CAES Working Paper Series

Effects of Entry Restriction on Free Entry General Competitive Equilibrium

Mitsuo Takase

Faculty of Economics

Fukuoka University

WP-2018-006

Center for Advanced Economic Study

Fukuoka University

(CAES)

8-19-1 Nanakuma, Jonan-ku, Fukuoka,
JAPAN 814-0180

Effects of Entry Restriction on Free Entry General Competitive Equilibrium

Mitsuo Takase*

September 3, 2018

* Faculty of Economics, Fukuoka University, 8-19-1, Jonan-ku, Nanakuma, Fukuoka 814-0180 JAPAN, Email: mtakase@fukuoka-u.ac.jp

Abstract

This paper examines effects of entry restriction in one market on the economy. I build a general competitive equilibrium model under free entry as a base model and show that the restriction reduces the household utility, total output measured by prices at which free entry is allowed, and the labor productivity of the restricted market. This paper suggests that the competitive equilibrium can achieve Pareto efficiency if profits of all firms become zero. As long as any firms have positive profits there is a room for improving the economic welfare through free entry. As a macroeconomic implication the restriction may cause inflation under recession.

Key wards: Entry restriction, General competitive equilibrium model, Total output

JEL code: A10, C30, D50, D51.

INTRODUCTION

The objective of this paper is to examine effects of entry restriction in a general equilibrium model under perfect competition. Entry restriction inevitably entails resource shifts from one market to the others. If resource endowments are fixed and fully employed, entry restriction reduces the number of firms in the affected market. Partial equilibrium analyses assume away these shifts of resources among markets. A general equilibrium analysis shows effects of the entry restriction on the economy as whole and these may have the long-run perspective.

According to the traditional partial equilibrium analysis, an entry restriction shifts the market supply curve leftward, decreases the quantity of output, increases the price, and decreases social welfare or social surplus consisting of consumer and producer surplus. This paper examines whether we can confirm these conventional conclusions of partial equilibrium model even in a general equilibrium setting and shows differences from the partial equilibrium.

This paper is based on the general competitive equilibrium model which Arrow and Debreu (1954) have developed. There are some studies, which discuss effects of new entry on markets under imperfect competition. Mankiw and Whinston (1986) find excessive entry or inefficiency of free entry under imperfect competition.

Hopenhayn (1992) considers an analytical model where entry and exit are determined endogenously in a long-run partial equilibrium setting where aggregate demand is given and the budget constraint of household sector is not included in the model. Hopenhayn and Rogerson (1993) consider a model where entry and exit are determined endogenously. Although their model consists of two markets which are one output market and labor market, they consider the substitution between goods consumption and leisure time(unemployment). The utility function is given and they have not examined how different parameters of the utility function affect simulation results.

This paper examines welfare effects of entry restriction in a general competitive equilibrium model by using simulation method. In order to seek the robustness of the simulation results, four values of the elasticity of substitution are examined in the use of utility function.

Takase (2011) analytically shows that the entry restriction reduces the household utility in a competitive general equilibrium model. This implies that Pareto efficiency cannot be achieved in a competitive general equilibrium model unless free entry is allowed. He assumes that the production set is convex where the production function exhibits monotonically increasing with labor input and strictly concave downward from the origin. This paper assumes that the production set is non-convex where the production function exhibits monotonically increasing, concave upward to an inflection point, and concave downward from that point. Because the production set is non-convex, it becomes hard to analyze the model analytically. Then this paper analyzes the model by simulation and presents what the simulation shows including the issue whether the entry restriction reduces the economic welfare even if competitive equilibrium is attained.

In order to discuss these issues, this paper is organized as follows. Section II presents a general equilibrium model of two goods and one factor. Section III shows the results of simulation analysis of the model. Section IV summarizes the main results and draws conclusions.

Ⅰ. MODEL

The model is based on a general competitive equilibrium model developed by Arrow and Debreu (1954) where they have proved the existence of equilibrium in the model of many goods and many factors. Arrow and Hahn (1971) prove the uniqueness of the equilibrium under various sufficient conditions where the production set is convex or approximately convex. Takase (2011) adopts their model for comparative statics in changing the number of firms in one market based on the general competitive equilibrium model where the production set is strictly convex. He shows that reducing the number of firms in one market by the restrictive policy reduces the household utility level and the total output measured by the prices which are those before strengthening the restriction.

This paper extends his model to a free entry general equilibrium model where the production set is non-convex. The production function in this paper exhibits monotonically increasing, concave upward to an inflection point, and concave downward from that point. Then each firm has U-shaped marginal cost curve and its positive minimum average cost. And this makes it possible for the number of firms to be endogenous in the model.

