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Entry Barriers, Reallocation, and Productivity Growth: Evidence from Japanese manufacturing firms

MURAO Tetsushi
Hitotsubashi University

NIREI Makoto
RIETI

Research Institute of Economy, Trade & Industry, IAA

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Entry Barriers, Reallocation, and Productivity Growth: Evidence from Japanese manufacturing firms

MURAO Tetsushi[1]
Hitotsubashi University
and
NIREI Makoto
Research Institute of Economy, Trade and Industry / Hitotsubashi University

Abstract

This paper investigates the effect of exogenous entry barriers on productivity growth, using an R&D-based endogenous growth model. Previous theoretical and empirical literature has emphasized the role of two types of reallocation on productivity growth, namely, reallocation of market shares among incumbent firms (selection channel) and firm turnover (entry/exit channel). When firms have heterogeneous innovation efficiency levels, we find that a reduction in entry costs may reduce the selection pressure on inefficient incumbents while it stimulates the entry of new firms.

We incorporate entry cost and free entry condition into the model proposed by Lentz and Mortensen (2008) and estimate entry cost and other structural parameters using Japanese firm-level data. A counterfactual simulation of the reduced entry cost suggests that positive effect of stimulated entry on productivity growth outweighs the negative one of reduced selection. We also show quantitatively that increased R&D tax credits enhance productivity growth through both reallocation channels.

Keywords: Entry barrier; Reallocation; Productivity growth decomposition.
JEL classification: O43, O47

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1 Introduction

Researchers and policymakers have devoted much attention to understand the source of aggregate productivity growth. Conceptually, the aggregate productivity growth is decomposed into contributions from three channels, that are, efficiency improvements within incumbent producers (within channel), the reallocation of market shares from less efficient to more efficient incumbent producers (selection channel), and the turnover of producers (entry/exit channel). Several methods have been proposed to decompose the aggregate productivity growth into these three factors using producer-level data (Baily, Hulten, and Campbell, 1992 (hereafter BHC); Foster, Hultiwanger, and Krizan, 1996 (FHK); Petrin and Levinsohn, 2011), and applied to various datasets to reveal that the entry/exit effect and the selection effect have substantial impacts on the aggregate productivity growth.

The growth decomposition exercises lead to the idea that the aggregate productivity growth can be enhanced by policies that affect turnover and selection. The removal of entry barriers can be such a policy.[2] Aghion, Blundell, Griffith, Howitt, and Prantl (2009, hereafter ABGHP) provide a suggestive analysis on the underlying mechanism by which the entry barrier affects the aggregate productivity growth. They show theoretically and empirically that the entry of frontier firms induces the incumbents in the sectors that are initially close to the technology frontier to innovate, while it reduces the R&D incentives of the incumbents in the sectors far behind the frontier. This implies that reducing entry barrier may have ambiguous effects on the productivity growth, because it may reduce the R&D incentive of incumbent firms and thereby negatively affect the within channel of the productivity growth. Moreover, ABGHP also observe that the aggregate productivity growth rate is increased if resources are

[2] In this paper, we consider a type of entry barrier that are enforced by some policy or regulation exogenous to the industry. This is different from the entry deterrence and endogenous entry barriers discussed in the industrial organization literature, such as the incumbent firm's strategic entry deterrence, network effects, or sizable investments.

exogenously reallocated from less to more technologically advanced sectors.

The following questions naturally arise: Does the entry barrier affect the selection channel *endogenously*, as it affects the within channel? If so, does it affect the aggregate productivity growth positively? More generally, how does the reduced entry barrier affect the relative importance of the three channels of aggregate productivity growth? So far, no studies have investigated these effects of entry regulation in terms of the growth decomposition.

In this paper, we show that the reduction of entry cost may decrease the contribution of selection effect to the aggregate productivity growth in the model of endogenous productivity growth with heterogeneous innovation efficiency. The intuition is as follows. Suppose that there are two types of firms in an economy: high-innovative and low-innovative. Consider a simple case in which the low-innovative firms conduct no R&D and just produce goods with the technology on hand, while the high-innovative firms do both R&D and production. If the entry cost is reduced, the Schumpeterian effect ensues: the stimulated entry of new firms suppresses the rent for innovation, and thus lowers the incentives for incumbent's R&D. This Schumpeterian effect is not uniform across firms in the heterogeneous setup: the R&D intensity of high-innovative firms falls whereas that of low-innovative firms does not change. This heterogeneous response effectively reduces the reallocation of market shares from low-productivity (innovative) firms to high-productivity (innovative) firms.

