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Abstract

Based on the generalized user-revenue model constructed by Homma (2009, 2012, 2018, 2021), this paper clarifies the relation between competitive pressure and the efficient structure and quiet-life hypotheses, and examines the intertemporal linkages and long-term competitive pressure when the sufficient condition for competitive pressure holds for the long term. Given that the source of this competitive pressure is the possibility of a decrease in quasi-short-run profits, the essence of the pressure is the increase in dynamic cost efficiency driven by that possibility. Competitive pressure defined from this point of view comes into existence when the efficient structure and quiet-life hypotheses are accepted and the two hypotheses have opposing implications with respect to industrial organization policy. From this perspective, the existence of such pressure is desirable insofar as the extended generalized-Lerner index (EGLI) on the cost frontier decreases (i.e., the degree of competition on the cost frontier increases). Indeed, if no competitive pressure exists, then there is the possibility that accepting the efficient structure hypothesis is undesirable with regard to industrial organization policy. Furthermore, when the derived sufficient condition for competitive pressure holds for the long term, there are a linkage between current and future improvements in the dynamic cost efficiencies, a linkage between current and future decreases in the EGLIs on the cost frontier, and long-term competitive pressure (i.e., a linkage between a previous decrease in the EGLI on the cost frontier and future improvements in dynamic cost efficiency).

Keywords: Competitive pressure; Efficient structure hypothesis; Quiet-life hypothesis; Generalized user-revenue model; Extended generalized-Lerner index; Cost frontier; Dynamic cost efficiency; Intertemporal linkage; Long-term competitive pressure

JEL classification: D24; G21; L13

1 Introduction

Based on the generalized user-revenue model (hereafter the GURM) proposed by Homma (2009, 2012, 2018, 2021), this paper clarifies the relation between competitive pressure and the efficient structure and quiet-life hypotheses, as well as the existence of intertemporal linkages and long-term competitive pressure when the sufficient condition for the existence of competitive pressure holds for the long term. First, from the perspective of empirical feasibility, competitive pressure is defined using dynamic cost efficiency as defined by Homma (2018, Definition 8, p. 20), together with the extended generalized-Lerner index (hereafter the EGLI) on the cost frontier described by Homma (2018, Definition 14, p. 46). From a similar perspective, the sufficient condition for the existence of competitive pressure is then derived using Homma (2018, Proposition 11, pp. 77-79) and Homma (2018, Proposition 14, p. 82). From this derivation, the relation between competitive pressure and the efficient structure and quiet-life hypotheses is clarified, and its implications from the perspective of industrial organization policy are examined. The case in which the derived sufficient condition for competitive pressure holds for the long term is of particular interest. For such a case, this paper establishes the intertemporal linkage of dynamic cost efficiencies via the EGLIs on the cost frontier, the intertemporal linkage of the EGLIs on the cost frontier via the dynamic cost efficiencies, and long-term competitive pressure. Finally, the policy implications in this case are addressed from the perspective of industrial organization policy.

The characteristics of the GURM were previously explained in detail by Homma (2018, 2021). Briefly, the GURM is a more general model that relaxes the following six implicit assumptions of Hancock's (1985, 1987, 1991) user-cost model of financial firms: (1) financial firms are risk-neutral, (2) there is no strategic interdependence between financial firms, (3) there is no asymmetric information in the market regarding financial assets and liabilities, (4) there is no uncertainty in holding revenues and costs, (5) the utility function of financial firms does not depend on equity capital, and (6) no cost or price inefficiencies exist in financial firms (i.e., financial firms are perfectly cost and price efficient). For this reason, the GURM is more theoretically rigorous and more appropriate than conventional models under the present conditions of having experienced the recent financial crises and natural disasters.[1]

Using the GURM, Homma (2018) explored the theoretical implications of the efficient structure hypothesis proposed by Demsetz (1973) and the quiet-life hypothesis put forward by Berger and Hannan (1998). Specifically, Homma (2018) developed mathematical formulations and theoretical interpretations of the two hypotheses, the relation between the hypotheses and the EGLI on the cost frontier proposed by Homma (2009, 2012), and the relation between the hypotheses and the existence of intertemporal regular linkages of single-period dynamic cost efficiencies, single-period optimal planned financial goods, single-period Herfindahl indices, and single-period EGLIs on the cost frontier. The theoretical concepts and propositions proposed in this paper are based on those of Homma (2018). For this reason, the related theoretical concepts and propositions of Homma (2018) are repeated in Section 2.

In Section 3, competitive pressure is defined by using the dynamic cost efficiency and the EGLI on the cost frontier, which are the theoretical concepts reviewed in Section 2. In consideration of empirical feasibility, this definition is based on the notion that the source of the competitive pressure is the possibility of a decrease in quasi-short-run profits, meaning that the essence of this pressure is an increase in the dynamic cost efficiency driven by that possibility.

Next, the sufficient condition for the existence of such competitive pressure is derived from Homma (2018, Proposition 11, pp. 77-79) and Homma (2018, Proposition 14, p. 82). The former proposition identifies the assumptions under which the efficient structure hypothesis decreases the EGLI on the cost frontier, while the latter proposition clarifies the assumptions under which the quiet-life hypothesis increases the EGLI on the cost frontier. Accordingly, using these propositions, the theoretical relation between competitive pressure and the efficient structure and quiet-life hypotheses becomes

[1] Homma et al. (2014, pp. 144-145) provides the details of the conventional model.

apparent.

Furthermore, from the perspective of industrial organization policy, the policy implications of the sufficient condition for the existence of this competitive pressure are clarified. It is pointed out that competitive pressure under this condition is desirable since the EGLIs on the cost frontier at the beginning and end of a period decrease (i.e., the degrees of competition on the cost frontier at the beginning and end of the period increase). In addition, it is pointed out that this competitive pressure comes into existence when the efficient structure and quiet-life hypotheses are accepted and the two hypotheses have opposing policy implications from an industrial organization policy perspective. It is also noted that there is the possibility that acceptance of the efficient structure hypothesis is not desirable from this perspective if no such pressure exists.

In Section 4, the intertemporal linkage of dynamic cost efficiencies is defined by examining the case in which the above derived sufficient condition holds for the long term. This linkage is formulated from the derivative used to define competitive pressure and the derivative representing the effect of the dynamic cost efficiency two periods prior on the EGLI on the cost frontier in the previous period. Furthermore, based on this equation, it is shown that this linkage exists and that this equation links the improvement in dynamic cost efficiency in the current period to improvements in future periods when the following two conditions hold for the long term: (1) the above derived sufficient condition, and (2) the condition concerned in the efficient structure hypothesis in that sufficient condition shifted ahead one period. In addition, the policy implications here are clarified from the perspective of industrial organization. It is pointed out that it is desirable that the improvement in dynamic cost efficiency in the current period be linked to improvements in as many future periods as possible. In addition, how the above derived sufficient condition holds for the long term is recognized as a significant policy issue.

Next, the intertemporal linkage of the EGLIs on the cost frontier is defined by focusing on a similar case to the above. This linkage is formulated using the derivative representing the effect of the dynamic cost efficiency in the previous period on the EGLI on the cost frontier in the most recent period and the derivative used to define the competitive pressure in the previous period. Furthermore, based on this equation, it is shown that this linkage exists and that this equation links a decrease in the EGLI on the cost frontier in the current period to those in future periods where the following conditions hold for the long term: (1) the condition concerned in the efficient structure hypothesis in the above derived sufficient condition, and (2) the sufficient condition shifted ahead one period. In addition, the policy implications are described from the perspective of industrial organization policy. It is further recognized that, from this perspective, it is desirable that a decrease in the EGLI on the cost frontier in the current period be linked to those in as many future periods as possible. Here, too, it is pointed out that how the derived sufficient condition holds for the long term is an important policy issue.

Finally, long-term competitive pressure is defined by again noting a similar case to the above. This pressure is formulated by using the derivatives used to define competitive pressure in the two different periods and the derivative representing the effect of the dynamic cost efficiency two periods prior on the EGLI on the cost frontier in the previous period. Furthermore, based on this equation, it is shown that this pressure exists and that the equation links a decrease in the EGLI on the cost frontier in one period prior to the initial period to the improvements of the dynamic cost efficiencies in the future periods where the following conditions hold for the long term: (1) the above derived sufficient condition, (2) the sufficient condition in which the time subscripts are replaced, and (3) the condition concerned in the efficient structure hypothesis in the sufficient condition in which the replacement of time subscripts is shifted ahead one period. In addition, the policy implications are shown from the perspective of industrial organization policy. It is pointed out that, from this perspective, it is desirable that a decrease in the EGLI on the cost frontier in the previous period be linked to improvements in dynamic cost efficiency in as many future periods as possible. It is also recognized that how the above derived sufficient condition holds for the long term is an important policy issue. The above linkages and this pressure are critical in that they enable long-term forecasting and long-term dynamic analyses.

Section 5 summarizes the study's major results and conclusions.