As a base case in this simulation analysis the number of firms in each goods market becomes endogenous variable. This free entry condition is given by constraints that the profits of all firms are zero.

The model consists of two goods and one input. All of markets in the economy are perfectly competitive and then each economic entity is a price taker. Each firm is assumed to maximize its profits. Each household is assumed to maximize its utility level subject to the budget constraint. I assume that firms in each market have the same size but may differ between markets. I also assume that all households have the same income level from given labor hours and the same dividend income. Here the dividend income comes from firm's profits. The total profits are assumed to be shared equally among all households.

To show a difference from the partial equilibrium analysis, I illustrate effects of entry restriction on both markets in the following Figures 1 and 2.

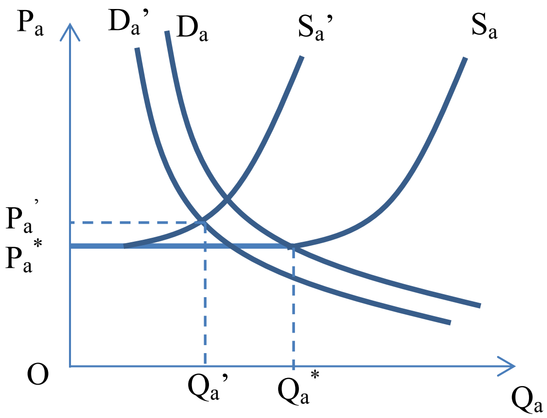

Figure 1: Good A Market

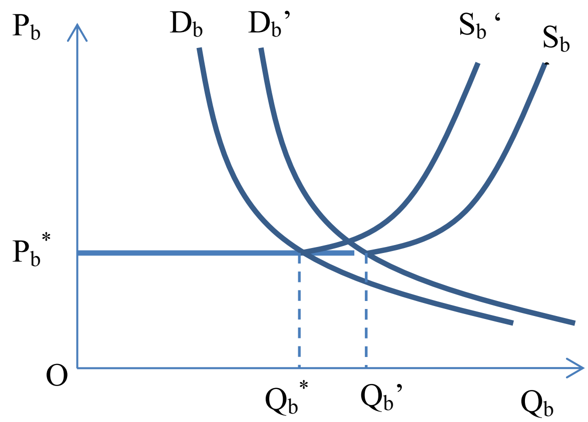

Figure 2: Good B Market

Figure 1 and Figure 2 show market supply and demand curves in Good A market and Good B market, respectively. When both markets are under free entry and perfect competition where the market supply and demand curves denoted S_a and D_a in the Good A market and S_b and D_b in the Good B market, respectively, the equilibrium price and quantity of each market are given as P_a* and Q_a* in Good A market and P_b* and Q_b* in Good B market, respectively. After imposing a restriction on the number of firms in Good A market, the market supply curve of Good A shifts leftward to S_a'. Since this price change causes a reduction of household purchasing power and lowering a relative price of the other market, the demand curve for Good A shift leftward to D_a'. The new equilibrium price and quantity become P_a' and Q_a'. This relative price change also affects the demand curve for Good B. The demand curve for Good B may shifts rightward or leftward. It depends on a positive substitution effect and a negative income effect of the price rise. Figure 2 illustrates a case of leftward shift of the demand curve to D_a'. Since Good B market is under free entry, the increase of demand for Good B attracts new entry and accordingly the market supply curve shifts rightward to S_b'. The new equilibrium price and quantity become P_b' and Q_b'.

One of the differences from a partial equilibrium model is that a general equilibrium model takes account of effects of the other market. In this case the entry restriction may not only reduce output of the target market but also increase output of the other market. A general equilibrium model plays an important role for understand external effects on the economy as a whole.

Since the production set is assumed to be non-convex, there are firm's shutdown points where the average cost reaches the minimum. Without the entry restriction all firms operate at zero profits where the price is equal to the minimum of average cost curve. This simulation analysis examines the cases where the number of firms in one market is restricted to a certain number and shows effects of this entry restriction on the economy. In the simulation I try to change the parameters of the utility function for examining the robustness of the simulation results.

A. Firms

Each firm is perfectly competitive and employs labor as a factor of production. The production function assumed to be a monotonically increasing convex function in the small production level and becomes a concave function in the larger production level so that its marginal cost curve shows U-shaped curve. There are two goods and one factor in the economy and these are presented as the good A, the good B, and labor, respectively.

