African Journal of Agricultural Research Vol. 7(20), pp. 3096-3102, 26 May, 2012
Available online at http://www.academicjournals.org/AJAR
DOI: 10.5897/AJAR10.1889
ISSN 1991-637X ©2012 Academic Journals

Full Length Research Paper

Minimum quality standards or quality-improving subsidies: Which one is the most helpful strategy to coffee growers in Peru?

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Accepted 3 May, 2012

The market of Peruvian coffee has faced decreasing exports and diminishing prices due to the country lack of generally recognized quality standards, and the best path is to build quality-recognized standards for the coffee growers. In order to analyze this scenario, a model of vertical product differentiation to discuss the influence of two policy tools on the quality of Peruvian coffee was set up. The first tool in question was to set minimum quality standards for the coffee industry, and the second one was to subsidize the coffee industry for quality-upgrading expenditures. It is shown that the policy effects are equivalent for the minimum quality standards and the quality-upgrading subsidies, which will no doubt help the Peruvian coffee growers raise its product quality.

Key words: Peruvian coffee industry, quality, minimum quality standards, quality-improving subsidies.

INTRODUCTION

Coffee is a major export crop in Peru. The production of Peruvian coffee is mainly performed by small-scale growers, who are unable to use chemicals or pesticides owing to their low income. This makes it easier for Peruvian coffee to meet the basic requirements for the organic coffee market or the quality coffee market. However, Peruvian coffee is affected by a price reduction in the world market because the country lacks generally recognized quality standards for organic coffee which makes Peruvian coffee growers face an austere challenge to maintain and expand their share of exports in the world market (Achermann, 2001)[1].

Quality is a major concern for selling products in the international markets (Giovannucci, 2001). Commercial quality standards provide not only a common trading platform for both buyers and sellers but also a reference for quality control. Standards are important to farmers and firms in the developing country because they determine the extent of access to specific market segments (For example, in defining products that are environment friendly), to specific countries (For example, through regulations and technical requirements), and the terms for participating in global value chains (For example, through matching quality standards) (Nadvi and Waltring, 2002; Wilson and Abiola, 2003; Gibbon and Ponte, 2004; Ponte and Gibbon, 2005).

Quality standards and procedures that control quality are vital aspects for coffee transactions in producing countries (Daviron and Ponte, 2005). On one hand, quality standards operate as entry barriers for new entrants in the market and present new challenges for existing suppliers. On the other hand, the challenge of increasing standards provide opportunities to selected suppliers for adding value, improving their products, and developing new methods for enhancing co-operation in a particular industry or country (Jaffee, 2004).

Peru maintains a growth rate of 45% annually in organic production. In 2008 and 2009, the Peruvian exports of organic products were valued at 194.22 and

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[1]So far, GTZ and Jacobs's coffee in Germany are joining forces to help Peruvian producers improve their coffee quality by introducing a quality assurance program and a reliable certification process (Achermann, 2001).