To evaluate the effect of the reduced entry barrier on the aggregate productivity growth and its decomposed channels, we incorporate the entry cost and free entry condition into the endogenous growth model with heterogeneous innovation efficiency proposed by Lentz and Mortensen (2008). In our model, the entry cost affects all three channels of the aggregate productivity growth, that is, the entry/exit effect, the within effect, and the selection effect. We estimate the underlying structural parameters including entry cost, by modifying the estimation algorithm of Lentz and Mortensen (2008). The effect of reduced entry cost on the aggregate productivity growth is examined with the estimated parameters. Moreover, we quantify the impact of the reduced entry cost on the decomposed effects.

Our results are summarized as follows. First, if the entry cost is reduced by 10% from the status quo, the aggregate productivity growth rate increases. Second, we find that, under the estimated structural parameters, the reduced entry cost actually hampers the reallocation of market shares from less productive to more productive firms. Third, the average incumbent innovation effect is also reduced by the reduction of entry cost, which confirms the Schumpeterian effect quantitatively under the estimated parameters. Finally, the reduced entry cost enhances the entry effect, which outweighs the other two negative effects on the aggregate productivity growth.

To compare with the above consequences of the reduction in entry barrier, we execute another counterfactual policy experiment that increases the R&D tax credit by 10%. This policy stimulates the R&D incentives of all types of incumbents and entrants, unlike the entry deregulation policy which we find has differential effects on firm-types. It turns out that the increased R&D tax credit has almost no effects on the share of each channel of aggregate productivity growth decomposition. This makes a sharp contrast with the case of reducing entry barrier in which the three channels are unevenly affected.

The contribution of this paper is three-fold. First, to our knowledge, this is the first attempt to estimate the entry cost structurally in the modern growth models and to examine the policy impact of reducing entry costs on the aggregate productivity growth rate. Much of the previous literature on the effect of entry cost has employed the stationary equilibrium model and focused on the *level* of aggregate productivity. Following the seminal work by Hopenhayn (1992), researchers such as Asplund and Nocke (2003), Blanchard and Giavazzi (2003) and Poschke (2010) further investigated theoretically the effect of changes in entry barrier on the level of aggregate productivity. Empirical studies using cross-country data are pursued by Nicoletti and Scarpetta (2003), Loayza et al. (2005), and Barseghyan (2008). These studies typically find the negative relationship between the strength of entry barrier or higher entry costs and lower aggregate productivity level. However, few studies have examined the effect of reduction in entry barrier on the *growth* of aggregate productivity.

Moreover, by estimating entry cost structurally, we are able to estimate the real effective entry cost that is faced by entry firms, which may be difficult to measure directly. The relationship of entry barrier and productivity has been empirically examined using cross-country datasets, such as in Nicoletti and Scarpetta (2003), Loayza et al. (2005), and Barseghyan (2008). These empirical works use the index of entry barrier that summarizes the actual fees, business days to acquire permits, and the number of procedures. However, these indices may differ from the actual entry cost recognized by firms if the opportunity cost of business days and procedures differ country by country. Moreover, the opportunity cost such as the real wage is determined in the general equilibrium, and, in principle, affected by the general policy environments on entry. Thus, our structural estimation approach is complementary to the approach using the indices constructed by the survey of entry barrier in real world.

Second, we quantify the impact of the reduced entry cost on three channels of aggregate productivity growth, namely, within, entry/exit, and selection channel. A particularly interesting result is that the selection effect is lowered by the reduced entry cost. This has not been pointed out in the previous literature. The prominent role of selection channel on the aggregate productivity growth found by the empirical applications of productivity growth decomposition generates vast theoretical literature which highlights the mechanism of aggregate productivity growth driven by reallocation. This literature includes Hopenhayn and Rogerson (1993), Melitz (2003), and Restuccia and Rogerson (2009) among others. This theoretical literature considers the firing cost, tariff, and firm specific wedge as the factors that hinder the efficient selection. Our result suggests that, as the entry barrier is lowered, the impact of the reallocation on the productivity growth is reduced.