1. *A Firm in the Good A Market*

The relation between labor input and output of the good A satisfies the following equation given as

$$l_a = q_a^3 - 2q_a^2 + 2q_a \qquad (1)$$

where q_a is the quantity of the good A produced by each firm,

l_a is the amount of labor employed by each firm to produce the good A.

Figure 3 shows the relation between labor input and output of the good A.

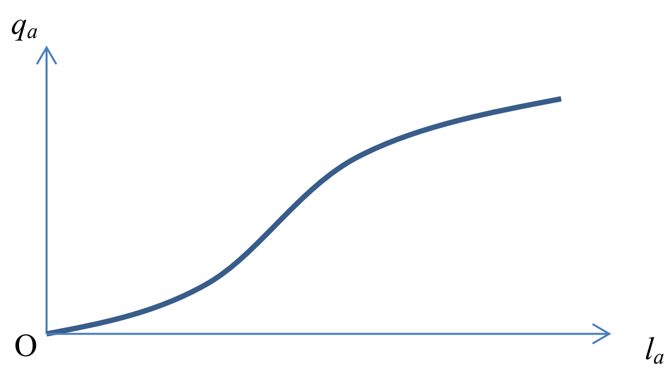

Figure 3: The relation between input and output

The marginal cost curve and the average cost curve are U-shaped given as Figure 4 and all firms produce outputs at the minimum point of average cost curve under free entry.

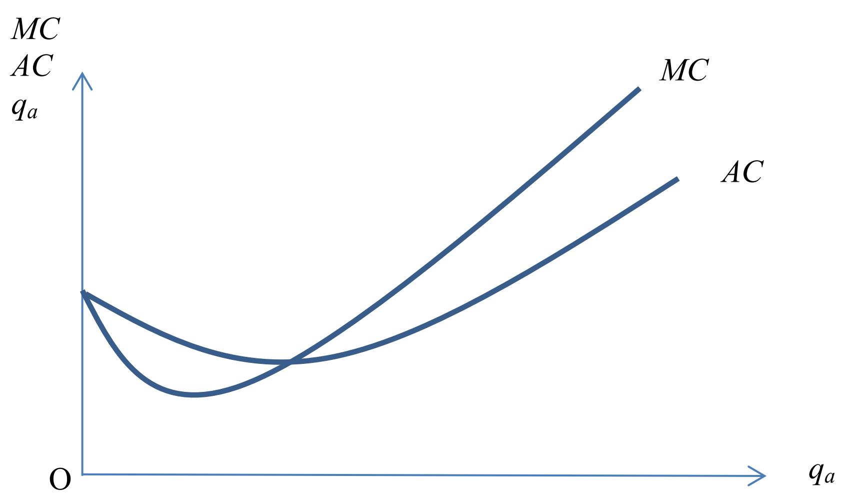

Figure 4: MC and AC curves

The total quantity of the good A in the market as a whole is given as

$$Q_a = n_a q_a \qquad (2)$$

where n_a represents the number of firms producing the good A and it is assumed that all firms in the market of the good A are equal in size.

The profit of each firm producing the good A is defined as

$$\pi_a = p_a q_a - w l_a \qquad (3)$$

where π_a is the profit of each firm producing the good A, p_a is the price of the good A, and w is the wage rate.

The total cost is obtained by multiplying both sides of Equation (1) by the wage rate. We get the total cost function as

$$C(q_a) = w(q_a^3 - 2q_a + 2q_a).$$

By differentiating this with q_a, we get the marginal cost. Each firm produces output to maximize its profit. function. Then the marginal cost is equal to the price of output.

The first order condition for profit maximization is given as

$$\frac{\partial C(q_a)}{\partial q_a} = p_a$$

or

$$p_a = w(3q_s - 4q_a + 2). \qquad (4)$$

The total profit of the market as a whole is given as

$$\Pi_a = n_a \pi_a \qquad (5)$$

where Π_a is the total profit of the market for the good A.

2 *A Firm in the Good B Market*

The relation between labor input and the good B satisfies the following equation as given as

$$l_b = q_b^3 - 2q_b^2 + 2q_b \tag{6}$$

where q_b is the quantity of the good B produced by each firm,

l_b is the amount of labor employed by each firm to produce the good B.

The total output of the good B in the market as a whole is given as

$$Q_b = n_b q_b \tag{7}$$

where n_b is the number of firms producing the good B and it is assumed that all firms in the market are equal in size.

The profit of each firm producing the good B is given as

$$\pi_b = p_b q_b - w l_b \tag{8}$$

where π_b is the profit of each firm in the market and p_b is the price of the good B.

