figure graphs the producer net returns for Scenario II. In this scenario, the low-quality and high-quality products coexist in the market, with the high-quality product produced by less efficient producers.

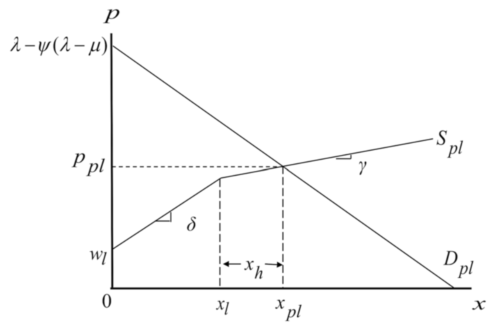

Fig. 4 Equilibrium conditions in Scenario II. This figure depicts the equilibrium conditions for Scenario II when the undifferentiated low-quality product coexists with its higher quality counterpart produced by less efficient producers.

As shown in Fig. 3, which graphs the producer net returns in Scenario II, the introduction of low-quality product does not drive the high-quality product out of the market; instead, the two products coexist. Higher cost producers with $A \in (A_l, A_h]$ continue producing the high-quality product, since, for these producers, the benefits from the reduced common cost are outweighed by the increased idiosyncratic costs of producing the low-quality product. More cost-efficient producers, on the other hand, find it optimal to switch to the low-quality product.

Mathematically, the share of producers that continue producing the high-quality product is

$$x_h = \frac{p_{pl}^f(\delta - \gamma) - \delta w_h + \gamma w_l}{\gamma(\delta - \gamma)}, \tag{6}$$

which is always positive when $w_l < w_h$ and $\delta > \delta^+$. The greater the costs associated with the production of the low-quality product, w_l and δ, and/or the greater the consumer valuation of the low-quality product, the greater is the share of producers that find it optimal to keep producing the high-quality product after the introduction of its (undifferentiated) low-quality counterpart. Figure 4 depicts the equilibrium conditions after the introduction of the undifferentiated low-quality product, with the inverse demand for the pooled product derived from Eq. (5). The relevant (kinked) supply schedule in this case is the lower envelop of the S_l and S_h schedules, with the higher cost producers being those producing the higher quality good. This kinked supply curve reflects the fact that producers will choose the production technology that minimizes their cost of production (and maximizes their net returns when the different products are marketed together as a pooled good).

Scenario III ($w_l > w_h$ & $\delta < \delta^+$). Scenario III mirrors Scenario II; the technology utilized to produce the low-quality product is more expensive to acquire but reduces the idiosyncratic costs of production—i.e., $w_l > w_h$ and $\delta < \gamma$. An example of such technology is agricultural biotechnology where the cost of GM seeds is generally greater than that of their conventional counterparts and the technology confers agronomic benefits to producers that reduce their idiosyncratic cost of production.

Figure 5 graphs the producer net returns and shows that, similar to Scenario II, the introduction of the low-quality product does not drive the high-quality product out of the market. The reason is that more cost-efficient producers (producers with $A \in [0, A_h)$ in Fig. 5) find it optimal to keep producing the high-quality product, since the reduction in the idiosyncratic costs of the low-quality product is outweighed by its increased common costs. Unlike Scenario II, however, it is the more cost-efficient producers that continue to produce the high-quality product.

Mathematically, the market share of the high-quality product in Scenario III depends on the relative magnitude of the difference between the common and idiosyncratic costs associated with the production of the different quality products; it is given by:

$$x_h = \frac{w_l - w_h}{\gamma - \delta}, \tag{7}$$

and is always positive under the conditions of this scenario. Figure 6 graphs the equilibrium conditions after the introduction of the low-quality product in the market. In this scenario, the supply curve is the lower envelope of the S_h and S_l schedules, with the lower cost producers being those producing the higher quality good.

At this point, it is important to note that the previous analysis and results hold when the production costs of the low-quality product are

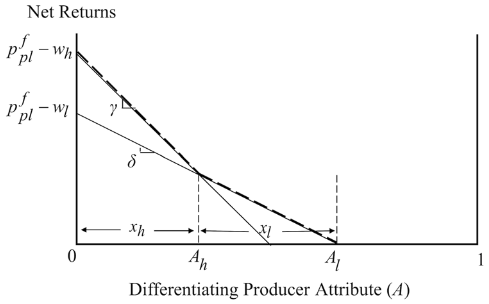

Fig. 5 Producer decisions in Scenario III. This figure graphs the producer net returns for Scenario III. In this scenario, the low-quality and high-quality products coexist in the market, with the high-quality product produced by more efficient producers.