2 Theoretical Specification: Related Theoretical Concepts and Propositions in Homma (2018)

As mentioned above, this paper develops a coherent theory using related theoretical concepts and propositions from Homma (2018). These concepts and propositions are summarized below.[2]

2.1 Dynamic Frontier Variable Cost Function: Homma (2018, Definition 6, p. 17)

Definition 1 (Dynamic Frontier Variable Cost Function) *The dynamic frontier variable cost function of the i-th financial firm in period t, denoted by* $C_i^{DFV}\left(\mathbf{p}_{i,t},\mathbf{q}_{i,t},\mathbf{z}_{i,t}^{Q},b_1\cdot\mathbf{HI}_{t-1},b_1\cdot EF_{i,t-1}^{S},\tau_{i,t}\right)$, *is given by*

$$\begin{aligned}&C_i^{DFV}\left(\mathbf{p}_{i,t},\mathbf{q}_{i,t},\mathbf{z}_{i,t}^{Q},b_1\cdot\mathbf{HI}_{t-1},b_1\cdot EF_{i,t-1}^{S},\tau_{i,t}\right)\\&=\min_{\mathbf{x}_{i,t}}\left\{\sum\nolimits_{j=1}^{M}p_{i,j,t}\cdot x_{i,j,t}\,\middle|\,\phi_i^{D}\left(\mathbf{q}_{i,t},\mathbf{x}_{i,t},\mathbf{z}_{i,t}^{Q},b_1\cdot\mathbf{HI}_{t-1},b_1\cdot EF_{i,t-1}^{S},\tau_{i,t}\right)=0\right\},\\&\qquad\qquad (t\geq 0)\,,\quad (2.1)\end{aligned}$$

where $\mathbf{p}_{i,t}=(p_{i,1,t},\cdots,p_{i,M,t})'$ *is a vector of input prices,* $\mathbf{q}_{i,t}=(q_{i,1,t},\cdots,q_{i,N_A+N_L,t})'$ *is a vector of real balances of financial goods, namely financial assets (i.e.,* $q_{i,1,t},\cdots,q_{i,N_A,t}$*) and liabilities (i.e.,* $q_{i,N_A+1,t},\cdots,q_{i,N_A+N_L,t}$*),* $\mathbf{x}_{i,t}=(x_{i,1,t},\cdots,x_{i,M,t})'$ *is a vector of real resource inputs, namely labor, materials, and physical capital,* $\mathbf{z}_{i,t}^{Q}=\left(\mathbf{z}_{i,1,t}^{Q\prime},\cdots,\mathbf{z}_{i,N_A+N_L,t}^{Q\prime}\right)'$ *is a vector of exogenous (state) variables affecting the quality of financial goods, namely, financial technological factors that affect financial goods and real resource inputs,* b_1 *is a parameter used to distinguish between the initial period and the later period:* $b_1=0$ *for*

[2] Definition number, equation number, and proposition number are different from those in Homma (2018).

the initial period (i.e., $t = 0$), and $b_1 = 1$ for the later period (i.e., $t \geq 1$), $\mathbf{HI}_{t-1} = (HI_{1,t-1}, ..., HI_{N_A+N_L,t-1})'$ is a vector of Herfindahl indices in the previous period, $EF^S_{i,t-1}$ is static cost efficiency in the previous period,[3] *$\tau_{i,t}$ is an index of (exogenous) technical change, and $\phi^D_i(\cdot,\cdot,\cdot,\cdot,\cdot,\cdot) = 0$ is a dynamic transformation function.*[4]

2.2 Dynamic Actual Variable Cost Function: Homma (2018, Definition 7, pp. 18-19)

Definition 2 (Dynamic Actual Variable Cost Function) *The dynamic actual variable cost function of the i-th financial firm in period t, denoted by $C^{DAV}_i\left(\mathbf{a}^{DIE}_{i,t}, \mathbf{p}_{i,t}, \mathbf{q}_{i,t}, \mathbf{z}^Q_{i,t}, b_1 \cdot \mathbf{HI}_{t-1}, b_1 \cdot EF^S_{i,t-1}, \tau_{i,t}\right)$, is given by*

$$\begin{aligned}
&C^{DAV}_i\left(\mathbf{a}^{DIE}_{i,t}, \mathbf{p}_{i,t}, \mathbf{q}_{i,t}, \mathbf{z}^Q_{i,t}, b_1 \cdot \mathbf{HI}_{t-1}, b_1 \cdot EF^S_{i,t-1}, \tau_{i,t}\right) \\
&= \sum_{j=1}^{M} p_{i,j,t} \cdot a^{DIE}_{i,j,t} \cdot \frac{\partial C^{DFV}_i\left(\mathbf{p}_{i,t}, \mathbf{q}_{i,t}, \mathbf{z}^Q_{i,t}, b_1 \cdot \mathbf{HI}_{t-1}, b_1 \cdot EF^S_{i,t-1}, \tau_{i,t}\right)}{\partial p_{i,j,t}} \\
&= \sum_{j=1}^{M} p_{i,j,t} \cdot a^{DIE}_{i,j,t} \cdot x^{DFD}_{i,j}\left(\mathbf{p}_{i,t}, \mathbf{q}_{i,t}, \mathbf{z}^Q_{i,t}, b_1 \cdot \mathbf{HI}_{t-1}, b_1 \cdot EF^S_{i,t-1}, \tau_{i,t}\right) \\
&\geq C^{DFV}_i\left(\mathbf{p}_{i,t}, \mathbf{q}_{i,t}, \mathbf{z}^Q_{i,t}, b_1 \cdot \mathbf{HI}_{t-1}, b_1 \cdot EF^S_{i,t-1}, \tau_{i,t}\right), (t \geq 0), \qquad (2.2)
\end{aligned}$$

where $\mathbf{a}^{DIE}_{i,t} = \left(a^{DIE}_{i,1,t}, \cdots, a^{DIE}_{i,M,t}\right)'$ is a vector of inefficiency coefficients of dynamic factor demand functions denoted by

$$\begin{aligned}
&x^{DFD}_{i,j}\left(\mathbf{p}_{i,t}, \mathbf{q}_{i,t}, \mathbf{z}^Q_{i,t}, b_1 \cdot \mathbf{HI}_{t-1}, b_1 \cdot EF^S_{i,t-1}, \tau_{i,t}\right) \\
&\left(= \partial C^{DFV}_i\left(\mathbf{p}_{i,t}, \mathbf{q}_{i,t}, \mathbf{z}^Q_{i,t}, b_1 \cdot \mathbf{HI}_{t-1}, b_1 \cdot EF^S_{i,t-1}, \tau_{i,t}\right) \Big/ \partial p_{i,j,t};\ j = 1, ..., M\right).
\end{aligned}$$

Some elements of this vector $\mathbf{a}^{DIE}_{i,t}$ may be less than, equal to, or greater than one, but not all can be less than one, as otherwise the dynamic actual variable cost function would be less than the dynamic frontier variable cost function.

[3] For details, see Homma (2018, Definition 4, p. 12).

[4] For details, see Homma (2018, Definition 5, pp. 14-17).

2.3 Dynamic Cost Efficiency: Homma (2018, Definition 8, p.20)

Definition 3 (Dynamic Cost Efficiency) *The dynamic cost efficiency of the i-th financial firm in period t, denoted by $EF_{i,t}^{D}$, is given by*

$$EF_{i,t}^{D} = \frac{C_i^{DFV}\left(\mathbf{p}_{i,t}, \mathbf{q}_{i,t}, \mathbf{z}_{i,t}^{Q}, b_1 \cdot \mathbf{HI}_{t-1}, b_1 \cdot EF_{i,t-1}^{S}, \tau_{i,t}\right)}{C_i^{DAV}\left(\mathbf{a}_{i,t}^{DIE}, \mathbf{p}_{i,t}, \mathbf{q}_{i,t}, \mathbf{z}_{i,t}^{Q}, b_1 \cdot \mathbf{HI}_{t-1}, b_1 \cdot EF_{i,t-1}^{S}, \tau_{i,t}\right)}, (t \geq 0)\,. \tag{2.3}$$

2.4 Quasi-Short-Run Profit Based on Dynamic Frontier Cost: Homma (2018, Definition 9, pp. 25-26)

Definition 4 (Quasi-Short-Run Profit Based on Dynamic Frontier Cost) *The quasi-short-run profit based on the dynamic frontier cost of the i-th financial firm during period t, denoted by $\pi_i^{QSF}\left(\mathbf{q}_{i,t-1}, \mathbf{q}_{i,t}, \mathbf{z}_{i,t}^{\pi}\right)$, is defined as follows:*

$$\begin{aligned}&\pi_i^{QSF}\left(\mathbf{q}_{i,t-1}, \mathbf{q}_{i,t}, \mathbf{z}_{i,t}^{\pi}\right)\\ &= \sum_{j=1}^{N_A+N_L} b_j \cdot \left[\left\{1 + b_C \cdot h_{i,j}^{R}\left(Q_{j,t-1}, \mathbf{z}_{i,j,t-1}^{DH}\right) + \zeta_{i,j,t}\right\} \cdot p_{G,t-1} \cdot q_{i,j,t-1} - p_{G,t} \cdot q_{i,j,t}\right]\\ &\qquad - C_i^{DFV}\left(\mathbf{q}_{i,t}, \mathbf{z}_{i,t}^{C}\right),\ (t \geq 1),\end{aligned} \tag{2.4.1}$$

$$\begin{aligned}&\pi_i^{QSF}\left(\mathbf{q}_{i,0}, \mathbf{z}_{i,0}^{\pi}\right)\\ &= \sum_{j=1}^{N_A+N_L} b_j \cdot \left\{b_C \cdot h_{i,j}^{R}\left(Q_{j,0}, \mathbf{z}_{i,j,0}^{DH}\right) + \zeta_{i,j,0}\right\} \cdot p_{G,0} \cdot q_{i,j,0} - C_i^{DFV}\left(\mathbf{q}_{i,0}, \mathbf{z}_{i,0}^{C}\right),\end{aligned} \tag{2.4.2}$$