The total cost is obtained by multiplying both sides of Equation (6) by the wage rate. We get the total cost function as

$$C(q_b) = w(q_b^3 - 2q_b + 2q_b).$$

By differentiating this with q_a, we get the marginal cost. Each firm produces output to maximize its profit. function. Then the marginal cost is equal to the price of output.

The first order condition for profit maximization is given as

$$\frac{\partial C(q_b)}{\partial q_b} = p_b$$

or

$$p_b = w(3q_b - 4q_b + 2) \tag{9}$$

where the value of marginal product of labor is equal to the wage rate.

The total profit of all firms in the market as a whole is given as

$$\Pi_b = n_b \pi_b \tag{10}$$

where Π_b is the total profit of the market for the good B.

B. Households

Each household is assumed to purchase the good A and the good B so that it maximizes its utility level subject to its budget constraint under given labor hours. For simplicity, each household is assumed to have the same labor hours and the same dividend income and therefore it has the same income level.

The utility function of each household is given as

$$u = u(q_{ai}, q_{bi}) \tag{11}$$

where u is the utility level, q_{ai} is the quantity of the good A, and q_{bj} is the quantity of the good B demanded by each household. In this simulation I examine four cases where the elasticity of substitution takes 0.5, 1, 1.5, and 2. When the elasticity of substitution is equal to 1, the Cobb-Douglass utility function is adopted. For the rest of three cases I adopt the CES utility function given as

$$u = \left(\beta q_a^{-\frac{1-\sigma}{\sigma}} + \gamma q_b^{-\frac{1-\sigma}{\sigma}}\right)^{-\frac{\sigma}{1-\sigma}}.$$

The Cobb-Douglass utility function is given as

$$u = q_a^{\alpha_a} q_b^{\alpha_b}.$$

The budget constraint of each household is given as

$$p_a q_{ai} + p_b q_{bi} = w\bar{l} + \pi_j \tag{12}$$

where $\bar{l}$ is the initial endowment of labor hours, π_j is the dividend or profit income held by each household.

The first order condition for the utility maximization subject to the budget constraint is given by

$$\frac{\partial u}{\partial q_{qj}} / \frac{\partial u}{\partial q_{bj}} = \frac{p_a}{p_b} \tag{13}$$

where the left hand side of the equation is the marginal rate of substitution expressed by the ratio of the marginal utility between the good A and the good B.

C. *Market Equilibrium Conditions*

The economy consists of two goods markets and one input market. The goods markets are markets of the good A and the good B. The input market is the labor market. These three markets are assumed to be in equilibrium.

The market equilibrium condition for the good A is given as

$$n_a q_a = m q_{ai} \tag{14}$$

where m represents the number of households in the economy. The left hand side of the equation is the quantity of the good A supplied by firms and the right hand side is the quantity of the good A demanded by households in the economy.

Similarly, the market equilibrium condition for the good B is given as

$$n_b q_b = m q_{bi} \tag{15}$$

where the left hand side is the quantity of the good B supplied by firms and the right hand side is the quantity of the good B demanded by households.

The equilibrium condition for the labor market is given by

$$n_a l_a + n_b l_b = m\bar{l} \tag{16}$$

where the left hand side is the amount of labor demanded by firms and the right hand side is the initial endowments of labor hours in the economy as a whole. The right hand side of the equation also means total amount of labor hours supplied by m households.

The total number of firms in the economy as a whole is $n_a + n_b$ that is the sum of the number of firms in the two goods markets.

For simplicity, the sum of profits of all firms is assumed to be distributed to every household by the same amount. Then, it holds that

$$n_a \pi_a + n_b \pi_b = m\pi_i. \tag{17}$$

Under free entry all firms' profits become zero and each firm produces outputs at the minimum of average cost. This is given by

$$\pi_a = 0 \tag{18}$$

and

$$\pi_b = 0. \tag{19}$$

When the number of firms in Good A market is restricted to a certain number, then Equation (18) does not hold and only zero profits condition given by Equation (19) holds in the Good B market.

Ⅱ. SIMULATION ANALYSIS

This section begins with a case of free entry as a base case and then shows cases where smaller numbers of firms are allowed to operate in one market by entry restrictions. This section examines effects of entry restriction in one maker on economic welfare and shows how the simulation results are affected by different utility functions. In this simulation analysis I use MicroSoft Excel add-in software called Solver.

