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Author(s): Chiou-nan Yeh, Sontachai Suwanakul and Chao-cheng Mai
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Revenue-Neutral Tax Policies Under Price Uncertainty: Comment

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In an interesting paper in this *Journal*, Holloway investigated the firm's response to revenue-neutral taxation under price uncertainty. In his analysis, revenue-neutral policies adjust simultaneously the marginal tax rate and the level of exemptions while keeping expected tax receipts constant. Using an assumption of nonincreasing absolute risk aversion, he concluded that a reduction in the marginal rate would cause the firm to contract output.

Holloway used the 1986 Tax Reform Act as an example of a revenue-neutral policy. As a matter of fact, the act was intended to be revenue-neutral while lowering marginal rates and broadening the tax base by changing depreciation rules and eliminating the investment tax credit. Since the act altered the tax rate structure and changed the rules under which profit subject to tax is calculated, it will undoubtedly have a significant long-run impact on production and investment decisions. Unfortunately, Holloway's analysis was limited to the short-run impact of a revenue-neutral policy in which the number of firms in the industry is exogenously given. Thus, his results may be somewhat misleading. The present note extends Holloway's analysis to include a long-run case in which firms are allowed to enter or exit the industry. It will be shown that the results derived in our analysis are significantly different from those obtained in Holloway.

Analysis

Adopting Holloway's notation, let us consider a competitive industry comprised of n firms, each of which produces a homogeneous output x_i. Following Appelbaum and Katz, we assume industry demand is stochastic and given by

$$(1) \quad p = g(X) + \gamma\epsilon, \quad \frac{\partial p}{\partial X} = \frac{\partial g}{\partial X} \equiv g_X < 0$$
$$E(p) \equiv \mu_p = g(X)$$

where p is the price, $X = \Sigma_{i=1}^{n} x_i$ is total industry output, j is a positive shift parameter, and ϵ is a random variable with probability density $k(\epsilon)$ of ϵ and $E(\epsilon) = 0$ and $E(\epsilon^2) = 1$. It is assumed here that $k(\epsilon)$ takes on positive values for the range $\underline{\epsilon} < \epsilon < \bar{\epsilon}$, where $\underline{\epsilon}$ is lower bound and $\bar{\epsilon}$ is upper bound of ϵ. This boundedness assumption allows that p is positive for any value of ϵ. It should be emphasized that the specification of (1) simply implies that the support of the random variable ϵ and its density are assumed to be independent of the output level and the number of firms. This specification is widely used in uncertainty literature. Although our assumption may be somewhat specific compared to Holloway's, it does make the analysis more tractable.

Given the symmetry of the firms, we have

$$(2) \qquad X = nx.$$

where n is the number of firms in the industry.

Following Holloway, the first-order condition for an individual firm is given by:

$$(3) \qquad K(x, n) \equiv E\{U'(W)[p - c'(x)]\} = 0$$

where $W = W_0 + \pi(x)$, W_0 is initial wealth, $\pi(x) = [px - c(x) - f][1 - \tau] + Y\tau$ is the firm's net profit, $c(x)$ is total variable cost, f is fixed cost, τ is a constant marginal tax rate, and Y is a tax exemption. The corresponding second-order condition is $E\{U''(W)[p - c'(x)]^2[1 - \tau] - U'(W)c''(x)\} < 0$.

In the long run, the number of firms in the industry is determined by free entry and exit such that the expected utility of being in the industry is equal to the utility of some benchmark activity. Denoting by R the utility of this benchmark, the long-run equilibrium entry condition can be specified as[1]

$$(4) \quad H(x,n) \equiv E\{U(W_0 + [px - c(x) - f][1 - \tau] + Y\tau)\} - R = 0.$$

Taking account of (1) and (2), equations (3) and (4) can be used to determine the equilibrium values of x and n. To determine the impact of revenue-neutral taxation on total industry output, we first substitute (1) and (2) into (3) and (4), then totally differ-

Chiou-nan Yeh is professor and Sontachai Suwanakul is assistant professor, Department of Business Administration, Alabama State University; Chao-cheng Mai is Director, Sun Yat-Sen Institute for Social Sciences and Philosophy, Academia Sinica.

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[1] Fixed costs, f, are not necessarily sunk and so may exist in the long run. For the long-run interpretation of fixed costs and their implications for entry, see Baumol and Willig.

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entiate the resulting expressions with respect to x, n, τ, and Y to obtain

$$(5)\quad \begin{bmatrix} K_{xx} & K_{xn} \\ H_x & H_n \end{bmatrix} \begin{bmatrix} dx \\ dn \end{bmatrix} = \begin{bmatrix} -K_{x\tau} \\ -H_\tau \end{bmatrix} d\tau + \begin{bmatrix} -K_{xY} \\ -H_Y \end{bmatrix} dY$$

where

$$\begin{aligned} K_{xx} &= \mathrm{E}\{U'(W)[ng_X - c''(x)]\} + [1-\tau] \\ &\quad \cdot \mathrm{E}\{[p - c'(x)]U''(W)[p - c'(x) + nxg_X]\} \\ K_{xn} &= xg_x\mathrm{E}\{U'(W)\} + [1-\tau]x^2 g_X \\ &\quad \cdot \mathrm{E}\{[p - c'(x)]U''(W)\} \\ K_{x\tau} &= -\mathrm{E}\{[p - c'(x)]U''(W)[px - c(x) - f - Y]\} \\ H_{xY} &= \tau\mathrm{E}\{[p - c'(x)]U''(W) \\ H_x &= [1-\tau][nxg_x]\mathrm{E}\{U'(W)\} \\ H_n &= [1-\tau]x^2 g_X \mathrm{E}\{U'(W)\} \\ H_\tau &= -\mathrm{E}\{U'(W)[px - c(x) - f - Y]\} \\ H_Y &= \tau\mathrm{E}\{U'(W)\}. \end{aligned}$$