where $\mathbf{z}_{i,t}^{\pi} = \left(\mathbf{z}_{i,t-1}^{DH\prime}, \boldsymbol{\zeta}_{i,t}^{\prime}, p_{G,t-1}, p_{G,t}, \mathbf{z}_{i,t}^{C\prime}\right)^{\prime}$ $(t \geq 0)$ are vectors of exogenous variables affecting quasi-short-run profit, and in the case of $t = 0$, $\mathbf{z}_{i,0}^{\pi} = \left(\mathbf{z}_{i,0}^{DH\prime}, \boldsymbol{\zeta}_{i,0}^{\prime}, p_{G,0}, , \mathbf{z}_{i,0}^{C\prime}\right)^{\prime}$. More specifically, $\mathbf{z}_{i,t-1}^{DH} = \left(\mathbf{HI}_{t-2}^{\prime}, EF_{i,t-2}^{S}, \mathbf{z}_{i,t-1}^{H\prime}\right)^{\prime}$ $(t \geq 0)$ are vectors of exogenous variables affecting the certain or predictable *components of SDEHRR and SDEHCR in the period* $t-1$ (≥ -1)*,*[5] *and in the case of* $t \leq 1$*,*

$$\mathbf{z}_{i,-1}^{DH} = \left(\mathbf{HI}'_{-2}, EF_{i,-2}^{S}, \mathbf{z}_{i,-1}^{H\prime}\right)' = \mathbf{z}_{i,0}^{DH} = \left(\mathbf{HI}'_{-1}, EF_{i,-1}^{S}, \mathbf{z}_{i,0}^{H\prime}\right)' = \mathbf{z}_{i,0}^{H}.$$

$\mathbf{z}_{i,t-1}^{H} = \left(\mathbf{z}_{i,1,t-1}^{H\prime}, \cdots, \mathbf{z}_{i,N_A+N_L,t-1}^{H\prime}\right)'$ $(t \geq 0)$ *are vectors of exogenous variables other than Herfindahl indices two periods prior and static cost efficiency two periods prior, and in the case of* $t = 0$, $\mathbf{z}_{i,-1}^{H} = \mathbf{z}_{i,0}^{H} = \left(\mathbf{z}_{i,1,0}^{H\prime}, \cdots, \mathbf{z}_{i,N_A+N_L,0}^{H\prime}\right)'$. $\boldsymbol{\zeta}_{i,t} = \left(\zeta_{i,1,t}, \cdots, \zeta_{i,N_A+N_L,t}\right)'$ $(t \geq 0)$ *are vectors of the uncertain or unpredictable components of SDEHRR and SDEHCR, and* $p_{G,t}$ $(t \geq 0)$ *are general price indices.* $\mathbf{z}_{i,t}^{C} = \left(\mathbf{p}'_{i,t}, \mathbf{z}_{i,t}^{Q\prime}, b_1 \cdot \mathbf{HI}'_{t-1}, b_1 \cdot EF_{i,t-1}^{S}, \tau_{i,t}\right)'$ $(t \geq 0)$ *are vectors of exogenous variables affecting the dynamic frontier variable cost function.* b_j *is a parameter distinguishing between financial assets and liabilities:* $b_j = 1$ *for financial assets (i.e.,* $j = 1, ..., N_A$*), and* $b_j = -1$ *for liabilities (i.e.,* $j = N_A + 1, ..., N_A + N_L$*).* $b_C \cdot h_{i,j}^{R}\left(Q_{j,t-1}, \mathbf{z}_{i,j,t-1}^{DH}\right) + \zeta_{i,j,t}$ $(j = 1, ..., N_A + N_L)$ *are the SDEHRRs or the SDEHCRs of the* j*-th financial good of the* i*-th firm at the end of period* $t-1$*, and* b_C *is a parameter distinguishing cash from other financial assets. In other words, if* $q_{i,j,t}$ *represents cash (i.e.,* $j = 1$*), then* $b_C = 0$*, whereas if the financial good is another type of financial asset (i.e.,* $j \neq 1$*), then* $b_C = 1$*.* $h_{i,j}^{R}\left(Q_{j,t-1}, \mathbf{z}_{i,j,t-1}^{DH}\right)$ *is the certain or predictable component of the SDEHRR or the SDEHCR, and* $Q_{j,t-1}$ *is total* j*-th financial goods (i.e., financial assets or liabilities) in the market.*

2.5 Quasi-Short-Run Profit Based on Dynamic Actual Cost: Homma (2018, Definition 10, pp. 26-27)

Definition 5 (Quasi-Short-Run Profit Based on Dynamic Actual Cost) *The quasi-short-run profit based on the dynamic actual cost of the* i*-th financial firm during period* t*, denoted by* $\pi_i^{QSA}\left(\mathbf{a}_{i,t}^{DIE}, \mathbf{q}_{i,t-1}, \mathbf{q}_{i,t}, \mathbf{z}_{i,t}^{\pi}\right)$*, is defined by replacing the dynamic frontier variable cost function* $C_i^{DFV}(\cdot,\cdot)$ *in Definition*

[5] For details regarding SDEHRR and SDEHCR, see Homma (2018, p.25).

9 with the dynamic actual variable cost function $C_i^{DAV}(\cdot,\cdot,\cdot)$ *as follows:*

$$\pi_i^{QSA}\left(\mathbf{a}_{i,t}^{DIE},\mathbf{q}_{i,t-1},\mathbf{q}_{i,t},\mathbf{z}_{i,t}^{\pi}\right)$$
$$=\sum\nolimits_{j=1}^{N_A+N_L} b_j\cdot\left[\left\{1+b_C\cdot h_{i,j}^{R}\left(Q_{j,t-1},\mathbf{z}_{i,j,t-1}^{DH}\right)+\zeta_{i,j,t}\right\}\cdot p_{G,t-1}\cdot q_{i,j,t-1}-p_{G,t}\cdot q_{i,j,t}\right]$$
$$-C_i^{DAV}\left(\mathbf{a}_{i,t}^{DIE},\mathbf{q}_{i,t},\mathbf{z}_{i,t}^{C}\right),\ (t\geq 1), \quad (2.5.1)$$

$$\pi_i^{QSA}\left(\mathbf{a}_{i,0}^{DIE},\mathbf{q}_{i,0},\mathbf{z}_{i,0}^{\pi}\right)$$
$$=\sum\nolimits_{j=1}^{N_A+N_L} b_j\cdot\left\{b_C\cdot h_{i,j}^{R}\left(Q_{j,0},\mathbf{z}_{i,j,0}^{DH}\right)+\zeta_{i,j,0}\right\}\cdot p_{G,0}\cdot q_{i,j,0}-C_i^{DAV}\left(\mathbf{a}_{i,0}^{DIE},\mathbf{q}_{i,0},\mathbf{z}_{i,0}^{C}\right), \quad (2.5.2)$$

where $\pi_i^{QSA}\left(\mathbf{a}_{i,t}^{DIE},\mathbf{q}_{i,t-1},\mathbf{q}_{i,t},\mathbf{z}_{i,t}^{\pi}\right)$ *is not greater than* $\pi_i^{QSF}\left(\mathbf{q}_{i,t-1},\mathbf{q}_{i,t},\mathbf{z}_{i,t}^{\pi}\right)$ *(i.e.,* $\pi_i^{QSA}\left(\mathbf{a}_{i,t}^{DIE},\mathbf{q}_{i,t-1},\mathbf{q}_{i,t},\mathbf{z}_{i,t}^{\pi}\right)\leq\pi_i^{QSF}\left(\mathbf{q}_{i,t-1},\mathbf{q}_{i,t},\mathbf{z}_{i,t}^{\pi}\right)$*), because* $C_i^{DAV}\left(\mathbf{a}_{i,t}^{DIE},\mathbf{q}_{i,t},\mathbf{z}_{i,t}^{C}\right)$ *is not less than* $C_i^{DFV}\left(\mathbf{q}_{i,t},\mathbf{z}_{i,t}^{C}\right)$ *(i.e.,* $C_i^{DAV}\left(\mathbf{a}_{i,t}^{DIE},\mathbf{q}_{i,t},\mathbf{z}_{i,t}^{C}\right)\geq C_i^{DFV}\left(\mathbf{q}_{i,t},\mathbf{z}_{i,t}^{C}\right)$*).*

2.6 Extended Generalized-Lerner Index on the Cost Frontier: Homma (2018, Definition 14, p. 46)

Definition 6 (Extended Generalized-Lerner Index on the Cost Frontier) *The extended generalized-Lerner index on the cost frontier of the* j*-th financial good of the* i*-th financial firm in period* t*, denoted by* $EGLI_{i,j,t}^{F}$*, is defined as*[6]

$$EGLI_{i,j,t}^{F}=\frac{p_{i,j,t}^{SURF}-MC_{i,j,t}^{DFV*}}{p_{i,j,t}^{SURF}}=-\frac{\eta_{i,j,t}^{BPF*}+MRS_{e,i,t}^{BPF\pi*}+\varpi_{i,j,t}^{BPF*}}{p_{i,j,t}^{SURF}}$$
$$=-\frac{b_C\cdot\eta_{i,j,t}^{*}+\left(MRS_{e,i,t}^{F\pi*}+\varpi_{i,j,t}^{F*}\right)\cdot\left(1+r_{i,t}^{FF*}\right)}{b_C\cdot h_{i,j,t}^{R*}-r_{i,t}^{FF*}};$$
$$j=1,\ldots,N_A+N_L. \quad (2.6)$$

[6]For details, see Homma (2018, pp. 33-46).