A. A Base Case: Perfect Competition Under Free Entry

This is a free entry case where all markets are under perfect competition and each output price is equal to the minimum of average cost curve. In the simulation the utility function given as Equation 11 is maximized subject to 18 constraints which are Equation 1 to Equation 10 and Equation 12 to Equation 19. There are 18 endogenous variables which are q_a , Q_a , π_a , l_a , Π_a , q_b , Q_b , π_b , l_b , Π_b , q_{aj} , q_{bj} , π_j , u , w , p_a , n_a , and n_b . The price of the Good B, p_b , is assigned to be equal to 1 and is treated as a numeraire. The utility function in the base case is a CES type utility function where the elasticity of substitution between two goods is a parameter taking the value of 0.5, 1.5 or 2.0 and a Cobb-Douglass type utility function where the elasticity of substitution is equal to 1.

In the base case simulation q_a, l_a , q_b , l_b, q_{aj}, q_{bj}, w, and p_a become all equal to 1. Q_a, Q_b , n_a and n_b become all equal to 50. π_a , Π_a , π_b , Π_b , π_j, are all equal to zero.

By the Walras' law, one of three market equilibrium conditions is not independent from the rest of the other market clearing equations. Then the equilibrium condition for the market of the good B given as equation (15) is removed from the system of equations theoretically. However, in the numerical simulation virtually all constraints are not fully but approximately satisfied and then no market equilibrium conditions are removed from the simulation.

The demand and supply functions in the markets are homogenous of degree zero in prices and profits and one of the unknowns of prices and profits is indeterminate theoretically.

Although this homogeneity condition is not fully but approximately satisfied in the simulation analysis, the price of the good B is assumed to be constant as a numeraire in order to make the simulation quickly converge to the solutions.

There are 7 parameters denoted as σ , α_a , α_b , β , γ , $\bar{l}$, and m . Except the value of σ all parameters are kept constant through this simulation. α_a and α_b are set to 0.5. β and γ are set to 1.0. $\bar{l}$ is set to 2.0. And m is set to 50.

B. Effects of Entry Restriction

In the base case the solutions for n_a and n_b are both 50. This means that the numbers of firms in two goods markets become both 50 under free entry. Under entry restriction I examine four cases which restrict the number of firms in Good A market, n_a , to 40, 30, 20, and 10 respectively. Good B market is always under free entry. Now n_a becomes a policy variable given as

$$n_a = \text{constant} \tag{20}$$

In the simulation the utility function given as Equation (11) is maximized subject to 18 constraints which are Equation (1) to Equation (10), Equation (12) to Equation (17), Equation (19), and Equation (20). There are 18 endogenous variables which are q_a , Q_a , π_a , l_a , Π_a , q_b , Q_b , π_b , l_b , Π_b , q_{aj} , q_{bj} , π_j , u , w , p_a , n_a , and n_b .

Table 1 presents the simulation results when the elasticity of substitution, $\sigma = 2$. First column shows a list of variables and the main economic indicators. The second column shows values of these variables and indicators when both goods markets are perfectly competitive under free entry. From the third column to the six column shows values of variables and indicators when the number of firms in the Good A market is restricted to 40, 30, 20, and 10, respectively. The seventh column summarizes 4 cases of simulation for $\sigma =$ 2, 1.5, 1, and 0.5 on effects of entry restriction in Good A market. – (minus sign) in the column represents a negative effect and the magnitude of effect gets larger as the restriction is strengthened. + (plus sign) in the column represents the magnitude of positive effect gets larger as the restriction is strengthened.

As σ gets smaller the magnitude of effect gets larger in q_a (the 3rd row), π_a (the 5th row), l_a (the 6th row), Π_a (the 7th row), π_j (the 14th row), p_a (the 16th row), total output (or $p_a Q_a + Q_b$) (the 18th row), total output measured by competitive prices under free entry (or $Q_a + Q_b$) (the 19th row), labor productivity of Good A market (or Q_a / l_a) (the 20th row), labor share of total output (or $wl_a/(p_a Q_a + Q_b)$) (the 24th row), growth rate of total output measured by prices before restriction strengthened (the 25th row), and growth rate of total output measured by prices before restriction relaxed (the 26th row). As σ gets smaller the magnitude of effect gets smaller in Q_a and q_{aj}. As for the share of Good A market in total output (the 22nd row) the effects of restriction is negative and weaker as $\sigma > 1$ and gets smaller. If $\sigma = 1$, then the share becomes 0.5 regardless of restriction. If $\sigma = 0.5$, the share gets larger as the entry restriction gets strengthened. I conduct the simulations for $\sigma = 1.5$, $\sigma = 1$, and $\sigma = 0.5$. For Q_b (the 9th row), q_{bj} (the 13th row) and the labor share of Good A market (23rd row) the entry restriction has a negative income effect on the demand for Good B. This effect is stronger when the value of σ gets smaller and becomes larger than the substitution effect of increase in p_a in the case that $\sigma = 0.5$ and the number of firms in the Good A market is limited to 10. The decrease of demand for Good B makes the individual demand for Good B, q_{bj}, the market supply of Good B, Q_b , and the market share of Good A (or

$p_a Q_a/(p_a Q_a + Q_b)$) increase. Those results are presented in Table 2, Table 3, and Table 4 in the Appendix.