Finally, our results may resolve an empirical puzzle pointed out in the literature. Bartelsman, Haltiwanger, and Scarpetta (2004) and Pages, Pierre, and Scarpetta (2009) apply BHC/FHK decomposition to the South American countries and find that the selection component is very small, or sometimes negative, even in the deregulation era in those countries. Nishida, Petrin, and Polanec (2011) show that this puzzle is partially resolved by using the decomposition method proposed by Petrin and Levinsohn (2011, hereafter PL). Our result implies that the smaller estimate of selection in the deregulation era may not be a puzzle if the deregulation policies effectively reduced the entry costs and resulted in the smaller importance of the selection channel, although sufficient reservation is needed since our decomposition methods differ from theirs (BHC/FHK).

The remainder of the paper is organized as follows. Section 2 introduces the model. The model draws on Lentz and Mortensen (2008), augmented with entry costs and the free entry condition. Section 3 explains the Japanese firm level panel data used in this study. Section 4 discusses the estimation bias from omitting the entry cost which potentially arises in the estimation method proposed by Lentz and Mortensen (2008). Their algorithm is applicable to the extended model with a slight modification. Section 5 presents the results on the structural estimation and the productivity growth decomposition. Section 6 presents the counterfactual simulations of policy changes such as 10% reduction in entry cost, 10% increase in R&D tax credit, and the both of these two policies. Section 7 concludes. The detailed model specification and the algorithm for counterfactual simulations are deferred to Appendix.

2 The model

The model draws on and extends Lentz and Mortensen (2008, LM hereafter). LM uses a product quality ladder model where firms are the monopolistic suppliers of differentiated intermediate goods. The model does not consider variety expansion, and all potential goods can be produced by any firms. Firms engage in R&D activity which yields stochastic quality improvement in a randomly chosen intermediate good. R&D is not directed; namely firms do not know ex-ante which of the goods will be improved by their innovation. In this paper, we concentrate on the case of the unit elasticity of substitution where the consumption good is produced by a Cobb-Douglas technology. This paper also extends LM by incorporating entry costs that are only born by the entrants.

2.1 Preference and Technology

There is a representative household in the economy. Let r be the discount rate of the household. The household maximizes the following life-time expected utility

$$U_t = \int_t^\infty e^{-r(s-t)} \ln C_s ds. \tag{1}$$

The final consumption good C_t is exchanged at price P_t. We set the numeraire so that the expenditure $P_t C_t$ is constant at Z over time. C_t is produced with intermediary inputs $x_t(j)$ through Cobb-Douglas production function

$$C_t = \exp\left[\int_0^\infty \alpha(j) \log(A_t(j) x_t(j)) dj\right], \tag{2}$$

where $A_t(j) \equiv \Pi_{i=1}^{J_t(j)} q_i(j) \geq 1$ denotes the quality of product j, $J_t(j)$ is the number of innovations made up to date t, and $q_i(j) > 1$ is the step size of quality improvement in the

i-th innovation in product j. The production function exhibits constant returns to scale, $\int_0^\infty \alpha(j)dj = 1$.

Let $p_t(j)$ denote the price of intermediate good j. From the first order condition of the cost minimization for the production of C_t, the derived demand for input j is represented as

$$x_t(j) = \frac{z_t(j)}{p_t(j)}, \tag{3}$$

where $z_t(j) \equiv \alpha(j)Z$. Thus, $z_t(j)$ represents the revenue per unit exogenously determined. We assume that $z_t(j)$ follows a three parameter Weibull distribution $G(\cdot)$.

We now turn to the production of intermediate good j. The production of j per unit requires one unit of labor and capital. Let w and κ denote wage and unit capital cost. The intermediate good j is supplied by a firm who achieves the highest efficiency in producing j. The firm faces monopolistic competition with the producers of other goods and also faces a Bertrand competition with firms who achieves lesser efficiency in producing j. Since we assume unit elasticity of substitution, the monopolist pricing of the firm in terms of the monopolistic competition is undefined (infinity). Thus, the price of j is determined by the Bertrand competition with the previous producer of j. Then, the producer sets the following Bertrand price

$$p_t(j) = q_t(j)(w + \kappa), \tag{4}$$

where $q_t(j)$ is the quality improvement that the producer made upon the quality of the previous producer. Using this, the profit per unit is written as:

$$\pi(q_t(j)) = (p_t(j) - w - \kappa)/p_t(j) = 1 - q_t(j)^{-1}. \tag{5}$$

2.2 R&D investment by firms

Let k denote the firm's current number of products. The number of products k evolves according to a birth-death process as a consequence of the firm's R&D investments. Along with LM, we follow Klette and Kortum (2004) and consider that k represents the firm's knowledge capital that facilitates innovation. We assume that the product arrival rate by R&D investment is determined by γk, where γ is the R&D intensity that is chosen by the firm. We assume that R&D investment requires labor inputs only, and that the R&D intensity level γ requires labor inputs $c(\gamma)k$.[3] Then, the total R&D cost is $wc(\gamma)k$. In the course of estimation, $c(\gamma)$ is specified as $c_0\gamma^{1+c1}$.