2.7 Acceptance of the Efficient Structure Hypothesis: Homma (2018, Definition 17, p. 59)

Definition 7 (Acceptance of the Efficient Structure Hypothesis) *If the planned optimal financial good (e.g., the planned optimal loan) in the current period increases because of improved dynamic cost efficiency in the previous period, then the efficient structure hypothesis is accepted. Specifically, if the sign of* $\partial q^{p*}_{i,j,t}/\partial EF^{D}_{i,t-1}$ *is positive (i.e.,* $\partial q^{p*}_{i,j,t}/\partial EF^{D}_{i,t-1} > 0$*), then the efficient structure hypothesis is accepted.*[7]

2.8 Acceptance of the Quiet-Life Hypothesis: Homma (2018, Definition 18, p. 68)

Definition 8 (Acceptance of the Quiet-Life Hypothesis) *If dynamic cost efficiency in the current period decreases because of an increase in the Herfindahl index in the previous period, then the quiet-life hypothesis is accepted. Specifically, if the sign of* $\partial EF^{D*}_{i,t}/\partial HI_{j,t-1}$ *is negative (i.e.,* $\partial EF^{D*}_{i,t}/\partial HI_{j,t-1} < 0$*), then the quiet-life hypothesis is accepted.*

2.9 Efficient Structure Hypothesis and the EGLI on the Cost Frontier: Homma (2018, Proposition 11, pp. 77-79)

Proposition 1 *The EGLI on the cost frontier decreases with dynamic cost efficiency in the previous period and the* j*-th optimal planned financial good in the current period (i.e., the degree of competition on the cost frontier increases with them,* $\partial EGLI^{F}_{i,j,t}/\partial EF^{D}_{i,t-1} < 0$ *and* $\partial EGLI^{F}_{i,j,t}/\partial q^{p*}_{i,j,t} < 0$*) if and only if the efficient structure hypothesis is accepted (i.e., dynamic efficiency improves,* $\partial q^{p*}_{i,j,t}/\partial EF^{D}_{i,t-1} > 0$*) under the following assumptions: (A1) The* j*-th financial good is an output (i.e.,* $p^{SURF}_{i,j,t} > 0$ *and* $MC^{DFV*}_{i,j,t} > 0$*);*

[7] For details regarding $q^{p*}_{i,j,t}$, see Homma (2018, pp. 28-33).

and (A2) One of the following two pairs of inequalities holds:

$$\begin{aligned}\partial p^{GURF}_{i,j,t}/\partial EF^{D}_{i,t-1} &> \max\left(ME_{i,j,t}, \left(MC^{DFV*}_{i,j,t}/p^{SURF}_{i,j,t}\right)\cdot\left(\partial p^{SURF}_{i,j,t}/\partial EF^{D}_{i,t-1}\right)\right)\\ \textit{and }\partial p^{GURF}_{i,j,t}/\partial q^{p*}_{i,j,t} &> \max\left(MQ_{i,j,t}, \left(MC^{DFV*}_{i,j,t}/p^{SURF}_{i,j,t}\right)\cdot\left(\partial p^{SURF}_{i,j,t}/\partial q^{p*}_{i,j,t}\right)\right),\end{aligned}$$

or

$$\begin{aligned}\left(MC^{DFV*}_{i,j,t}/p^{SURF}_{i,j,t}\right)\cdot\left(\partial p^{SURF}_{i,j,t}/\partial EF^{D}_{i,t-1}\right) &< \partial p^{GURF}_{i,j,t}/\partial EF^{D}_{i,t-1} < ME_{i,j,t}\\ \textit{and }\left(MC^{DFV*}_{i,j,t}/p^{SURF}_{i,j,t}\right)\cdot\left(\partial p^{SURF}_{i,j,t}/\partial q^{p*}_{i,j,t}\right) &< \partial p^{GURF}_{i,j,t}/\partial q^{p*}_{i,j,t} < MQ_{i,j,t},\end{aligned}$$

where $ME_{i,j,t}$ and $MQ_{i,j,t}$ are respectively expressed as

$$\begin{aligned}ME_{i,j,t} &= \left\{EF^{D*}_{i,t} + \left(\frac{\partial \ln C^{DAV*}_{i,t}}{\partial EF^{D*}_{i,t}}\right)^{-1}\right\}\cdot\frac{\partial MC^{DAV*}_{i,j,t}}{\partial EF^{D}_{i,t-1}}\\ &\quad -MC^{DAV*}_{i,j,t}\cdot\frac{\partial^2 \ln C^{DAV*}_{i,t}}{\partial EF^{D}_{i,t-1}\partial EF^{D*}_{i,t}}\Bigg/\left(\frac{\partial \ln C^{DAV*}_{i,t}}{\partial EF^{D*}_{i,t}}\right)^2, \qquad (2.9.1)\\ MQ_{i,j,t} &= \left\{EF^{D*}_{i,t} + \left(\frac{\partial \ln C^{DAV*}_{i,t}}{\partial EF^{D*}_{i,t}}\right)^{-1}\right\}\cdot\frac{\partial MC^{DAV*}_{i,j,t}}{\partial q^{p*}_{i,j,t}}\\ &\quad -MC^{DAV*}_{i,j,t}\cdot\frac{\partial^2 \ln C^{DAV*}_{i,t}}{\partial q^{p*}_{i,j,t}\partial EF^{D*}_{i,t}}\Bigg/\left(\frac{\partial \ln C^{DAV*}_{i,t}}{\partial EF^{D*}_{i,t}}\right)^2. \qquad (2.9.2)\end{aligned}$$

Proof. See Homma (2018, Proposition 11, pp.77-79). ■

2.10 Quiet-Life Hypothesis and the EGLI on the Cost Frontier: Homma (2018, Proposition 14, p. 82)

Proposition 2 *The EGLI on the cost frontier increases with the Herfindahl index in the previous period (i.e., the degree of competition on the cost frontier decreases, $\partial EGLI^{F}_{i,j,t}/\partial HI_{j,t-1} > 0$) if and only if the quiet-life hypothesis is accepted (i.e., $\partial EF^{D*}_{i,t}/\partial HI_{j,t-1} < 0$). The EGLI on the cost frontier decreases with dynamic cost efficiency in the "current" period (i.e.,*

$\partial EGLI_{i,j,t}^{F}/\partial EF_{i,t}^{D*} < 0$) *under the following assumptions: (A7) The j-th financial good is an output (i.e.,* $p_{i,j,t}^{SURF} > 0$ *and* $MC_{i,j,t}^{DFV*} > 0$) *and the sign of* $MC_{i,j,t}^{DAV*}$ *is the same as the sign of* $MC_{i,j,t}^{DFV*}$ *(i.e.,* $MC_{i,j,t}^{DAV*} > 0$*); and (A8) The following inequality holds:*

$$\frac{\partial p_{i,j,t}^{GURF}}{\partial HI_{j,t-1}} < \min\left(MH_{i,j,t}, \frac{MC_{i,j,t}^{DFV*}}{p_{i,j,t}^{SURF}} \cdot \frac{\partial p_{i,j,t}^{SURF}}{\partial HI_{j,t-1}} \right),$$

where $MH_{i,j,t}$ *is expressed as*

$$\begin{aligned} MH_{i,j,t} &= \left\{ EF_{i,t}^{D*} + \left(\frac{\partial \ln C_{i,t}^{DAV*}}{\partial EF_{i,t}^{D*}} \right)^{-1} \right\} \cdot \frac{\partial MC_{i,j,t}^{DAV*}}{\partial HI_{j,t-1}} \\ &\quad - MC_{i,j,t}^{DAV*} \cdot \frac{\partial^2 \ln C_{i,t}^{DAV*}}{\partial HI_{j,t-1} \partial EF_{i,t}^{D*}} \bigg/ \left(\frac{\partial \ln C_{i,t}^{DAV*}}{\partial EF_{i,t}^{D*}} \right)^2. \end{aligned} \quad (2.10)$$

Proof. See Homma (2018, pp.81-82). ■

3 Competitive Pressure and the Efficient Structure and Quiet-Life Hypotheses

3.1 Definition of Competitive Pressure

Two alternative formulations can been used to define competitive pressure. Principally from a theoretical perspective, the first formulation considers the strategic interdependence of financial firms on the basis of game theory. The second, which arises from a more empirical perspective, uses dynamic cost efficiency and the degree of competition on the cost frontier. This paper adopts the latter formulation for two reasons: First, empirical feasibility is considered to be of preeminent importance; second, the strategic interdependence of financial firms is considered in the degree of competition on the cost frontier. Specifically, in this paper, competitive pressure is defined by using the dynamic cost efficiency defined in Definition 3 in Subsection 2.3 and the EGLI on the cost frontier as defined in Definition 6 in Subsection 2.6. The strategic interdependence of financial firms is considered as the market structure and conduct effect based on the cost frontier, $\eta_{i,j,t}^{BPF*}$ $(= b_j \cdot p_{G,t} \cdot b_C \cdot \eta_{i,j,t}^{*} / (1 + r_{i,t}^{FF*}))$, in the EGLI on the cost frontier. Importantly, consideration of the EGLI on the cost frontier makes it possible to consider the true degree of competition, completely excluding the effects of inefficiencies. From the above, competitive pressure is defined as follows:

Definition 9 (Existence of Competitive Pressure) *If the dynamic cost efficiency in the current period increases because of a decrease in the EGLI on the cost frontier in the previous period, then the competitive pressure exists. Specifically, if $EGLI_{i,j,t-1}^{F}$ decreases and the sign of $\partial EF_{i,t}^{D} / \partial EGLI_{i,j,t-1}^{F}$ is negative (i.e., $\partial EF_{i,t}^{D} / \partial EGLI_{i,j,t-1}^{F} < 0$), then the competitive pressure exists.*

For example, where a decrease in the EGLI on the cost frontier in the previous period (i.e., $EGLI_{i,j,t-1}^{F} = (p_{i,j,t-1}^{SURF} - MC_{i,j,t-1}^{DFV}) / p_{i,j,t-1}^{SURF}$) is the result of a decrease in the stochastic user-revenue price on the cost frontier in the previous period (i.e., $p_{i,j,t-1}^{SURF} = b_j \cdot p_{G,t-1} \cdot (b_C \cdot h_{i,j,t-1}^{R} - r_{i,t-1}^{FF}) / (1 + r_{i,t-1}^{FF})$), which results from a decrease in the certain or predictable component (i.e., $b_C \cdot h_{i,j,t-1}^{R}$; $j = 1, ..., N_A$) of the stochastic dynamic endogenous holding-revenue rate (the above SDEHRR) in the current period (i.e., $b_C \cdot h_{i,j,t-1}^{R} + \zeta_{i,j,t}$; $j = 1, ..., N_A$) or an increase in the certain or predictable component (i.e., $h_{i,j,t-1}^{R}$; $j = N_A + 1, ..., N_A + N_L$) of the stochastic dynamic endogenous holding-cost rate (the above SDEHCR) in the current period (i.e., $h_{i,j,t-1}^{R} + \zeta_{i,j,t}$; $j = N_A + 1, ..., N_A + N_L$),[8] from Definition 4 in Subsection 2.4, the quasi-short-run profit based on the dynamic frontier cost in the current period decreases if the dynamic frontier variable cost in the current period does not decrease. Therefore, the pressure to decrease this frontier cost rises. Similarly, from Definition 5 in Subsection 2.5, the quasi-short-run profit based on the dynamic actual cost in the current period decreases if the dynamic actual variable cost in the current period does not decrease. Therefore, the pressure to decrease this actual cost rises. From Definition 2 in Subsection

[8] The following equation holds: $h_{i,j,t-1}^{R} = h_{i,j}^{R} (Q_{j,t-1}, \mathbf{z}_{i,j,t-1}^{DH})$.

2.2, the dynamic actual variable cost in the current period is not less than the dynamic frontier variable cost in the current period. Therefore, the quasi-short-run profit based on the dynamic actual cost in the current period is not greater than the quasi-short-run profit based on the dynamic frontier cost in the current period. For this reason, there is a strong possibility that the pressure to decrease the dynamic actual variable cost in the current period is greater than the pressure to decrease the dynamic frontier variable cost in the current period. Consequently, the dynamic cost efficiency in the current period increases.

From the above, the source of the competitive pressure is the possibility of a decrease in the quasi-short-run profits based on the dynamic frontier or actual cost in the current period; thus, the essence of this pressure is an increase in the dynamic cost efficiency in the current period driven by that possibility.

3.2 Sufficient Condition for the Existence of Competitive Pressure

The sufficient condition for the existence of competitive pressure as defined in Definition 9, Subsection 3.1, is shown as Proposition 3 below. From this proposition, the theoretical relation between the competitive pressure and the efficient structure and quiet-life hypotheses becomes clear.

Proposition 3 *Competitive pressure exists under the following assumptions: (P1) The EGLI on the cost frontier in the previous period (i.e.,* $EGLI^F_{i,j,t-1}$*) decreases (i.e., the degree of competition on the cost frontier in the previous period increases); (P2) For the j-th financial good in the current period, the efficient structure hypothesis is accepted (i.e., Definition 7 holds) and Proposition 1 holds (i.e., Assumptions (A1) and (A2) hold); and (P3) For the j-th financial good in the previous and current periods, the quiet-life hypothesis is accepted (i.e., Definition 8 holds) and Proposition 2 holds (i.e., Assumptions (A7) and (A8) hold).*

Proof. From Assumption (P1), it holds that $EGLI^{F}_{i,j,t-1}$ decreases. Moreover, from Assumption (P2), $\partial EGLI^{F}_{i,j,t} / \partial EF^{D}_{i,t-1}$ is negative (i.e., $\partial EGLI^{F}_{i,j,t} / \partial EF^{D}_{i,t-1} < 0$) because Proposition 1 holds. Furthermore, from Assumption (P3), $\partial EF^{D}_{i,t-1} / \partial EGLI^{F}_{i,j,t-1} \left(= \left[\partial EGLI^{F}_{i,j,t-1} / \partial EF^{D}_{i,t-1}\right]^{-1}\right)$ and $\partial EF^{D}_{i,t} / \partial EGLI^{F}_{i,j,t} \left(= \left[\partial EGLI^{F}_{i,j,t} / \partial EF^{D}_{i,t}\right]^{-1}\right)$ are negative (i.e., $\partial EF^{D}_{i,t-1} / \partial EGLI^{F}_{i,j,t-1}$, $\partial EF^{D}_{i,t} / \partial EGLI^{F}_{i,j,t} < 0$) because Proposition 2 holds. Consequently, the following equation holds:

$$\frac{\partial EF^{D}_{i,t}}{\partial EGLI^{F}_{i,j,t-1}} = \frac{\partial EF^{D}_{i,t}}{\partial EGLI^{F}_{i,j,t}} \cdot \frac{\partial EGLI^{F}_{i,j,t}}{\partial EF^{D}_{i,t-1}} \cdot \frac{\partial EF^{D}_{i,t-1}}{\partial EGLI^{F}_{i,j,t-1}} < 0.$$

■

Assumption (P2) in Proposition 3 implies that, for the financial good concerned in the current period, the efficient structure hypothesis is accepted and this acceptance is equivalent to a decrease in the EGLI (i.e., an increase in the degree of competition) on the cost frontier in the current period due to the improvement of the dynamic cost efficiency in the previous period and an increase in the planned optimal financial good concerned in the current period. Not only the acceptance of the efficient structure hypothesis but also the equivalent of this acceptance to a decrease in the EGLI on the cost frontier in the current period is one of the conditions included in the sufficient condition for the existence of the competitive pressure. In addition, Assumption (P3) in Proposition 3 signifies that, for the financial good concerned in the previous and current periods, the quiet-life hypothesis is accepted and this acceptance is equivalent to an increase in the EGLI (i.e., a decrease in the degree of competition) on the cost frontier in the current period due to an increase in the Herfindahl index in the previous period. Not only the acceptance of the quiet-life hypothesis but also the equivalent of this acceptance to an increase in the EGLI on the cost frontier in the current period is also one of the conditions included in the sufficient condition for the existence of competitive pressure. In this way, the acceptance of both hypotheses and the link between this acceptance and a decrease and an increase in the EGLI on the cost frontier become the conditions included in the sufficient condition for the existence of competitive pressure.

3.3 Policy Implications from the Perspective of Industrial Organization Policy

As can be seen from the proof of Proposition 3, the existence of competitive pressure due to the satisfaction of Assumptions (P1), (P2), and (P3) is desirable from the perspective of industrial organization policy insofar as it entails a decrease in the EGLI (i.e., an increase in the degree of competition) on the cost frontier in the previous and current periods. Moreover, Assumption (P2) in Proposition 3 means that, for the financial good concerned in the current period, acceptance of the efficient structure hypothesis is desirable from the same perspective as above because of the linkage to a decrease in the EGLI (i.e., an increase in the degree of competition) on the cost frontier in the current period. Furthermore, Assumption (P3) in Proposition 3 signifies that, for the financial good concerned in the previous and current periods, acceptance of the quiet-life hypothesis is undesirable from the above perspective because of the linkage to an increase in the EGLI (i.e., a decrease in the degree of competition) on the cost frontier in the previous and current periods. Consequently, the competitive pressure comes into existence due not only to the acceptance of both hypotheses but also to their opposing policy implications from the perspective of industrial organization policy.

From another point of view, when the contraposition of Proposition 3 is considered, if there is no competitive pressure, then there is a possibility that (1) the efficient structure hypothesis is not accepted, or (2) the acceptance of the efficient structure hypothesis is not desirable even if the hypothesis is accepted. There is also the possibility that (3) the quiet-life hypothesis is not accepted, or (4) the acceptance of the quiet-life hypothesis is desirable even if the hypothesis is accepted. In particular, possibility (2) becomes a problem from the perspective of industrial organization policy. A lack of competitive pressure creates the possibility that there is no justification for the efficient structure hypothesis.

4 Intertemporal Linkages and Long-Term Competitive Pressure

This section establishes the existence of intertemporal linkages and long-term competitive pressure where the sufficient condition for the existence of competitive pressure (i.e., Proposition 3) holds for the long term. Specifically, this section makes it clear that there are a linkage between current and future improvements in dynamic cost efficiencies, a linkage between current and future decreases in the EGLIs on the cost frontier, and long-term competitive pressure (i.e., a linkage between the previous decrease in the EGLI on the cost frontier and future improvements in dynamic cost efficiency). In addition, the policy implications from the perspective of industrial organization are identified. These linkages enable long-term forecasting and long-term dynamic analyses, making them critical elements.