As for q_b (the 8th row), π_b (the 10th row), l_b (the 11th row), w (the15th row), and labor productivity of Good B market (or Q_b/l_b) (the 21st row), all these are constant through the simulation. The reason is that Good B market is under perfect competition with free entry and all firms in the market produce at the minimum of average cost with zero profits.

Ⅲ. CONCLUSION

This paper examines effects of entry restriction on an economy. The general competitive equilibrium model in this paper is based on Arrow and Debreu (1954) although they have not considered free entry in the model. I build a two-goods one-factor general competitive equilibrium model under free entry. The number of firms is endogenously determined. Labor is only a factor endowment in the economy and is fixed. This paper examines effects of policy which restricts the number of firms in one market to a certain number.

The entry restriction in Good A market raises the price of Good A (p_a), total profits of firms in the Good A market (Π_a), an individual firm's output (q_a), profit (π_a), and employment (l_a) in the Good A market, an individual household's dividend income from profits (π_j), and (nominal) total output (or $p_a Q_a + Q_b$) evaluated current prices. On the other hand, this restriction in Good A market reduces the household utility level (u), (real) total output (or $Q_a + Q_b$) evaluated with the prices under free entry, an individual household's consumption of Good A (q_{aj}), the total output of Good A (Q_a) and the labor productivity of Good A (Q_a/l_a)..

This paper suggests that the competitive equilibrium under free entry can achieve Pareto efficiency. As long as any firms have positive profits there is a room for improving the economic welfare through free entry. In other words, this paper suggests that the competitive equilibrium cannot be to Pareto efficient unless free entry is allowed. Equality of the marginal rate of substitution between different goods for every household is achieved and equality between the marginal rate of transformation and the marginal rate of substitution between different goods are achieved. Those rates are all equal to the relative price between different goods in this model. Perfect competition prevails in all markets including goods markets and a factor market. Labor can freely move between industries. This paper implies that the first fundamental theorem of welfare economics does not always hold under the conventional assumptions. If the assumption of free entry or zero profits is satisfied, then the theorem holds true under the conventional assumptions.

The model adopted in this paper is a general equilibrium model and then has macroeconomic implications. The entry restriction reduces labor productivity of Good A market, labor share of total income, and (real) total output (or $Q_a + Q_b$) . The entry restriction raises the relative price of Good A and may affect the Consumer Price Index and the GNP deflator. The price of Good B is used as a numeraire in this model and any price change is a relative price change. If money market is included in this model, one can discuss the general (nominal) price change. Since the entry restriction is shown to reduce a total output in the model, it reduces the transaction demand for money. If money supply is fixed, this reduction of money demand may result in inflation. If neutrality of money is assumed, then the inflation rate is equal to the reduction rate of real total output.

The model developed in this study can serve as a base model to tackle with many economic policy issues and give some useful insights. By adding or deleting some endogenous variables and constraints from the model one may derive many fruitful policy implications and provide some macroeconomic insights. However, these will be left for further research.

Table 1 : simulation results when $\sigma = 2$.