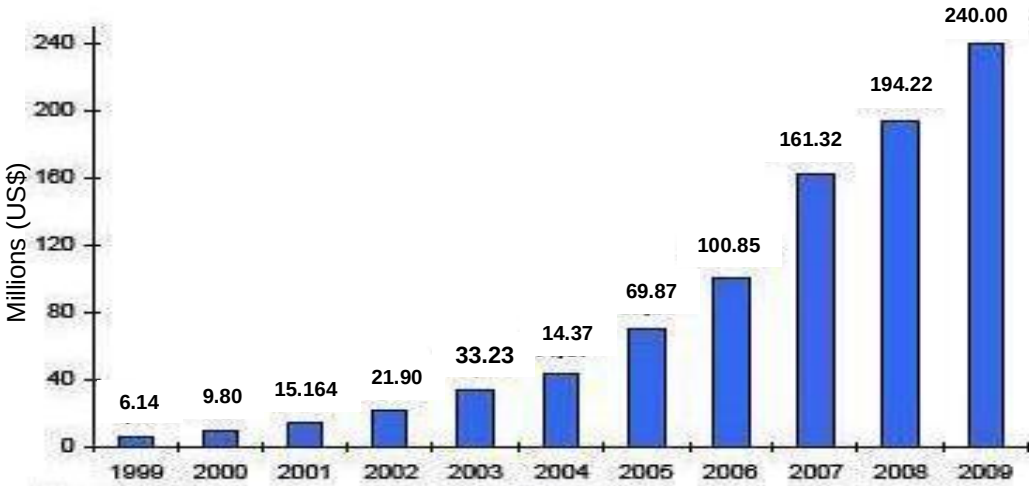

Figure 1. FOB value of export of organic products in Peru. Source: Peru National Customs Service, ADUANAS.

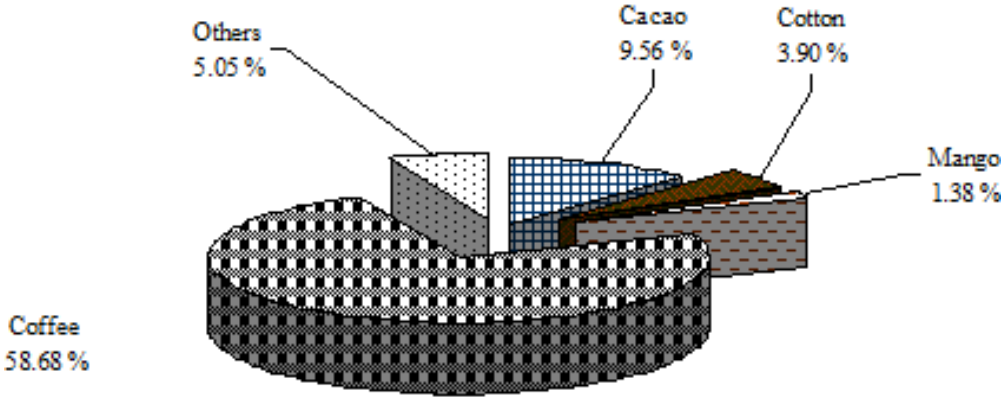

Figure 2. Peru: Export by organic products 2008. Source: Peru National Customs Service, ADUANAS.

US $ 240 million, respectively (Figure 1). The production of organic agriculture is being promoted in the country through activities such as trade fairs, ecological product booths in supermarkets, and diffusion through media[2]. Over the recent years, the interest in Peruvian conventional smallholders involved in the production of organic products has been growing. According to Willer and Kilcher (2009), Peru has approximately 33,500 smallholders who produce organic products and makes top seven in world ranking. This trend was further encouraged by a previous decision that was taken by the regional governments in Peru to ban genetically modified crops and promote organic growing instead.

The organic products exported from Peru include coffee, cacao, cotton, and mango. Coffee is the primary organic export product in the country and constitutes 58.68% of the total exports of organic products (Figure 2). In addition, Peru was formerly one of the world's single largest sources of coca leaves and accounted for approximately two-thirds of the total cocaine production in the world (UNODC). Coca cultivation is a centuries-old tradition practiced by the ancient Andean Inca Empire. The Incas used coca for religious and medicinal purposes. However, today, the age-old tradition of coca cultivation poses potential threats to the national securities of organized crime, guerilla insurgency movements, and drug addiction. For these reasons, the United States Government focused on combating cocoa production in Peru. According to the United Nations Office on Drugs and Crime (UNODC), cultivation of cocoa in Peru was substantially reduced from 115,000 in the mid-1990s to 46,232 ha respectively in the 2000s.

Each grower in Peru has approximately 23 ha for coffee production and a majority of the small scale farmers have formed associations or agrarian

2See the February 2009 report from the Commission for the Promotion of Peruvian Exports and Tourism (PromPeru), which is available on http://www.siicex.gob.pe.

Table 1. Peru: Exports of organic coffee by market 2008.