4.1 Intertemporal Linkage of Dynamic Cost Efficiencies via the EGLIs on the Cost Frontier

In this subsection, the intertemporal linkage of dynamic cost efficiencies is defined for the case in which the above derived sufficient condition (i.e., Proposition 3) holds for the long term. This linkage is formulated using the derivative used to define competitive pressure (i.e., the derivative of the dynamic cost efficiency in the latest period with respect to the EGLI on the cost frontier in the previous period) and the derivative representing the effect of the dynamic cost efficiency two periods prior on the EGLI on the cost frontier in the previous period (i.e., the derivative of the EGLI on the cost frontier in the previous period with respect to the dynamic cost efficiency two periods prior). Furthermore, based on this equation, it is shown that this linkage exists and that the equation links an improvement in dynamic cost efficiency in the current period to those in future periods when the following conditions hold for the long term: (1) the above derived sufficient condition, and (2) the condition concerned in the efficient structure hypothesis in the sufficient condition shifted one period ahead. In addition, the policy implications are clarified from the perspective of industrial organization policy.

The intertemporal linkage of dynamic cost efficiencies, which indicates that an improvement in dynamic cost efficiency in the current period (i.e., in period t) is linked to those in future periods (i.e., in period $t+2T+2$, where T is an integer), is defined as follows:

Definition 10 *If the dynamic cost efficiency in period $t+2T+2$, where T is an integer, increases because of an increase in the dynamic cost efficiency in period t, then there exists the intertemporal linkage of dynamic cost efficiencies. Specifically, if the sign of $\partial EF^D_{i,t+2T+2} / \partial EF^D_{i,t}$ is positive (i.e., $\partial EF^D_{i,t+2T+2} / \partial EF^D_{i,t} > 0$), then there exists the intertemporal linkage of dynamic cost efficiencies.*

The reason for specifying future periods as period $t+2T+2$, where T is an integer, is that it allows us to consider the intertemporal linkage of dynamic cost efficiencies via the EGLIs on the cost frontier, thereby showing a relation to Proposition 3. Although some generality is lost by this specification, theoretical clarity and accuracy are obtained, making way for the rigorous theoretical expansion and development shown below.

The intertemporal linkage of dynamic cost efficiencies via the EGLIs on the cost frontier is formulated in the following proposition:

Proposition 4 $\partial EF^D_{i,t+2T+2} / \partial EF^D_{i,t}$*, where T is an integer, is expressed as follows:*

$$\frac{\partial EF^D_{i,t+2T+2}}{\partial EF^D_{i,t}} = \prod_{k=0}^{T} \left(\frac{\partial EF^D_{i,t+2k+2}}{\partial EGLI^F_{i,j,t+2k+1}} \cdot \frac{\partial EGLI^F_{i,j,t+2k+1}}{\partial EF^D_{i,t+2k}} \right). \tag{4.1}$$

Proof. $\partial EF^D_{i,t+2} / \partial EF^D_{i,t}$ is expressed as follows:

$$\frac{\partial EF^D_{i,t+2}}{\partial EF^D_{i,t}} = \frac{\partial EF^D_{i,t+2}}{\partial EGLI^F_{i,j,t+1}} \cdot \frac{\partial EGLI^F_{i,j,t+1}}{\partial EF^D_{i,t}}. \tag{P4.1}$$

Similarly, $\partial EF^D_{i,t+4} / \partial EF^D_{i,t}$ is expressed as follows:

$$\frac{\partial EF^D_{i,t+4}}{\partial EF^D_{i,t}} = \left(\frac{\partial EF^D_{i,t+4}}{\partial EGLI^F_{i,j,t+3}} \cdot \frac{\partial EGLI^F_{i,j,t+3}}{\partial EF^D_{i,t+2}} \right) \cdot \left(\frac{\partial EF^D_{i,t+2}}{\partial EGLI^F_{i,j,t+1}} \cdot \frac{\partial EGLI^F_{i,j,t+1}}{\partial EF^D_{i,t}} \right). \tag{P4.2}$$

Consequently, from Equations (P4.1) and (P4.2), $\partial EF^D_{i,t+2T+2} / \partial EF^D_{i,t}$, where T is an integer, is expressed as Equation (4.1). ■

The positive sign of Equation (4.1) (i.e., the existence of the intertemporal linkage of dynamic cost efficiencies via the EGLIs on the cost frontier) is shown as the following proposition.

Proposition 5 *If Proposition 3 with subscript t replaced by $t + 2k + 2$ and Assumption (P2) in Proposition 3 with subscript t replaced by $t + 2k + 1$ both hold for the long term (i.e., $k = 0, 1, 2, 3, ..., T$, where T is an integer), then the sign of Equation (4.1) is positive (i.e., there exists an intertemporal linkage of dynamic cost efficiencies via the EGLIs on the cost frontier).*

Proof. The sign of $\partial EF^D_{i,t+2k+2} / \partial EGLI^F_{i,j,t+2k+1}$ ($k = 0, 1, 2, 3, ..., T$, where T is an integer) is negative (i.e., $\partial EF^D_{i,t+2k+2} / \partial EGLI^F_{i,j,t+2k+1} < 0$) because Proposition 3 in which the subscript t is replaced by $t + 2k + 2$ holds for the long term (i.e., $k = 0, 1, 2, 3, ..., T$, where T is an integer). Furthermore, the sign of $\partial EGLI^F_{i,j,t+2k+1} / \partial EF^D_{i,t+2k}$ is also negative (i.e., $\partial EGLI^F_{i,j,t+2k+1} / \partial EF^D_{i,t+2k} < 0$) because Assumption (P2) in Proposition 3 with subscript t is replaced by $t+2k+1$ holds for the long term. Consequently, the sign of Equation (4.1) is positive (i.e., there exists an intertemporal linkage of dynamic cost efficiencies via the EGLIs on the cost frontier). ■

From Propositions 4 and 5, when Proposition 3 with subscript t replaced by $t+2k+2$ and Assumption (P2) in Proposition 3 with subscript t replaced by $t+2k+1$ both hold for the long term (i.e., $k = 0, 1, 2, 3, ..., T$, where T is an integer), the improvement in dynamic cost efficiency in the current period (i.e., in period t) is linked to improvements in future periods (i.e., in period $t + 2T + 2$, where T is an integer) by repeating that the improvement of the dynamic cost efficiency in period $t + 2k$ is linked to that in period $t + 2k + 2$ via a decrease in the EGLI (i.e., an increase in the degree of competition) on the cost frontier in period $t+2k+1$. In this case, it is desirable that the improvement in dynamic cost efficiency in the current period be linked to those in as many future periods as possible (i.e., large T) from the perspective of industrial organization policy. How Proposition 3 holds for the long term is an important policy issue.

4.2 Intertemporal Linkage of the EGLIs on the Cost Frontier via the Dynamic Cost Efficiencies

In this subsection, the intertemporal linkage of the EGLIs on the cost frontier is defined by focusing on a similar case to the above. Moreover, this linkage is formulated by using the derivative representing the effect of the dynamic cost efficiency in the previous period on the EGLI on the cost frontier in the latest period (i.e., the derivative of the EGLI on the cost frontier in the latest period with respect to the dynamic cost efficiency in the previous period) and the derivative used to define the competitive pressure in the previous period (i.e., the derivative of the dynamic cost efficiency in the previous period with respect to the EGLI on the cost frontier two periods prior). Furthermore, based on this equation, it is shown that this linkage exists and that this equation links a decrease in the EGLI on the cost frontier in the current period to those in future periods when the following conditions hold for the long term: (1) the condition concerned in the efficient structure hypothesis in the above derived sufficient condition, and (2) the sufficient condition shifted ahead one period. In addition, the policy implications are clarified from the perspective of industrial organization policy.

The intertemporal linkage of the EGLIs on the cost frontier, which means that a decrease in the EGLI on the cost frontier in the current period (i.e., in period t) is linked to those in the future periods (i.e., in period $t+2T+2$, where T is an integer), is defined as follows:

Definition 11 *If the EGLI on the cost frontier in period* $t{+}2T{+}2$*, where* T *is an integer, decreases because of a decrease in the EGLI on the cost frontier in period* t*, then there exists the intertemporal linkage of the EGLIs on the cost frontier. Specifically, if the sign of* $\partial EGLI^F_{i,j,t+2T+2} / \partial EGLI^F_{i,j,t}$ *is positive* *(i.e.,* $\partial EGLI^F_{i,j,t+2T+2}/\partial EGLI^F_{i,j,t} > 0$*), then there exists the intertemporal linkage of the EGLIs on the cost frontier.*

Similar to the intertemporal linkage of dynamic cost efficiencies, the reason for specifying the future periods as period $t+2T+2$, where T is an integer, is that it allows us to consider the intertemporal linkage of the EGLIs on the cost frontier via the dynamic cost efficiencies, and a relation to Proposition 3 is thereby shown. As mentioned above, this specification makes it theoretically clear and accurate, thus clearing the way for the rigorous theoretical expansion and development presented below.