variables	Free entry	$n_a = 40$	$n_a = 30$	$n_a = 20$	$n_a = 10$	Effect of restriction
u	4.00	3.97	3.88	3.68	3.32	- for 4 values of σ
q_a	1.00	1.07	1.15	1.26	1.43	+ for 4 values of σ
Q_a	49.97	42.78	34.51	25.11	14.29	- for 4 values of σ
π_a	0.00	0.16	0.40	0.81	1.75	+ for 4 values of σ
l_a	1.00	1.07	1.18	1.34	1.69	+ for 4 values of σ
Π_a	0.00	6.38	11.95	16.13	17.53	+ for 4 values of σ
q_b	1.00	1.00	1.00	1.00	1.00	no change
Q_b	50.10	57.07	64.76	73.28	83.04	inconclusive
π_b	0.00	0.00	0.00	0.00	0.00	no change
l_b	1.00	1.00	1.00	1.00	1.00	no change
q_{aj}	1.00	0.86	0.69	0.50	0.29	- for 4 values of σ
q_{bj}	1.00	1.14	1.30	1.47	1.66	inconclusive
π_j	0.00	0.13	0.24	0.32	0.35	+ for 4 values of σ
w	1.00	1.00	1.00	1.00	1.00	no change
p_a	1.00	1.15	1.37	1.71	2.41	+ for 4 values of σ
n_b	50.14	57.10	64.79	73.30	83.02	inconclusive
(nominal) Total output, $(p_aQ_a + Q_b)$	100.14	106.48	112.04	116.18	117.49	+ for 4 values of σ
(real) Total output, $(Q_a + Q_b)$	100.14	99.91	99.32	98.43	97.35	- for 4 values of σ
Labor productivity of Good A market, (Q_a/l_a)	1.00	1.00	0.98	0.94	0.84	- for 4 values of σ
Labor productivity of Good B market, (Q_b/l_b)	1.00	1.00	1.00	1.00	1.00	no change
Share of Good A market in total output, ($p_aQ_a/(p_aQ_a + Q_b)$)	0.50	0.46	0.42	0.37	0.29	depends on σ
share of labor in Good A market, ($wl_a/(p_aQ_a)$)	0.50	0.43	0.35	0.27	0.17	inconclusive
Labor share of total output ($wl_a/(p_aQ_a + Q_b)$)	1.00	0.94	0.89	0.86	0.85	- for 4 values of σ
Growth rate of total output measured by prices before restriction strengthened		-0.2 %	-1.7%	-3.9%	-7.5%	- for 4 values of σ
Growth rate of total output measured by prices before restriction relaxed	1.2 %	3.2 %	6.5%	13.9%		+ for 4 values of σ

APPENDIX

Table 2: simulation results when $\sigma = 1.5$.

variables	Free entry	$n_a = 40$	$n_a = 30$	$n_a = 20$	$n_a = 10$
u	8.00	7.93	7.69	7.21	6.30
q_a	1.00	1.08	1.18	1.32	1.55
Q_a	50.00	43.37	35.52	26.35	15.46
π_a	0.00	0.20	0.52	1.10	2.62
l_a	1.00	1.09	1.22	1.45	2.01
Π_a	0.00	7.94	15.48	22.03	26.18
q_b	1.00	1.00	1.00	1.00	1.00
Q_b	50.02	56.36	63.29	71.02	80.13
π_b	0.00	0.00	0.00	0.00	0.00
l_b	1.00	1.00	1.00	1.00	1.00
q_{aj}	1.00	0.87	0.71	0.53	0.31
q_{bj}	1.00	1.13	1.27	1.42	1.60
π_j	0.00	0.16	0.31	0.44	0.52
w	1.00	1.00	1.00	1.00	1.00
p_a	1.00	1.15	1.47	1.94	2.99
n_b	50.00	56.38	63.30	71.02	80.23
(nominal) Total output, $(p_a Q_a + Q_b)$	100.04	108.01	115.50	122.05	126.43
(real) Total output, $(Q_a + Q_b)$	100.04	99.75	98.83	97.37	95.60
Labor productivity of Good A market, (Q_a/l_a)	1.00	0.99	0.97	0.91	0.77
Labor productivity of Good B market, (Q_b/l_b)	1.00	1.00	1.00	1.00	1.00
Share of Good A market in total output, $(p_a Q_a/(p_a Q_a + Q_b))$	0.50	0.48	0.45	0.42	0.37
share of labor in Good A market, $(wl_a/(p_a Q_a))$	0.50	0.44	0.37	0.29	0.20
Labor share of total output $(wl_a/(p_a Q_a + Q_b))$	1.00	0.93	0.87	0.82	0.79
Growth rate of total output measured by prices before restriction strengthened		-0.3 %	-2.2 %	-5.0 %	-9.8 %
Growth rate of total output measured by prices before restriction relaxed	1.4 %	4.0 %	8.2 %	18.6 %	

Table 3: simulation results when $\sigma = 1$.