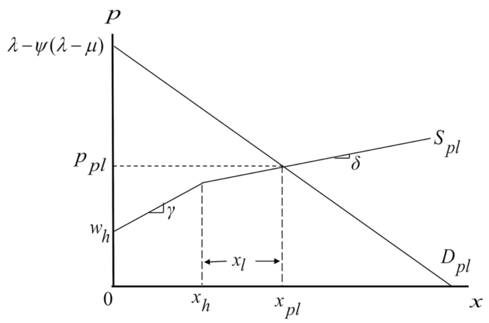

Fig. 6 Equilibrium conditions in Scenario III. This figure depicts the equilibrium conditions for Scenario III when the undifferentiated low-quality product coexists with its higher quality counterpart produced by more efficient producers.

such that some producers find it optimal to produce this product. For this to happen, δ cannot exceed $\delta^{+} = \frac{\gamma(p_{pl}^{f} - w_l)}{p_{pl}^{f} - w_h}$ when $w_l > w_h$. If $\delta > \delta^{+}$, then $\prod_h > \prod_l \geq 0$ and the low-quality product fails to enter the market (which is Scenario IV discussed earlier).

Figure 7 summarizes the combinations of the common and idiosyncratic costs associated with the production of the low quality product (w_l and δ, respectively), that lead to the four scenarios considered in this study. The threshold value δ^{+} and the common cost of the high-quality product, w_h, divide the space into the areas corresponding to the four scenarios. As shown earlier, relatively low values of the cost parameters δ and w_l result in the low quality driving the high quality out of the market (Scenario I); relatively high values of δ and low values of w_l lead to the coexistence of the high-quality and low-quality products with the low-quality product being supplied by more efficient producers (Scenario II); relatively low values of δ and high values of w_l also lead to the coexistence of the high-quality and low-quality products but with the low-quality product produced by less efficient producers (Scenario III); while high values of δ and w_l lead to the undifferentiated low-quality product failing to enter the market (Scenario IV).

While Scenario I is consistent with Akerlof's Lemons Result, Scenarios II and III are not. In these cases, the introduction of the undifferentiated low-quality product fails to drive its high quality counterpart out of the market and ends up, instead, coexisting with it.

Before concluding this section, it is important to note that, while the explicit consideration of the welfare effects of the introduction of the low-quality product under the different scenarios is outside the scope of our study, our framework indicates that the introduction of

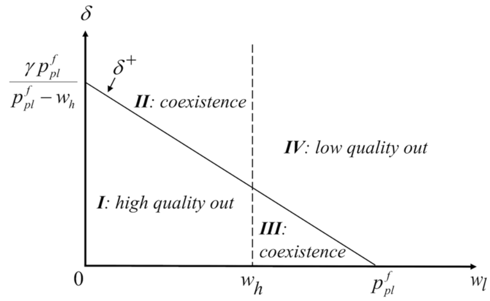

Fig. 7 Impact of undifferentiated low-quality product. This figure summarizes the combinations of the common and idiosyncratic costs associated with the production of the low-quality product that lead to the four scenarios considered in this study.

the low-quality product creates winners and losers among the interest groups involved (i.e., consumers and producers of the low-quality and high-quality products). For instance, while the introduction of an undifferentiated low-quality product results in welfare losses for consumers with strong preference for quality (due to the uncertainty and reduced utility associated with the consumption of the pooled product), consumers with weaker preference for quality can benefit, since, for these consumers, the gains from the reduced price of the pooled product (relative to the price of the high-quality product prior to the introduction of its lower quality counterpart) outweigh the losses from the utility reduction. Similarly, while producers that find it optimal to produce the low-quality product (i.e., more efficient producers in Scenario II and less efficient producers in Scenario III) may gain from the introduction of this product, producers that continue producing the high-quality product lose due to the reduced (pooled) price they receive in the presence of the low-quality product in the market. The relative magnitude of these gains and losses determines the overall welfare change and the relative desirability of introducing the low quality product under the different scenarios.