Country	Percentage (%)
United States	27.06
Germany	26.88
Belgium	12.02
Sweden	11.31
Canada	6.05
Others	16.69

Peru National Customs Service, ADUANAS Ministry of Foreign Commerce and Tourism.

cooperatives, which enable them to obtain better prices, improve post-harvest handling of production, and access quality certifications(USDA-FAS Peru report, 2010).

According to the United States Department of Agriculture (USDA) and Foreign Agricultural Service (FAS), coffee production for the year 2010 in Peru amounted to 3.05 million kilogram bags. The average price for coffee in 2010 is approximately 130 and $165 per hundredweight for conventional coffee and organic coffee, respectively[3]. The organic coffee from Peru is mainly exported to Germany and United States, which accounts for 54% of the total sales (Table 1).

The livelihood of over 150 thousand families in Peru directly depends on coffee bean production, and an average of 1.5 million people belongs to sectors that are associated with the coffee business (Agrobanco, 2007)[4]. Volatility or decline in coffee prices directly influences access to education, housing, food, medical services, and other basic necessities for people whose livelihood depend on coffee.

There is a profound need for Peruvian governments to assist growers in the coffee industry that deem quality as a major force for increasing industry profit and market share. The subsequent section aims to discuss the effects of two widely-applied policy tools, MQS and quality-improving subsidies on coffee quality and profit.

Regarding the theoretical sphere, product differentiation in the literature on trade and industrial organization can be classified into two categories: vertical or horizontal product differentiation. Given that the two variants of a product are identically priced, if a few consumers purchase one variant and others purchase the other variant, then this implies that these two variants are different in the horizontal sphere. On the other hand, given that the two variants of a product are identically priced, if all consumers purchase the same variant, then this implies that the two variants possess quality differences. In summary, the former product category is horizontally differentiated and the latter is vertically differentiated (Gabszewicz and Thisse, 1986). Hence, products that possess quality differences are indicated as vertical product differentiation. Numerous scholars including Gabszewicz and Thisse (1986), Choi and Shin (1992), Motta (1993), Aoki and Prusa (1996) and Aoki (2003) have been focusing on issues related to product qualities via a work-horse model coined as vertically differentiated models.

In the seminal paper by Ronnen (1991), a standard analysis is set forth in a vertical differentiation model on minimum quality standards (hereafter, MQS) and the economic effect of an exogenous MQS is derived[5]. Subsequent researches following Ronnen (1991) in the strand of MQS literature, such as Ecchia and Lambertini (1997), Valletti (2000), Zhou and Vertinsky (2002), Jinji and Toshimitsu (2004), Garella (2006), Kuhn (2007) and Saitone and Sexton (2010), gradually develop a complete ground to our understanding on MQS. Ecchia and Lambertini (1997) in their study obtained the result that collusion is less likely to take place when governments impose MQS on the premise that market is fully-covered. Valletti (2000) states that the policy of MQS leads to a lower welfare level when firms compete in Cournot. Zhou and Vertinsky (2002) analyze the effect of VER and MQS. Jinji and Toshimitsu (2004) discuss the relation of MQS and asymmetric costs of firms. Their result firmly supported the finding of Ronnen (1991). Garella (2006) uses a Hotelling model to show that MQS may be lower than the quality level of low quality firm. Kuhn (2007) discusses the relation of MQS and market mode in the premise that consumers generate basic consumption utility irrespective of purchasing. Saitone and Sexton (2010) addressed the impact of MQS on market in the condition that MQS is determined by production groups.

Besides MQS, it is a common practice for government to impose subsidies on research expenditures to enhance product qualities. Governments often practice policies in control of product prices, quantities, or qualities. New trade theory has shown that subsidies on export products normally generate the profit shifting effect. GATT and the WTO prohibit the use of subsidies to promote trade performance of domestic firms, thus, policies that help the “stealing business effect” or “beg thy neighbor” nowadays, can be countered by countervailing duties. Contrary to this export subsidy, policies of quality subsidies often take place when firms upgrade their technology, increase expenditures on research and development, or need aids to improve their competition abilities. In developing countries, governments subsidize firms on machine tool investment or technology development. For instance, in the 1980s Taiwan governments chose the electronic industry and

3The USDA's Foreign Agricultural Service (FAS) published the Peru coffee annual report 2010; it is available on http://gain.fas.usda.gov.