The intertemporal linkage of the EGLIs on the cost frontier via the dynamic cost efficiencies is formulated by the following proposition:

Proposition 6 $\partial EGLI^F_{i,j,t+2T+2}/\partial EGLI^F_{i,j,t}$*, where* T *is an integer, is expressed as follows:*

$$\frac{\partial EGLI^F_{i,j,t+2T+2}}{\partial EGLI^F_{i,j,t}} = \prod_{k=0}^{T} \left(\frac{\partial EGLI^F_{i,j,t+2k+2}}{\partial EF^D_{i,t+2k+1}} \cdot \frac{\partial EF^D_{i,t+2k+1}}{\partial EGLI^F_{i,j,t+2k}} \right). \tag{4.2}$$

Proof. $\partial EGLI^F_{i,j,t+2}/\partial EGLI^F_{i,j,t}$ is expressed as follows:

$$\frac{\partial EGLI^F_{i,j,t+2}}{\partial EGLI^F_{i,j,t}} = \frac{\partial EGLI^F_{i,j,t+2}}{\partial EF^D_{i,t+1}} \cdot \frac{\partial EF^D_{i,t+1}}{\partial EGLI^F_{i,j,t}}. \tag{P6.1}$$

Similarly, $\partial EGLI^F_{i,j,t+4}/\partial EGLI^F_{i,j,t}$ is expressed as follows:

$$\frac{\partial EGLI^F_{i,j,t+4}}{\partial EGLI^F_{i,j,t}} = \left(\frac{\partial EGLI^F_{i,j,t+4}}{\partial EF^D_{i,t+3}} \cdot \frac{\partial EF^D_{i,t+3}}{\partial EGLI^F_{i,j,t+2}} \right) \cdot \left(\frac{\partial EGLI^F_{i,j,t+2}}{\partial EF^D_{i,t+1}} \cdot \frac{\partial EF^D_{i,t+1}}{\partial EGLI^F_{i,j,t}} \right). \tag{P6.2}$$

Consequently, from Equations (P6.1) and (P6.2), $\partial EGLI^F_{i,j,t+2T+2}/\partial EGLI^F_{i,j,t}$, where T is an integer, is expressed as Equation (4.2). ■

The positive sign of Equation (4.2) (i.e., the existence of the intertemporal linkage of the EGLIs on the cost frontier via the dynamic cost efficiencies) is shown as the following proposition.

Proposition 7 *If Proposition 3 with subscript t replaced by $t+2k+1$ and Assumption (P2) in Proposition 3 with subscript t replaced by $t+2k+2$ both hold for the long term (i.e., $k=0,1,2,3,...,T$, where T is an integer), then the sign of Equation (4.2) is positive (i.e., there exists the intertemporal linkage of the EGLIs on the cost frontier via the dynamic cost efficiencies).*

Proof. The sign of $\partial EF^D_{i,t+2k+1}/\partial EGLI^F_{i,j,t+2k}$ ($k=0,1,2,3,...,T$, where T is an integer) is negative (i.e., $\partial EF^D_{i,t+2k+1}/\partial EGLI^F_{i,j,t+2k} < 0$) because Proposition 3 in which the subscript t is replaced by $t+2k+1$ holds for the long term (i.e., $k=0,1,2,3,...,T$, where T is an integer). Furthermore, the sign of $\partial EGLI^F_{i,j,t+2k+2}/\partial EF^D_{i,t+2k+1}$ is also negative (i.e., $\partial EGLI^F_{i,j,t+2k+2}$ $/\partial EF^D_{i,t+2k+1} < 0$) because Assumption (P2) in Proposition 3 in which the subscript t is replaced by $t+2k+2$ holds for the long term. Consequently, the sign of Equation (4.2) is positive (i.e., there exists the intertemporal linkage of the EGLIs on the cost frontier via the dynamic cost efficiencies). ■

From Propositions 6 and 7, where Proposition 3 with subscript t replaced by $t+2k+1$ and Assumption (P2) in Proposition 3 with subscript t replaced by $t+2k+2$ both hold for the long term (i.e., $k=0,1,2,3,...,T$, where T is an integer), then a decrease in the EGLI on the cost frontier in the current period (i.e., in period t) is linked to those in the future periods (i.e., in period $t+2T+2$, where T is an integer) by repeating that a decrease in the EGLI (i.e., an increase in the degree of competition) on the cost frontier in period $t+2k$ is linked to that in period $t+2k+2$ via the improvement of the dynamic cost efficiency in period $t+2k+1$. In this case, it is desirable that a decrease in the EGLI on the cost frontier in the current period be linked to those in as many future periods as possible (i.e., large T) from the perspective of industrial organization policy. Here again, how Proposition 3 holds for the long term is an important policy issue.

4.3 Long-Term Competitive Pressure

In this subsection, long-term competitive pressure is defined by considering a case similar to the one above. Here, the pressure is formulated by using the derivatives that define the competitive pressures in two different periods (i.e., the derivatives of the dynamic cost efficiencies in the latest and initial periods with respect to the EGLIs on the cost frontier in the previous period and one period prior to the initial period, respectively) and the derivative representing the effect of the dynamic cost efficiency in two periods prior on the EGLI on the cost frontier in the previous period (i.e., the derivative of the EGLI on the cost frontier in the previous period with respect to the dynamic cost efficiency two periods prior). Based on this equation, it is shown that this pressure exists and that the equation links a decrease in the EGLI on the cost frontier in one period prior to the initial period to the improvements of the dynamic cost efficiencies in the future periods when the following conditions hold for a long term: (1) the above derived sufficient condition, (2) the sufficient condition in which the time subscripts are replaced, and (3) the condition concerned in the efficient structure hypothesis in the sufficient condition in which the replacement of time subscripts is shifted ahead one period. In addition, the policy implications are shown from the perspective of industrial organization policy.

The long-term competitive pressure, which means that the EGLI on the cost frontier in the previous period (i.e., in period $t-1$) is linked to improvements in the dynamic cost efficiency in future periods (i.e., in period $t+2T+2$, where T is an integer), is defined as follows:

Definition 12 *If the dynamic cost efficiency in period* $t+2T+2$*, where* T *is an integer, increases because of a decrease in the EGLI on the cost frontier in period* $t-1$*, then there exists long-term competitive pressure. Specifically, if the sign of* $\partial EF^D_{i,t+2T+2} / \partial EGLI^F_{i,j,t-1}$ *is negative (i.e.,* $\partial EF^D_{i,t+2T+2} / \partial EGLI^F_{i,j,t-1} < 0$*), then long-term competitive pressure exists.*

Similar to the above two intertemporal linkages, the reason for specifying the future periods as period $t+2T+2$, where T is an integer, is that it allows us to consider long-term competitive pressure via the intertemporal linkage of dynamic cost efficiencies, thereby showing a relation to Proposition 3. As described below, the existence of the intertemporal linkage of dynamic cost efficiencies clears the way for establishing the existence of long-term competitive pressure.

Long-term competitive pressure via the intertemporal linkage of dynamic cost efficiencies is formulated by the following proposition:

Proposition 8 $\partial EF_{i,t+2T+2}^{D}/\partial EGLI_{i,j,t-1}^{F}$, *where* T *is an integer, is expressed as follows:*

$$\begin{aligned}\frac{\partial EF_{i,t+2T+2}^{D}}{\partial EGLI_{i,j,t-1}^{F}} &= \frac{\partial EF_{i,t+2T+2}^{D}}{\partial EF_{i,t}^{D}} \cdot \frac{\partial EF_{i,t}^{D}}{\partial EGLI_{i,j,t-1}^{F}} \\ &= \prod_{k=0}^{T}\left(\frac{\partial EF_{i,t+2k+2}^{D}}{\partial EGLI_{i,j,t+2k+1}^{F}} \cdot \frac{\partial EGLI_{i,j,t+2k+1}^{F}}{\partial EF_{i,t+2k}^{D}}\right) \cdot \frac{\partial EF_{i,t}^{D}}{\partial EGLI_{i,j,t-1}^{F}}. \end{aligned} \quad (4.3)$$

Proof. The proof of this proposition is similar to the proof of Proposition 6; consequently, we omit the derivation. ■

The negative sign in Equation (4.3) (i.e., the existence of long-term competitive pressure via the intertemporal linkage of dynamic cost efficiencies) is shown by the following proposition:

Proposition 9 *If not only Proposition 3 holds, but also Proposition 3 with subscript* t *replaced by* $t+2k+2$ *and Assumption (P2) in Proposition 3 with subscript* t *replaced by* $t+2k+1$ *both hold for the long term (i.e.,* $k=0,1,2,3,...,T$*, where* T *is an integer), then the sign of Equation (4.3) is negative (i.e., there exists long-term competitive pressure via the intertemporal linkage of dynamic cost efficiencies).*

Proof. The sign of $\partial EF_{i,t}^{D}/\partial EGLI_{i,j,t-1}^{F}$ is negative (i.e., $\partial EF_{i,t}^{D}/\partial EGLI_{i,j,t-1}^{F} < 0$) because Proposition 3 holds. Moreover, the sign of $\partial EF_{i,t+2k+2}^{D}/\partial EGLI_{i,j,t+2k+1}^{F}$ ($k=0,1,2,3,...,T$, where T is an integer) is also negative (i.e., $\partial EF_{i,t+2k+2}^{D}/\partial EGLI_{i,j,t+2k+1}^{F} < 0$) because Proposition 3 in which the subscript t is replaced by $t+2k+2$ holds for the long term (i.e., $k=0,1,2,3,...,T$, where T is an integer). Furthermore, the sign of $\partial EGLI_{i,j,t+2k+1}^{F}/\partial EF_{i,t+2k}^{D}$ is also negative (i.e., $\partial EGLI_{i,j,t+2k+1}^{F}/\partial EF_{i,t+2k}^{D} < 0$) because Assumption (P2) in Proposition 3 in which subscript t is replaced by $t+2k+1$ holds for the long term. Consequently, the sign of Equation (4.3) is negative (i.e., there exists the long-term competitive pressure via the intertemporal linkage of dynamic cost efficiencies). ■

From Propositions 8 and 9, if not only Proposition 3 holds, but also Proposition 3 with subscript t replaced by $t + 2k + 2$ and Assumption (P2) in Proposition 3 with subscript t replaced by $t + 2k + 1$ both hold for the long term (i.e., $k = 0, 1, 2, 3, ..., T$, where T is an integer), then a decrease in the EGLI on the cost frontier in the previous period (i.e., in period $t - 1$) is linked to improvements in the dynamic cost efficiency in future periods (i.e., in period $t + 2T + 2$, where T is an integer) not only by the existence of competitive pressure from the previous period to the current period, but also by repeating that the improvement in the dynamic cost efficiency in period $t+2k$ is linked to that in period $t+2k+2$ via a decrease in the EGLI (i.e., an increase in the degree of competition) on the cost frontier in period $t+2k+1$. In this case, it is desirable that a decrease in the EGLI on the cost frontier in the previous period is linked to improvements in the dynamic cost efficiency in as many future periods as possible (i.e., large T) from the perspective of industrial organization policy. Here, as well, how Proposition 3 holds for the long term is an important policy issue.

