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Journal of Environmental Economics and Management 47 (2004) 284–306
JOURNAL OF ENVIRONMENTAL ECONOMICS AND MANAGEMENT
http://www.elsevier.com/locate/jeem

Environmental quality competition and eco-labeling

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Received 1 July 2002; revised 20 November 2002

Abstract

A three-stage game of investment, environmental quality provision and price competition is developed to study the impact of green technology investment (eco-labeling), in a duopoly model of vertical product differentiation. The firms' incentives to invest in green technologies depend on their relative cost structure. When firms are identical with respect to fixed costs, both firms will always invest, but if one firm is more efficient in investing, then the other firm may or may not invest depending on the level of unit cost of investment. Quality competition will be tighter when the low-quality firm is more efficient, and looser when the high-quality firm is more efficient in investing. Socially optimal investment for both firms is always positive, but lower than in the duopoly solution. In the absence of environmental externalities, the quality dispersion chosen by profit maximizing firms may be too high or too low, while environmental externalities increase the possibility low-quality dispersion that is too low within the market solution. Finally, and importantly, ecolabeling can be used as a means of reducing excessive investment and increasing environmental quality that is too low.

JEL classification: L13; H23; Q20

Keywords: Product differentiation; Technology investment; Socially optimal quality and investments

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doi:10.1016/S0095-0696(03)00078-0

Nomenclature

$k = \mathrm{H}, \mathrm{L}$	index of technology for high-quality (H) and low-quality (L) cost firms
b	marginal cost parameter for provision of quality by firm $k = \mathrm{H}, \mathrm{L}$
$\alpha_k(I_k)$	fixed costs of quality provision depending on investment
s_k	quality of goods provided in second stage
$c_k(s_k, I_k)$	total cost of providing quality for the firm $k = \mathrm{H}, \mathrm{L}$
p_k^*	optimal (Bertrand) prices from third-stage price competition for firm $k = \mathrm{H}, \mathrm{L}$
u	utility of consumer
π^k	profit function for low-quality ($k = \mathrm{L}$) and high-quality ($k = \mathrm{H}$) firms
s_k^*	quality level of goods provided by duopoly for low ($k = \mathrm{L}$) and high ($k = \mathrm{H}$) quality
s_k^{w}	socially optimal quality level of goods for low ($k = \mathrm{L}$) and high ($k = \mathrm{H}$) quality
s_k^{we}	quality level of goods provided in market under the externality case for low ($k = \mathrm{L}$) and high ($k = \mathrm{H}$) quality
x	difference in fixed costs, $x = x(I_{\mathrm{H}}, I_{\mathrm{L}}) = \alpha_{\mathrm{H}}(I_{\mathrm{H}}) - \alpha_{\mathrm{L}}(I_{\mathrm{L}})$
θ	consumer i's taste parameter, i.e., marginal willingness to pay for good
$\hat{\theta}$	threshold taste parameter for consumer who is indifferent between consumption of high and low environmental quality goods
$\bar{\theta}$	upper bound on consumers' marginal willingness to pay for environmental quality
$\underline{\theta}$	lower bound on consumers' marginal willingness to pay for environmental quality
$\tilde{\theta}$	index of marginal consumer when both high- and low-quality goods are sold at marginal cost
I^k	first-stage investment in technology for firm $k = \mathrm{H}, \mathrm{L}$.
$I_{\mathrm{W}k}$	social welfare maximizing level of investment in technology ($k = \mathrm{H}, \mathrm{L}$)
d_k	demand (number of consumers) purchasing high- ($k = \mathrm{H}$) and low- ($k = \mathrm{L}$) quality goods
$\tilde{\pi}^k$	profits of high- and low-quality firms ($k = (\mathrm{H}, \mathrm{L})$), gross of investment costs, when prices and qualities have been chosen optimally
V^k	profit function corresponding to first stage, where firms choose their production technology
u^{e}	utility of consumer in the presence of an externality
γ	weight reflecting the magnitude of the externality
s_{a}	average level of environmental quality across the firms
SW	social welfare function in the absence of environmental-quality-related externalities
$\bar{\theta}_k$	partial derivative of upper bound on marginal willingness to pay wrt quality $k = \mathrm{H}, \mathrm{L}$
$\underline{\theta}_k$	partial derivative of lower bound on marginal willingness to pay wrt quality $k = \mathrm{H}, \mathrm{L}$