Concluding remarks

The purpose of this paper is to determine the empirically relevant conditions under which the introduction of a low-quality product in a market with asymmetric/hidden information does and does not drive its higher quality counterpart(s) out of this market. To achieve this objective, we focus on a market for vertically differentiated products supplied by heterogeneous producers differing in their costs of producing these products.

By distinguishing between the common and idiosyncratic costs of production we are able to identify and examine four possible scenarios regarding the relative costs of producing the low-quality and high-quality products. We show that for the low-quality product to drive the high-quality product out of the market, the total (common plus idiosyncratic) costs associated with the production of the low-quality product must be lower than those of the high-quality product for all producers.

If, as is often the case, the technology used in the production of the low-quality product has asymmetric effects on the common and idiosyncratic parts of the production costs (by being cheaper to acquire but increasing production costs or by lowering production costs but being more expensive to acquire), at least some producers find it optimal to continue producing the high-quality product. An understanding of the low-quality product's relative common and idiosyncratic costs is critical in properly analyzing and evaluating economic behavior and outcomes in markets with asymmetric information where quality matters.

Understanding the low-quality product's relative common and idiosyncratic costs is also vital to understanding the welfare effects and the social desirability of introducing low-quality products in markets with asymmetric information. While our analysis can serve as the basis for this determination, we leave the detailed examination of these complex relationships to future research.

Data availability
Data sharing is not applicable to this article as no datasets were generated or analyzed during this study.

Received: 16 September 2020; Accepted: 5 November 2020;
Published online: 14 December 2020

Notes
1 For a comprehensive review of the literature on mechanisms and outcomes in the presence of hidden information, see Auster and Gottardi (2019).

2 Our example refers to the 1st generation GM products that focus on conferring agronomic benefits to producers (and constitute the vast majority of commercialized GM products). As pointed out by an anonymous reviewer, there are 2nd generation GM products that focus on providing benefits to consumers (like functional foods and nutraceuticals) and may be considered superior to their conventional counterparts (Giannakas and Yiannaka, 2008).

3 While some suppliers have started labeling their conventional products as either Non-GM or GM-free, based on arguments of substantial equivalence, most GM and conventional products during the past quarter century have been marketed in the United States together as non-labeled (and, thus, undifferentiated) goods (Fulton and Giannakas, 2004).

4 Products are vertically differentiated when they are uniformly quality- (and, thus, utility-) ranked by consumers so that, if offered at the same price, all consumers would prefer the higher quality product. While consumers agree on the relative quality ranking of the vertically differentiated products, they differ in their valuation of (and willingness to pay for) the perceived quality difference of these products (Tirole, 1988).

5 While differences in consumer preferences are an important feature of food and agricultural markets (Lusk et al., 2014), the assumption of consumer differences is not required for the results of our analysis to hold. Instead, as will be shown in this article, the impact of the introduction of a low-quality product in a market with asymmetric information depends on the unobservability of product quality by consumers and the relative costs of producing the different quality products for different producers.

6 As pointed out by an anonymous reviewer, the pooled product is similar to a probabilistic product (Fay and Xie, 2008; Zhang et al., 2015) in that consumers are uncertain as to whether the product in question is of high or low quality and consumer utility is given as a weighted average of the utility of the high and low quality goods. However, while the probabilistic product is offered along with the high-quality and low-quality ones, the pooled product replaces both the high-quality and low-quality products, thus fundamentally altering the consumer choice problem. In addition to this major difference, the literature on probabilistic products assumes the high-quality, low-quality and probabilistic products are supplied by the same supplier who has market power. In contrast, the pooled product in our model consists of a mix of high-quality and low-quality products supplied by different suppliers (that may or may not have market power) and marketed together as an undifferentiated good.

7 It is important to note that the common price of the pooled product is a key element of these markets with asymmetric information and will occur regardless of whether consumers differ in their valuation of the quality differences between the low-quality and high-quality products or not. Indeed, even if all consumers have the same preferences for the high-quality and low-quality products, the price of these products will be the same when they are marketed together as an undifferentiated good.

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Competing interests
The authors declare no competing interests.

Additional information
Supplementary information is available for this paper at https://doi.org/10.1057/s41599-020-00658-w.

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