variables	Free entry	$n_a = 40$	$n_a = 30$	$n_a = 20$	$n_a = 10$
u	1.00	0.99	0.95	0.87	0.71
q_a	1.00	1.11	1.24	1.42	1.75
Q_a	50.00	44.27	37.09	28.34	17.47
π_a	0.00	0.26	0.72	1.68	4.56
l_a	1.00	1.12	1.31	1.66	2.72
Π_a	0.00	10.46	21.70	33.51	45.58
q_b	1.00	1.00	1.00	1.00	1.00
Q_b	50.00	55.23	60.91	66.80	72.79
π_b	0.00	0.00	0.00	0.00	0.00
l_b	1.00	1.00	1.00	1.00	1.00
q_{aj}	1.00	0.89	0.74	0.57	0.35
q_{bj}	1.00	1.10	1.22	1.34	1.46
π_j	0.00	0.21	0.43	0.67	0.91
w	1.00	1.00	1.00	1.00	1.00
p_a	1.00	1.25	1.64	2.36	4.17
n_b	50.00	55.23	60.95	66.83	72.79
(nominal) Total output, $(p_a Q_a + Q_b)$	100.00	110.46	121.83	133.60	145.58
(real) Total output, $(Q_a + Q_b)$	100.00	99.50	98.00	95.14	90.26
Labor productivity of Good A market, (Q_a/l_a)	1.00	0.99	0.95	0.85	0.64
Labor productivity of Good B market, ($p_a Q_a/(p_a Q_a + Q_b)$)	1.00	1.00	1.00	1.00	1.00
Share of Good A market in total output, $(p_a Q_a/(p_a Q_a + Q_b)$)	0.50	0.50	0.50	0.50	0.50
share of labor in Good A market, ($wl_a/(p_a Q_a)$)	0.50	0.45	0.39	0.33	0.27
Labor share of total output ($wl_a/(p_a Q_a + Q_b)$)	1.00	0.91	0.82	0.75	0.69
Growth rate of total output measured by prices before restriction strengthened		-0.5 %	-3.0 %	-7.0 %	-14.7 %
Growth rate of total output measured by prices before restriction relaxed	1.7 %	5.0 %	11.0 %	27.0 %	

Table 4: simulation results when $\sigma = 0.5$.

variables	Free entry	$n_a = 40$	$n_a = 30$	$n_a = 20$	$n_a = 10$
u	0.50	0.49	0.47	0.41	0.30
q_a	1.00	1.14	1.33	1.59	2.09
Q_a	50.02	45.79	39.81	31.81	20.90
π_a	0.00	0.38	1.15	2.99	9.53
l_a	1.00	1.17	1.47	2.14	4.57
Π_a	0.00	15.20	34.60	59.75	95.26
q_b	1.00	1.00	1.00	1.00	1.00
Q_b	50.05	53.28	55.98	57.14	54.29
π_b	0.00	0.00	0.00	0.00	0.00
l_b	1.00	1.00	1.00	1.00	1.00
q_{aj}	1.00	0.92	0.80	0.64	0.42
q_{bj}	1.00	1.07	1.12	1.14	1.09
π_j	0.00	0.30	0.69	1.20	1.91
w	1.00	1.00	1.00	1.00	1.00
p_a	1.00	1.35	1.98	3.23	6.75
n_b	50.08	53.29	56.01	57.16	54.30
(nominal) Total output, $(p_a Q_a + Q_b)$	100.12	115.26	134.69	159.81	195.30
(real) Total output, $(Q_a + Q_b)$	100.12	99.13	95.84	88.99	75.21
Labor productivity of Good A market, (Q_a/l_a)	1.00	0.98	0.90	0.74	0.46
Labor productivity of Good B market, (Q_b/l_b)	1.00	1.00	1.00	1.00	1.00
Share of Good A market in total output, ($p_a Q_a/(p_a Q_a + Q_b)$)	0.50	0.54	0.58	0.64	0.72
share of labor in Good A market	0.50	0.47	0.44	0.43	0.46
Labor share of total output ($w l_a/(p_a Q_a + Q_b)$)	1.00	0.87	0.74	0.63	0.51
Growth rate of total output measured by prices before restriction strengthened		-1.0 %	-4.7 %	-10.9 %	-23.8 %
Growth rate of total output measured by prices before restriction relaxed	2.2 %	6.8 %	15.4 %	39.1 %	

References

Arrow, Kenneth.J., and Gerard Debreu (1954). Existence of an Equilibrium for a Competitive Economy, *Econometrica*, 22, 265-290.

Arrow, Kenneth J., and F. H. Hahn (1971). *General Competitive Analysis*, Holden-Day, Inc., San Francisco.

Hopenhayn, Hugo A. (1992). "Entry, Exit, Firm Dynamics in Long Run Equilibrium," *Econometrica*, 60, 1127-1150.

Hopenhayn, Hugo A. and Richard Rogerson (1993). "Job Turnover and Policy Evaluation: A General Equilibrium Analysis," *Journal of Political Economy*, 10, 1915-938.

Mankiw, N. Gregory, and Michael D. Whinston (1986). "Free Entry and Social Inefficiency," *Rand Journal of Economics*, 17, 48-58.

Takase, Mitsuo (2011). "Effects of New Entry in a General Equilibrium Model", Center for Advanced Economic Study Working Paper, WP-2011-008, Fukuoka University.