5 Conclusion

Based on the GURM constructed by Homma (2009, 2012, 2018, 2021), this paper clarifies the relation between competitive pressure and the efficient structure and quiet-life hypotheses, and confirms the existence of intertemporal linkages and long-term competitive pressure when the sufficient condition for the existence of competitive pressure holds for the long term. First, from the perspective of empirical feasibility, competitive pressure is defined using the definition of dynamic cost efficiency given by Homma (2018, Definition 8, p. 20) and the EGLI on the cost frontier defined by Homma (2018, Definition 14, p. 46). Next, from a similar perspective, the sufficient condition for the existence of competitive pressure is derived using Homma (2018, Proposition 11, pp. 77-79) and Homma (2018, Proposition 14, p. 82). From this derivation, the relation between the competitive pressure and the efficient structure and quiet-life hypotheses is clarified, and its policy implications from the perspective of industrial organization are highlighted. Particular attention is given to the case in which the above derived sufficient condition holds for the long term. For such a case, the intertemporal linkage of dynamic cost efficiencies via the EGLIs on the cost frontier, the intertemporal linkage of the EGLIs on the cost frontier via the dynamic cost efficiencies, and long-term competitive pressure are shown, and the policy implications of this linkage from the perspective of industrial organization are detailed. The study's major results, along with its conclusions, are summarized below:

1. The source of competitive pressure is the possibility of a decrease in quasi-short-run profits based on the dynamic frontier or actual cost in the current period; thus, the essence of this pressure is an increase in dynamic cost efficiency in the current period driven by that possibility.

2. The existence of competitive pressure when Proposition 3 is satisfied is desirable from the perspective of industrial organization policy, as it entails a decrease in the EGLI (i.e., an increase in the degree of competition) on the cost frontier in the previous and current periods.

3. From Assumption (P2) in Proposition 3, both the acceptance of the efficient structure hypothesis and the desirability of this acceptance from the perspective of industrial organization policy are included in the sufficient condition for the existence of competitive pressure. In addition, from Assumption (P3) in Proposition 3, both the acceptance of the quiet-life hypothesis and the undesirability of this acceptance from the above perspective are included in the sufficient condition for the existence of competitive pressure. Consequently, competitive pressure comes into existence due not only to the acceptance of both hypotheses but also to their opposing industrial organization policy implications.

4. From the contraposition of Proposition 3, if there is no competitive pressure, then there is a possibility that the acceptance of the efficient structure hypothesis is not desirable even if this hypothesis is accepted.

The lack of competitive pressure creates the possibility that there is no justification for the efficient structure hypothesis.

5. From Propositions 4 and 5, when Proposition 3 with subscript t replaced by $t + 2k + 2$ and Assumption (P2) in Proposition 3 with subscript t replaced by $t + 2k + 1$ both hold for the long term (i.e., $k = 0, 1, 2, 3, ..., T$, where T is an integer), the improvement in dynamic cost efficiency in the current period (i.e., in period t) is linked to improvements in future periods (i.e., in period $t + 2T + 2$, where T is an integer) by repeating that the improvement of the dynamic cost efficiency in period $t + 2k$ is linked to that in period $t + 2k + 2$ via a decrease in the EGLI (i.e., an increase in the degree of competition) on the cost frontier in period $t + 2k + 1$. Moreover, in this case, it is desirable that the improvement of the dynamic cost efficiency in the current period be linked to those in as many future periods as possible (i.e., large T) from the perspective of industrial organization policy.

6. From Propositions 6 and 7, where Proposition 3 with subscript t replaced by $t + 2k + 1$ and Assumption (P2) in Proposition 3 with subscript t replaced by $t + 2k + 2$ both hold for the long term (i.e., $k = 0, 1, 2, 3, ..., T$, where T is an integer), then a decrease in the EGLI on the cost frontier in the current period (i.e., in period t) is linked to those in the future periods (i.e., in period $t + 2T + 2$, where T is an integer) by repeating that a decrease in the EGLI (i.e., an increase in the degree of competition) on the cost frontier in period $t + 2k$ is linked to that in period $t + 2k + 2$ via the improvement of the dynamic cost efficiency in period $t + 2k + 1$. In this case, it is desirable that a decrease in the EGLI on the cost frontier in the current period be linked to those in as many future periods as possible (i.e., large T) from the perspective of industrial organization policy.

7. From Propositions 8 and 9, if not only Proposition 3 holds, but also Proposition 3 with subscript t replaced by $t + 2k + 2$ and Assumption (P2) in Proposition 3 with subscript t replaced by $t + 2k + 1$ both hold

for the long term (i.e., $k = 0, 1, 2, 3, ..., T$, where T is an integer), then a decrease in the EGLI on the cost frontier in the previous period (i.e., in period $t-1$) is linked to improvements in the dynamic cost efficiency in future periods (i.e., in period $t + 2T + 2$, where T is an integer) not only by the existence of competitive pressure from the previous period to the current period, but also by repeating that the improvement in the dynamic cost efficiency in period $t + 2k$ is linked to that in period $t + 2k + 2$ via a decrease in the EGLI (i.e., an increase in the degree of competition) on the cost frontier in period $t + 2k + 1$. In this case, it is desirable that a decrease in the EGLI on the cost frontier in the previous period be linked to improvements in the dynamic cost efficiency in as many future periods as possible (i.e., large T) from the perspective of industrial organization policy.

8. From Propositions 4 through 9, how Proposition 3 holds for the long term is an important policy issue.

References

[1] Berger, A. N. and T. H. Hannan (1998), "The Efficiency Cost of Market Power in the Banking Industry: A Test of the "Quiet Life" and Related Hypothesis," *Review of Economics and Statistics*, 80, 454-464.

[2] Demsetz, H. (1973), "Industry Structure, Market Rivalry, and Public Policy," *Journal of Law and Economics*, 16:1, 1-9.

[3] Hancock, D. (1985), "The Financial Firm: Production with Monetary and Nonmonetary Goods," *Journal of Political Economy*, 93, 859-880.

[4] Hancock, D. (1987), "Aggregation of Monetary and Nonmonetary Goods: A Production Model," in W.A. Barnett and K. Singleton, eds., *New Approaches to Monetary Economics*, Cambridge University Press (Cambridge, MA), 200-218.

[5] Hancock, D. (1991), *A Theory of Production for the Financial Firm*, Kluwer Academic Publishers (Boston, MA).

[6] Homma, T. (2009), "A Generalized User-Revenue Model of Financial Firms under Dynamic Uncertainty: Equity Capital, Risk Adjustment, and the Conjectural User-Revenue Model," University of Toyama, Faculty of Economics, (http://doi.org/10.15099/00002076), Working Paper No. 229.

[7] Homma, T. (2012), "A Generalized User-Revenue Model of Financial Firms under Dynamic Uncertainty: An Interdisciplinary Analysis of Producer Theory, Industrial Organization, and Finance," University of Toyama, Faculty of Economics, (http://doi.org/10.15099/00002090), Working Paper No. 271.

[8] Homma, T. (2018), "Competition on the Cost Frontier and Intertemporal Regular Linkages: Theoretical Implications of the Efficient Structure and Quiet-Life Hypotheses," University of Toyama, Faculty of Economics, (http://doi.org/10.15099/00018350), Working Paper No. 313.

[9] Homma, T. (2021), "Competition and Efficiency in the Regional Banking Industry: Empirical Implications of the Quiet-Life Hypothesis," University of Toyama, School of Economics, (http://doi.org/10.15099/00020775), Working Paper No. 340.

[10] Homma, T. (2023), "Competitive Pressure and the Efficient Structure and Quiet-Life Hypotheses: From the Viewpoint of Dynamic Cost Efficiency and the Degree of Competition on the Cost Frontier," University of Toyama, School of Economics, (http://doi.org/ 10.15099/00022317), Working Paper No. 355 (in Japanese).

[11] Homma, T., Y. Tsutsui, and H. Uchida (2014), "Firm Growth and Efficiency in the Banking Industry: A New Test of the Efficient Structure Hypothesis," *Journal of Banking and Finance*, 40, 143-153.