When a firm enters the goods markets, it enters with one product and thus $k = 1$. Incumbent firms increase k with arrival rate γk. When a firm increases k, it necessarily decreases the number of products of an incumbent firm. Namely, when either an incumbent or a potential entrant succeeds in innovation, the new product replaces old one. This represents the process of creative destruction. The rate of creative destruction per product is denoted as δ, which is the sum of the product arrival rates for all incumbents and potential entrants. Since R&D is not directed, the rate of the creative destruction is the same for all products as δ. Firms with $k = 1$ will exit from the market if it loses the product by a creative destruction.

[3]Specifically, the following R&D cost function is assumed:

$$C(\Gamma, k), \tag{6}$$

where Γ is the firm-level innovation rate and $C(.,.)$ is linearly homogeneous degree 1. Then, (6) can be rewritten as:

$$C(\Gamma, k) = C(\Gamma/k, 1)\, k \equiv c(\gamma)k, \tag{7}$$

where $\gamma \equiv \Gamma/k$.

2.3 Firm type heterogeneity

Firms are different in their distribution from which stochastic quality improvements are drawn. We denote this firm type by τ. We assume that an entrant draws τ from the type distribution $\phi(\cdot)$. Type τ determines the distribution F_τ of the quality improvement q_τ. The distribution of type τ stochastically dominates that of lesser type $\tau' < \tau$ as:

$$F_{\tau'}(\tilde{q}) \leq F_\tau(\tilde{q}), \quad \forall \tilde{q} \geq 1. \tag{8}$$

We interpret τ as the determinant of the *profitability*. The stationary distribution of firm types τ exists in the economy where all firms exit in the long run and the entrants draw a lottery on profitability from time-invariant distribution ϕ.

2.4 R&D intensity choice

A firm's state is the number of products k, the stochastic quality improvement on the products $\tilde{q}^k = \{\tilde{q}_1, \ldots, \tilde{q}_k\}$, and the demand realization of the products $\tilde{z}^k = \{\tilde{z}_1, \ldots, \tilde{z}_k\}$. As in LM, the value of a type τ firm is:

$$rV_\tau(\tilde{q}^k, \tilde{z}^k, k) = \max_{\gamma \geq 0} \left\{ \begin{array}{c} \sum_{i=1}^k \tilde{z}_i \pi(\tilde{q}_i) - kwc(\gamma) \\ +k\gamma[E_\tau[V_\tau(\tilde{q}^{\tau+1}, \tilde{z}^{k+1}, k+1)] - V_\tau(\tilde{q}^k, \tilde{z}^k, k)] \\ +k\delta \left[\frac{1}{k} \sum_{i=1}^k V_\tau(\tilde{q}^{k-1}_{\langle i \rangle}, \tilde{z}^{k-1}_{\langle i \rangle}, k-1) - V_\tau(\tilde{q}^k, \tilde{z}^k, k) \right] \end{array} \right\}, \tag{9}$$

where $(\tilde{q}^{k-1}_{\langle i \rangle}, \tilde{z}^{k-1}_{\langle i \rangle})$ refers to $(\tilde{q}^k, \tilde{z})$ without the ith elements. Note that the overall quality improvements other than k products do not affect the value because of our assumption of the unit elasticity of substitution.

From the first order condition, the optimal choice for R&D intensity γ by an incumbent firm solves the following equation:

$$w\hat{c}'(\gamma_\tau) = \nu_\tau, \tag{10}$$

where $\nu_\tau \equiv E_\tau[V_\tau(\tilde{q}^{\tau+1}, \tilde{z}^{k+1}, k+1)] - V_\tau(\tilde{q}^k, \tilde{z}^k, k)$ represents the type conditional expected value of an additional product. LM showed that ν_τ is increasing in profit per product $\bar{\pi}_\tau$. Combined with $c''(\gamma) > 0$, this implies that γ is increasing in profitability τ. In other words, the firm with higher profitability has a higher expected growth rate. Thus, the firms with higher profitability selectively expand.