Noting from (2) that $dx = ndx + xdn$ and applying Cramer's rule, we obtain[2]

$$(6)\quad \left.\frac{\partial X}{\partial \tau}\right|_{dE\{\bar{G}\}=0} = \frac{\bar{x}^2}{D}\mathrm{E}\{U''(\bar{W})[p - c'(\bar{x})]^2[1-\tau] - U'(\bar{W})c''(\bar{x})\} \cdot \mathrm{E}\{U'(\bar{W})(p - \mu_p)\}$$

where

$$\begin{aligned} D &= [1-\tau]\bar{x}^2 g_X \mathrm{E}\{U'(\bar{W})\} \\ &\quad \cdot \mathrm{E}\{U''(\bar{W})[p - c'(\bar{x})]^2[1-\tau] - U'(\bar{W})c''(\bar{x})\} > 0. \end{aligned}$$

Because the second-order condition requires $\mathrm{E}\{U''(\bar{W})[p - c'(\bar{x})]^2[1-\tau] - U'(\bar{W})c''(\bar{x})\} < 0$ and $\mathrm{E}\{U'(\bar{W})(p - \mu_p)\} < 0$ (Ishii, p. 769 and Mai, p. 1163), we have $\partial X/\partial\tau > 0$. Hence industry output responds positively to marginal changes in revenue-neutral taxation when one allows for endogeneity of price, output, and entry into the industry. This result extends Holloway's original finding that the individual firm responds positively to marginal changes in the tax rate. More significantly, however, it implies that a revenue-neutral reduction in the marginal tax rate will contract industry output regardless of whether or not absolute risk aversion is decreasing.[3] The intuition for this result is as follows: a revenue-neutral reduction in the marginal tax rate increases the variance in profits but leaves the mean unchanged. Being risk averse, the industry decreases total output. In long-run equilibrium, a firm remaining in the industry should not be better or worse off than it was before the revenue-neutral tax change. Therefore, the firm's absolute risk aversion will remain unchanged and, hence, it does not matter how risk aversion might alter in response to a change in the firm's welfare.

Finally, the effect of a revenue-neutral tax policy on the mean of tax receipts can be derived as follows:

$$(7)\quad \left.\frac{\partial \mu_G}{\partial \tau}\right|_{d\mathrm{E}\{\bar{G}\}=0} = n\tau\mu_p[\xi + \lambda]\cdot\left.\frac{\partial x}{\partial \tau}\right|_{d\mathrm{E}\{\bar{G}\}=0} + \tau\left[\tau\left.\frac{\partial Y}{\partial \tau}\right|_{d\mathrm{E}\{\bar{G}\}=0} + \bar{x}\mu_p\xi\right]\cdot\left.\frac{\partial n}{\partial \tau}\right|_{d\mathrm{E}\{\bar{G}\}=0}$$

where

$$\xi \equiv \frac{\partial \mu_P}{\partial \bar{X}}\frac{\bar{X}}{\mu_P}, \quad \lambda \equiv \frac{\mu_P - c'(\bar{x})}{\mu_P}$$

and $\mathrm{E}\{\bar{G}\}$ is the expected level of fiscal receipts.

The impact on tax receipts of tax policy can be decomposed into two effects: the first term on the right-hand side of (7) is the output-induced effect resulting from a revenue-neutral change in τ; it is the same as the one in Holloway's paper. The second term represents an entry-induced effect that results from treating the number of firms, n, as an endogenous variable. It is this entry-induced effect that causes our results to deviate from Holloway's. Specifically, the effects of a revenue-neutral tax policy on mean receipts are, in general, indeterminate and hence Holloway's assertion (i.e., mean receipts likely increase as a result of a revenue-neutral reduction in the marginal tax rate when demand is inelastic or producers have low risk aversion) is invalid in a long-run framework.

Conclusion

We have extended Holloway's short-run analysis to a long-run model in which firms are allowed to enter or exit the industry. Results show that a revenue-neutral reduction in the marginal tax rate will contract industry output whether or not absolute risk aversion changes with increases in wealth. These results extend Holloway's finding that a revenue-neutral reduction in the marginal tax rate will cause the individual firm to contract output under nonincreasing absolute risk aversion. Our results also cast doubt on the validity of Holloway's assertion that mean receipts may increase as a result of a revenue-neutral tax rate reduction when demand is inelastic or producers have low risk aversion. Our contrasting results stem solely from assumptions about the endogeneity of price, output, and number of firms.

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[2] The derivations of equations (6) and (7) are available from the authors upon request.

[3] It can easily be shown that the effects of a decline in the marginal tax rate on individual output and number of firms are ambiguous even if decreasing absolute risk aversion is assumed. The former result contrasts with Holloway's claim that this policy will cause the individual firm to contract output.

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