4See the survey of the Agrarian Bank of Peru on http://www.agrobanco.com.pe. /EstudiosXProductos.htm, or on its homepage as http://www.agrobanco.com.pe.

[5]MQS has been considered by governments as a direct measure to improve product qualities in order to achieve social welfare maximization, or in cases of under-provision of quality, a common remedy is the introduction of MQS.

telecommunication industry as major industries for the society and subsidized these firms for their quality or technology-upgrading expenditures (Ursacki and Vertinsky, 1994).

However, the discussion of policy effect regarding this quality subsidies has been confined to the scope of horizontal differentiation, such as Spencer and Brander (1983), Freeman and Soete (1997) and Hwang and Mai (2007). To our knowledge, in the sphere of vertical product differentiation, scholars paid limited attention to the topic of quality-improving subsidies, except for Zhou et al. (2002) and Toshimitsu (2003)[6]. Zhou et al. (2002) analyzed the direction of strategic trade policy in different competition modes and examined the incentive of quality investment for the exporting firms under the premise of join welfare maximization. They derived that in price competition, developing (developed) country should subsidize (tax) the quality investment. Toshimitsu (2003) discussed discriminatory subsidies on research and development (R and D) along with the optimal quality choices in a closed economy. His major result is that imposing subsidies on R and D activity for the high quality firm will increase the social welfare irrespective of competition mode being prices or quantities.

Despite the fact that the immense studies mentioned earlier largely enhanced our understanding regarding the role of product quality in business competition, these studies shed scarce light on the comparison of two commonly-applied policy tools, namely, MQS and quality-improving subsidies. This note aims in attempt to help bridge this gap. In other words, the effect of minimum quality standards and quality-improving subsidies were examined and compared, and a promising perspective to help the coffee exporting industry for the Peruvian governments was also proposed.

A brief overview of Peruvian coffee industry before analyzing the effect of the policy tools was provided. The main result of this note is that imposing the policy of MQS raises the quality of both the domestic and foreign coffee; also, the quality difference of the two coffees is narrowed down which further brings down the price gap. Moreover, adopting a subsidization policy causes the same effect on price, quality and quantity. Therefore, the policy effects are equivalent for minimum quality standards and quality-upgrading subsidies, which with no doubt help the domestic coffee bean industry to raise their product quality.

MATERIALS AND METHODS

Equilibrium analysis of the policy

Imagine there are two coffee firms, a foreign firm and Peruvian firm. These two firms produce coffee in different qualities and sell their product in an international market. The foreign firm, denoted as firm 1, produces higher-quality coffee (hereafter, the high-quality firm) and the Peruvian firm, firm 2, produces slightly lower-quality coffee (hereafter, the low-quality firm). The respective qualities of the two coffees are denoted as q_1 and q_2, where $q_1 \geq q_2$. The quality upgrading cost is assumed to be q_1^2 and q_2^2. It implies that the form of quality cost is the same for both firms if they increase quality, a common assumption in the literature of Motta (1993), Aoki and Prusa (1996), and Aoki (2003). On the demand side, there is a unit mass of consumers in the international market whose tastes are different from one another by a parameter, $\theta \in$ (0 and 1). While purchasing, a consumer who does not differentiate between coffee 1 and 2 is expressed as $\theta_1 = (p_1 - p_2)/(q_1 - q_2)$. A consumer who is indifferent about purchasing coffee 2 or not purchasing anything at all is expressed as, $\theta_2 = p_2 / q_2$.