2.5 Potential Entrants

Potential entrants must conduct R&D investment to enter a market. In LM, the R&D cost function is identical among potential entrants and incumbents. In this sense, in the LM economy, there is no barrier to entry nor entry decision. The potential entrants decide the level of R&D intensity similarly to the incumbents. An entry occurs whenever any potential entrant generates an innovation. In LM, the supply of the potential entrants is also exogenously determined at μ. As a consequence, the net expected value of a potential entrant is positive $Z(\gamma_e \sum_\tau \nu_\tau \phi_\tau - wc(\gamma_e))$. Thus, the potential entrants earn positive rents. However, it is straightforward to modify their model to impose the standard free entry condition and endogenize the mass of potential entrants by assuming that the potential entrants must bear additional fixed cost wc_e/Z to be able to innovate.

The representative household owns the potential entrants, and bear the entry costs.

The total costs and benefits of having a potential entrant with intensity γ_e are written as follows

$$\text{(Total cost)} = w\hat{c}(\gamma_e) + wc_e/Z, \tag{11}$$

$$\text{(Expected value for a entrant)} = \gamma_e \sum_{\tau} \phi_\tau v_\tau. \tag{12}$$

The free entry condition and the first order condition with respective to γ_e is represented as, respectively,

$$w\hat{c}(\gamma_e^*) + wc_e/Z = \gamma_e^* \bar{v}, \tag{13}$$

$$w\hat{c}'(\gamma_e^*) = \bar{v}. \tag{14}$$

where $\bar{v} = \sum_\tau \phi_\tau v_\tau$. From (13), the potential entrants no longer earn positive rents, while the incumbent firms earn positive quasi rents as much as $wc_e/Z = \gamma_e \sum_\tau \phi_\tau v_\tau - w\hat{c}(\gamma_e)$.

The aggregate entry rate is expressed as

$$\eta = \gamma_e \mu, \tag{15}$$

where μ denotes the mass of potential entrants that is constant at a stationary equilibrium. While the fixed entry cost appear in the budget constraint of the representative household, no other equilibrium conditions except for (13) are unchanged from the original LM model.

2.6 Labor market

The labor market clearing condition requires that the sum of total R&D and total production labor demand is equal to the inelastically supplied aggregate labor ℓ:

$$\ell = \sum_{\tau} K_\tau \ell_\tau + \mu(c(\gamma_e) + c_e), \tag{16}$$

where K_τ is the total mass of products produced by type τ firms and ℓ_τ^d is type-conditional production labor demand and ℓ_τ is type-conditional labor demand;

$$\ell_\tau = \ell_\tau^d + c(\gamma_\tau), \tag{17}$$

$$\ell_\tau^d = \frac{Z(1-\bar{\pi}_\tau)}{(w+\kappa)}. \tag{18}$$

2.7 Firm size distribution

Klette and Kortum (2004) show that the mass of firms with type τ with product k is written as follows:[4]

$$M_\tau(k) = \frac{k-1}{k}\frac{\gamma_\tau}{\delta} M_\tau(k-1) = \frac{\eta\phi_\tau}{\delta k}\left(\frac{\gamma_\tau}{\delta}\right). \tag{19}$$

Thus, the mass of firms with type τ is written as in LM:

$$K_\tau = \sum_{k=1}^{\infty} k M_\tau(k) = \frac{\eta\phi_\tau}{\delta - \gamma_\tau}. \tag{20}$$

[4]The equation is derived from the flow condition which is satisfied at the steady state.

The type-conditional creative-destruction rate δ_τ is expressed as,

$$\delta_\tau = \phi\eta + K_\tau\gamma_\tau, \tag{21}$$

where the first term is type-conditional entry rate and the second is type conditional creation rate of incumbents. Then aggregate creative destruction rate is given by the sum of δ_τ,

$$\delta = \eta + \sum_\tau K_\tau\gamma_\tau. \tag{22}$$

2.8 Productivity growth decomposition results

The rate of aggregate productivity growth (APG) in the current model is exactly the same as LM,

$$g \equiv \frac{\dot{C}}{C} = \sum_\tau \delta_\tau E[\ln \tilde{q}_\tau], \tag{23}$$

where δ_τ is given by (21) and the expectation is taken with respect to quality step size distribution.