Minimum quality standards

The game of the MQS policy consists of three stages in which government sets an MQS in pursuit of maximum domestic social welfare in the first stage, then both firms determine simultaneously their quality levels in the second stage, and finally in the third stage, the two firms compete in prices. We apply backward induction to derive the sub-game perfect equilibrium. In the final stage of the game, the costs incurred on account of quality development are considered to have already sunk. The quantities demanded from the high- and low-quality firms are defined as $x_1 = 1 - \theta_1$ and $x_2 = \theta_1 - \theta_2$, respectively. In light of the aforementioned information, the profit function of the two firms may be expressed as[7]:

$$\pi^{\mathrm{i}} = p_{\mathrm{i}} x_{\mathrm{i}} - q_{\mathrm{i}}^{\ 2}, \; i = 1, 2 \tag{1}$$

We take the policies and product qualities as given and differentiate (1) with respect to each firm's price to obtain the first-order condition for profit maximization as follows:

$$\frac{d\pi^i}{dp_i} = p_i \frac{dx_i}{dp_i} + x_i = 0, \quad i = 1, 2 \tag{2}$$

Solving (2) yields the optimal prices for the two products as $p_1 = 2q_1(q_1 - q_2)/(4q_1 - q_2)$ and $p_2 = q_2(q_1 - q_2)/(4q_1 - q_2)$[8]. Substituting these prices into the marginal consumer conditions to rewrite the market demand

[6]Except for the above mentioned two policy tools for governments to regulate product quality, there are plenty of tools available for governments and analyses regarding these tools are meaningful. Das and Donnenfeld (1989) discussed the impact of quota on product quality. Herguera et al. (2002) addressed the issue of tariff and quality reversal. Recently, Hwang and Mai (2010) investigate the relation of discriminatory subsidy and product quality.

[7]The result of this note remains if we take into consideration the fixed cost for firms, such as buying lands. The fixed cost will reduce the profit by a constant number for firms.

[8]The second-order and stability conditions are both satisfied, that is, $\pi^1_{p_1 p_1} = -2/(q_1 - q_2) < 0$, $\pi^2_{p_2 p_2} = -2[1/(q_1 - q_2) + 1/q_2] < 0$ and $\pi^1_{p_1 p_1}\pi^2_{p_2 p_2} - \pi^2_{p_2 p_1}\pi^1_{p_1 p_2} > 0$.

Table 2. Before and after the policy.

Variable	q_1	q_2	q_1 / q_2	p_1	p_2	p_1 / p_2	x_1	x_2	Profit 1	Profit 2
Before MQS	0.126655	0.0241192	5.25123	0.0538309	0.005125	10.5025	0.524994	0.262497	0.0122193	0.000763706
After MQS	0.126667	0.0271972	5.23476	0.0538043	0.005139	10.4695	0.525076	0.262538	0.0122069	0.000763714
Change (%)	↑0.0089	↑ 0.3237	↓ 0.3138	↓ 0.0494	↑ 0.2652	↓ 0.3138	↑ 0.0157	↑ 0.0157	↓ 0.101	↑ 0.00106
Before quality subsidy	0.126655	0.0241192	5.25123	0.0538309	0.00512555	10.5025	0.524994	0.262497	0.0122193	0.000763706
After quality subsidy	0.126667	0.0241972	5.23476	0.0538043	0.00513914	10.4695	0.525076	0.262538	0.0122069	0.000766246
Change (%)	↑0.0089	↑ 0.3237	↓ 0.3138	↓ 0.0494	↑ 0.2652	↓ 0.3138	↑ 0.0157	↑ 0.0157	↓ 0.101	↑0.3326

Notation: q_i, product quality of firm *i*; q_1 / q_2, quality ratio; p_i, price of product *i*; p_1 / p_2, price ratio; x_i : product quantity of firm i.

as $x_1 = 2q_1/(4q_1 - q_2)$ and $x_2 = q_1/(4q_1 - q_2)$. We immediately obtained the market share of firms as 1/3 and 2/3, irrespective of quality levels. It implies that when firms engage in price competition in the context of vertical product differentiation, the market share for the high quality firm is twice larger than that of low-quality firm. Now, we move to the second stage game. For any given MQS, the range of quality available for firms is likely to narrow down as firms are forced to set the quality levels above the MQS[9]. Given this, the low-quality firm is forced to comply with the MQS, that is, $q_2 = \underline{q}$, where $\underline{q}$ represents an MQS. In other words, we need to work only on the profit function of the high-quality firm as:

$$\pi^1 = \pi^1(p_1(q_1, \underline{q}), p_2(q_1, \underline{q}), q_1, \underline{q}) \quad (3)$$

The quality level of the high-quality firm is derivable by substituting optimal prices into (3) and then taking the first derivative with respect to q_1, which yields:

$$\frac{d\pi^1}{dq_1} = \frac{4q_1(4q_1^2 - 3q_1\underline{q} + 2\underline{q}^2)}{(4q_1 - \underline{q})^3} - 2q_1 = 0 \quad (4)$$

Totally differentiating (4) and rearranging terms yield the following[10]:

$$\frac{dq_1}{d\underline{q}} = -\frac{\pi^1_{q_1\underline{q}}}{\pi^1_{q_1q_1}} > 0 \quad (5)$$

The expression in (5) indicates that the quality level of the high-quality firm will increase with a more stringent MQS. In the first stage the Peruvian government which has the jurisdiction over the low-quality firm, determines the MQS for maximizing domestic social welfare (W). The social welfare function comprises the exporting firm so that $W = \pi^2$. The welfare-maximizing MQS is derivable by maximizing the social welfare function with respect to $\underline{q}$ as:

$$\frac{dW}{d\underline{q}} = \frac{\partial W}{\partial q_1}\frac{dq_1}{d\underline{q}} + \frac{\partial W}{\partial \underline{q}} = 0 \quad (6)$$

Using Equation 5 to solve 6 yields the welfare-maximizing MQS, which is expressed as[11]:

$$\underline{q}^{MQS} = 0.0272 \quad (7)$$

Substituting Equation 7 into 4 yields the optimal quality of the high-quality firm as:

$$q_1^{MQS} = 0.1267 \quad (8)$$

The market equilibrium is demonstrated in Table 2 where an MQS increases the quality level of both the high- and low- quality firm. In addition, the profit of low-quality firm is increased up as well (rows 2 to 4 in Table 2).

Quality-improving subsidies

In the game of quality subsidies, the government in Peru

[9]In Table 2, we show that in equilibrium the quality level for the low quality firm without MQS is *q2*=0.0241192, which is lower than that with MQS. This implies that the MQS policy is binding.

[10]$\pi^1_{q_1q_1} = -8\underline{q}^2(5q_1 + \underline{q})/(4q_1 - \underline{q})^4 - 1 < 0$ and $\pi^1_{q_1\underline{q}} = 8q_1\underline{q}(5q_1 + \underline{q})/(4q_1 - \underline{q})^4 > 0$.

[11]The results in this note are rounded to four decimal places (Table 2).

determines a subsidy ratio for the quality upgrading expenditures in order to maximize the domestic welfare. Then the firms choose their quality levels in the second stage, and finally compete in prices. The profit function of low-quality firm reads:

$$\pi^2 = p_2 x_2 - (1-s){q_2}^2 \quad (9)$$

Where s stands for the ratio that government subsidizes for expenditures in improving product quality. The third stage equilibrium is as seen in Equation 2. In the second stage, when the equilibrium prices obtained in Equation 2 are substituted into Equation 1, Equations 1 and 9 are derived with respect to its quality to obtain the first-order-condition for quality as observed in Equation 4 and as shown in the following equation:

$$\frac{d\pi^2}{dq_2} = \frac{q_1^2(4q_1 - 7q_2)}{(4q_1 - q_2)^3} - 2(1\text{-}s)q_2 \quad (10)$$