Plugging (21) into (23) and adding and subtracting $\sum_\tau \gamma_\tau E[\ln \tilde{q}_\tau]\phi_\tau$ yields the following decomposition formula.

$$g \equiv \frac{\dot{C}}{C} = \underbrace{\eta \sum_\tau E[\ln \tilde{q}_\tau]\phi_\tau}_{\text{Entry/Exit}} + \underbrace{\sum_\tau \gamma_\tau E[\ln \tilde{q}_\tau][K_\tau - \phi_\tau]}_{\text{Selection effect}} + \underbrace{\sum_\tau \gamma_\tau E[\ln \tilde{q}_\tau]\phi_\tau}_{\text{Within}} \tag{24}$$

Equation (24) gives the foundation of a model-based measured productivity growth decomposition and each term has the following economic interpretation.

- 1st term: Net contribution of entry and exit to APG

- 2nd term: Contribution of firm type selection to APG
- 3rd term: Contribution to APG in case of no firm type selection or aggregate entrant innovation.

Thus, all productivity growth in the model is attributed to some forms of worker reallocation (between entrants/incumbents, across types, or within types).

Traditionally, the degree of gross worker reallocation which contributes to APG is considered to be measured by Baily-Hulten-Campbell (BHC) decomposition. Lentz and Mortensen (2008) and Petrin and Levinsohn (2011) point out a theoretical issue in the BHC decomposition. In the model of heterogeneous innovative-types such as LM, the aggregate share of products supplied by each type must be constant in the steady state, Thus, no *net* worker reallocation across firm-types takes place in the steady state. In this case, measured "between" and "cross" terms in the BHC decomposition merely reflect measurement errors and transitory shocks. Instead, the firm-type selection term in (24) captures the compositional impacts of firm-type selection within a cohort. As noted earlier, the high-innovative type firms gradually replace the low-innovative types in the same age cohort. A steady state exists because the age cohort contracts as time goes by.[5]

2.9 Equilibrium

A stationary equilibrium consists of a triple of (w, δ, g), entry rate $\eta = \mu\gamma_e$, creation rate γ_τ, mass of potential entrants μ and the mass of firms τ K_τ for all τ that satisfies equations (10) (13) (14) (16) (20) (22) (23).

[5]LM put it as "The selection effect measures the loss in productivity growth that would result if more productive firms types in any given cohort were counterfactually not allowed to increase their resource share relative to that at birth."

3 Empirical analysis

3.1 Data

We use Japanese firm level panel data from the *Basic Survey of Japanese Business Structure and Activities* collected by the Ministry of Economy, Trade, and Industry (METI). It covers all firms whose employment size is larger than 50. This censoring criterion is stricter than that of Danish counterpart, 20, used in LM. On one hand, the stricter censoring may cause the problem of over-representation of exits. On the other hand, Nishimura, Nakajima, and Kiyota (2003) argue that the strict criterion may be suitable for our study of active and innovating firms since there are many "dormant" small firms in Japan that exist mainly for non-business purposes.

The estimated sample are restricted to manufacturing firms. We use the period of 2001-2004, which is recognized as a recovery period of productivity. As in LM, firms that are observed in 2001 and in all subsequent periods until exit are used in the estimation. Specifically, the unbalanced panel is consisted of real value added (Y_{it}), wage bill (W_{it}), and labor force size (N_{it}). Consequently, the number of observations in the estimated sample is 6983.

Each variable is constructed as follows. Value added Y_{it} is computed as (Sales - Operating cost + Total wage paid + Depreciation + Borrowing and lending cost). Total wage paid is directly used as real wage bill. Value added and total wage are deflated by GDP deflator. The end-of-period payroll number is used as employment size.[6]

[6]Sales, Operating Cost, Total Wage Paid, Depreciation, Borrowing and Lending Cost, and End-of-Period Payroll Number are reported in the *BSJBSA* as *Uriage-daka*, *Eigyo-hiyou* (=*Sales cost* + *Management cost*), *Chingin-so-shiharai*, *Genka-Syokyaku*, *Taisyaku-hi Kimatsu-jugyoin-su*, respectively.

4 Estimation

In this section, we apply the estimation algorithm developed by LM to our modified model economy. In the course of estimation, we assume that the economy is on the steady state in the initial year 2001. Quality adjusted employment of firm j is defined as $N_j^* = W_j/w$, where W_j is the total wage paid by the firm j and

$$w = \frac{\sum_j W_j}{\sum_j N_j} \tag{25}$$

is the average wage paid per worker in the market. w can be computed directly from the above equation. While w is determined in the model endogenously, the model parameters are estimated to be consistent with the observed w. In addition, we set $r = 0.05$, which is the same as in LM.

A salient feature of LM algorithm is that identification of structural parameters only requires information about firms existing in the initial year (2001). That is, LM does not use information about subsequent entrants after 2001. As described later, this also holds for our modified model.