Making use of Equations 4 and 10, then applying Cramer's rule, we obtain the following comparative statics:

$$\frac{\partial q_1}{ds} = \frac{2}{D}\pi^1{}_{q_1 q_2} q_2 > 0 \quad (11a)$$

$$\frac{\partial q_2}{ds} = \frac{-2}{D}\pi^1{}_{q_1 q_1} q_2 > 0 \quad (11b)$$

Equation 11 is positive, meaning that a higher subsidy on quality upgrading expenditure does improve the quality for both of the competing firms[12]. By backward induction, in the first stage the Peruvian governments pursue social welfare as:

$$W = \pi^2 - s{q_2}^2 \quad (12)$$

Deriving Equation 12 with respect to subsidy ratio to obtain the first order condition of optimal quality subsidy, we have the following equation:

$$\frac{dW}{ds} = \frac{\partial \pi^2}{\partial p_1}\left(\frac{\partial p_1}{\partial q_1}\frac{dq_1}{ds} + \frac{\partial p_1}{\partial q_2}\frac{dq_2}{ds}\right) + \frac{\partial \pi^2}{\partial p_2}\left(\frac{\partial p_2}{\partial q_1}\frac{dq_1}{ds} + \frac{\partial p_2}{\partial q_2}\frac{dq_2}{ds}\right) + \frac{\partial \pi^2}{\partial q_1}\frac{dq_1}{ds} + \frac{\partial \pi^2}{\partial q_2}\frac{dq_2}{ds} + \frac{\partial \pi^2}{\partial s} - 2sq_2\frac{dq_2}{ds} - {q_2}^2 = 0 \quad (13)$$

Inserting Equations 2 and 11 into Equation 13, the following can be obtained:

$$\frac{dW}{ds} = \frac{\partial \pi^2}{\partial p_1}\frac{\partial p_1}{\partial q_1}\frac{dq_1}{ds} + \frac{\partial \pi^2}{\partial q_1}\frac{dq_1}{ds} - 2sq_2\frac{dq_2}{ds} = 0 \quad (14)$$

Applying Equations 1, 2 and 11, the optimal quality subsidy is obtained as 0.0043. Substitute this ratio into Equations 4 and 10 to obtain the quality level for both firms as 0.1267 and 0.0242. Furthermore, substitute this quality level into Equation 2 to have prices for the two products as 0.0538 and 0.0051. In Table 2, numbers of rows 5 to 7 demonstrate the equilibrium before and after the imposition of the quality-improving subsidy policy. It shows that after the imposition of quality subsidies, the quality level of the low quality firm increases, along with the market served.

Accordingly, imposing the policy of minimum quality standards raises the quality of both domestic and foreign coffee, and the difference in the quality of the two coffees is also narrowed down which further brings down the price gap. Moreover, adopting a subsidization policy gives rise to the same effect on price, quality and the quantity. Therefore, the policy effects are equivalent for the minimum quality standards and the quality-upgrading subsidies, which will no doubt help the Peruvian coffee raise its product quality and profit.

Conclusion

Regardless of the extensive contributions been made to our understanding in the literature on trade and industrial organization, the analysis and comparison of the two commonly practiced policy tools such as MQS and quality-improving subsidies regarding vertical product differentiation has not yet been examined. This short note aims to analyze the effect of minimum quality standards and quality-improving subsidies. It is shown that minimum quality standards is equivalent to quality subsidies in that quality levels and price levels are the same under these two policies. This implies that Peruvian governments can start imposing a policy of quality subsidies as a short-term policy, and then, switch to the policy of minimum quality standards when national budget is limited without disturbing the market.

ACKNOWLEDGEMENTS

We are grateful to the National Science Council (98-2410-H-218-019) for their financial support. Also, we thank the editor and the two anonymous referees for providing very constructive comments and suggestions.

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[12] $\pi^1{}_{q_1 q_1} = \frac{-8{q_2}^2(5q_1 + q_2)}{(4q_1 - q_2)^4} - 2 < 0$ and

$D = [\frac{-8{q_2}^2(5q_1 + q_2)}{(4q_1 - q_2)^4} - 2][-\frac{2{q_1}^2(8q_1 + 7q_2)}{(4q_1 - q_2)^4} - 2(1-s)]$

$-\frac{2q_1 q_2(8q_1 + 7q_2)}{(4q_1 - q_2)^4}\frac{8q_1 q_2(5q_1 + q_2)}{(4q_1 - q_2)^4} > 0$. The second order is satisfied.

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