Estimation is conducted in the following two steps. In the first step, the parameters associated with incumbent firm behavior and Weibull distributions are estimated. In the second step, the parameters about entry behavior are estimated.

4.1 First stage estimation

Parameters other than $(\mu, \ell, c_e, \gamma_e)$ are estimated by Simulated Method of Moments (SMM). Namely, we simulate (Y_{it}, W_{it}, N_{it}) of firms existing in the initial year and store the simulated moments. Then, parameters are estimated so that the simulated moments become close to the data moments. We follow LM to choose the moments used in the SMM, that are presented in Table3.

Denote the entire panel as $\{Y_i, W_i, N_i\}_{t=2001}^{2004}$. Let $\psi_{jt} = (Y_{jt}, W_{jt}, N^*_{jt})$ denote an observation in the panel of a firm observed in year t. Let $\psi_j = (\psi_{j1}, \ldots, \psi_{jT})$ be an entire observation of firm j, and $\psi = (\psi_1, \ldots, \psi_J)$ be an entire sample.

Let $\Gamma(\psi)$ denote the vector of sample moments. We can simulate a panel $\psi^s(\omega) = (\psi_1(\omega), \ldots, \psi_J(\omega))$ of the model given parameters $\omega \in \Omega$. Then, the simulated moments are defined as

$$\hat{\Gamma}_\omega = \frac{1}{S}\sum_{s=1}^{S}\Gamma(\psi^s(\omega)). \tag{26}$$

The simulated minimum distance estimator is given as follows:

$$\hat{\omega} = \arg\min_{\omega\in\omega}(\hat{\Gamma}_\omega - \Gamma(\psi))' A^{-1}(\hat{\Gamma}_\omega - \Gamma(\psi)), \tag{27}$$

where A is variance-covariance matrix of data moments.

4.2 Second stage estimation

We turn to the estimation of (μ, l, c_e, γ_e). From (22), η is computed from the first stage SMM estimates of δ and γ_τ. Then, unit entry rate γ_e is derived from first order condition for the potential entrants (13). Then, c_e is computed from the free entry condition (13). By the definition, $\mu = \eta/\gamma_e$ can be obtained. Finally, from above estimates, labor supply ℓ is derived from the labor market clearing condition, (16).

4.3 Bias from omitting entry cost

From the above discussion, we can see whether the omitted variable bias regarding c_e presents or not. Note that c_e only appears in (13) and (16). Equation (13) is used only to estimate c_e given w and (c_0, c_1, Z, ν_τ) that are all obtained from the first stage estimation. In turn, c_e is used to estimate ℓ from (16). Here, (ℓ, c_e) are used to estimate no other parameters. The implication is summarized as follows.

> **Remark** (Omitting c_e)
> If parameters are estimated under $c_e = 0$ while there is positive c_e in the economy, the estimates of ℓ are biased. Parameters other than ℓ are consistently estimated with omitting c_e. Thus, the results of the decomposition in equation (24) are unbiased.

That is, the estimates of structural parameters and endogenous variables always reflect the true value of c_e even if we (implicitly) set $c_e = 0$. Above Remark is obtained as a by-product of LM estimation algorithm. In the first stage estimation of LM, we do not need any information of entrants other than aggregate entry rate η. This is because η is the sufficient information about entrants to simulate the behavior of incumbent firms. In other words, η summarizes the entire information about firm entry including entry cost. This η is structurally estimated so as to match the simulated and data moments of firms existing in the first year.

As discussed above, c_e affects equilibrium objects through free entry condition (13) and labor market clearing condition (16), and in turn affects the growth rate and its components in (24). Then, it is possible to quantify the effect of c_e on g and its component by estimating c_e and solve the equilibrium under counterfactual c_e.

4.4 Estimated parameters and moment fit

Estimation results are summarized in Table1, Table2, and Table3.

4.4.1 Recovered Danish parameters

Table 1 shows the estimated structural parameters of Danish and Japanese case. By our Remark above, we can obtain unbiased estimates other than ℓ even if the entry cost is omitted in the model. Thus, we use the LM estimates and recover ℓ. The recovered estimate (c_e, ℓ and R&D labor share) are reported with square brackets "[]" in Table 1 and Table2.

4.4.2 Entry cost

The first row in Table 1 shows the estimated labor input for entry procedure, c_e. c_e in Japan (1.31) is higher than that of Denmark (1.20).

This result is consistent with the previous measurement of country-specific strength of entry barrier. The literature includes Djankov, La Porta, Lopez-De-Silanes, and Shleifer (2002) and Kaufmann, Kraay, and Zoldo-Lobàton (1999) for developed and developing countries, and Nicoletti, Scarpetta, and Boylaud (2000) and Pryor (2002) for OECD countries. These authors construct indicators for entry barrier that summarize the actual fees, business days to obtain permits, and the number of procedures. In our model, c_e loosely corresponds to such indices. In these studies, Japan is often classified as the country with higher entry barrier. For example, Kaufmann, Kraay, and Zoldo-Lobàton (1999) conclude that Japan is the most entry-regulated country. Nicoletti, Scarpetta, and Boylaud (2000) rank Japan at the 12th and Pryor (2002) at the 15th in terms of free entry environment among OECD 21 countries. Moreover, all three studies conclude that entry barrier in Japan is higher than that of Denmark. These results are consistent with our estimate that c_e is larger in Japan than that in Denmark.

On the other hand, as is clear in (13), the real effective entry cost faced by potential entrants in our model is $c_e w/Z$. The estimate of $c_e w/Z$ is presented in the second row in Table 1. From the table, $c_e w/Z$ reads *larger* in Denmark than in Japan. This presents a sharp contrast to the comparison of c_e. As will become apparent below, the lower real effective entry cost $c_e w/Z$ is a major cause of the higher estimate of entry/exit contribution to APG in Japan.

In the previous literature, the relationship between entry barrier and productivity is examined empirically using cross-country data such as by Nicoletti and Scarpetta (2003), Loayza et al. (2005), and Barseghyan (2008). These empirical works rely on the index of entry barrier created by above authors. Our estimation results of c_e and $c_e w/Z$ may indicate a possible gap between the entry barrier indicator and the actual entry cost the entrants face. This gap is relevant to policy experiments, as our model allows the possibility that a deregulation policy that reduces c_e results in the higher real wage and pushes up the actual entry cost, hindering the start-ups. Thus, the structural estimation of entry barrier serves as a complementary approach to the previous approach that uses directly surveyed indices.

4.4.3 Other parameters

Estimated cost function parameters are presented in the second and third rows in Table1. Cost elasticity c_1 in Japan is about 1.9, which is about a half of that of Denmark (about 3.7), as well as estimated coefficient c_0/Z in Japan (about 17.1) is much smaller than that of Denmark (about 175.8).

The 6th row in Table1 reports the shape parameter of type conditional quality distribution which is assumed to be a Weibull distribution. The shape parameter β_q in Japan is much larger (about 31.8) than that of Denmark. This means that quality step size distribution is much more dispersed in Japan compared with Denmark. Weibull shape parameter of demand realization β_z in Japan is as large as in Denmark.

4.4.4 Moment fit

Table 3 shows that the estimated model predicts the medians of distributions more precisely than standard deviations. For example, the median of real value added in the first year computed from the data is about 40,874 while the prediction of the estimated model is only 21,274. The standard deviation of real value added in the first year computed from the data is about 210,646 which is also significantly greater than the model prediction, 33,602. This implies that the right tail of the actual real value added distribution is much heavier than that of the prediction. Much the same is true for the total employments and wage paid.

This problem is also reported in LM, but it seems to be less serious in their estimates. The discrepancy between LM and ours may be attributed to the difference in the number of observations. The number of observation in ours is 11,703 while it is 4,872 in LM. It is well known that the right tail of the firm size distribution is well approximated by Pareto distribution with the Pareto index (shape parameter) near 1. For example, Luttmer (2007) estimated the Pareto index of U.S. firm size distribution to be 1.06. When the Pareto index is less than 2, the population standard deviation does not exist. In such a case, the larger the number of observation, the bigger the sample standard deviation becomes. In a word, the standard deviation is not an appropriate statistic in this case. More serious treatment of the right-tail distributional property is left to the future work.

5 Estimates of aggregate productivity growth and decomposition

The results of the productivity growth and its decomposition according to the current model are summarized in Tables 4 and 5. First column in Table 4 presents the results for Denmark obtained by LM. The second column in Table 4 presents the results for Japanese data, which we call the baseline results.

The second column of Table 4 shows that the estimated aggregate productivity growth rate in Japan is about 1.38% which is closely coincides with that of Denmark (1.38%). However, it becomes clear from Table 4 that the productivity growth in each country is achieved through quite different channels.

5.1 Comparison of Japanese and Danish decomposition results

Three decomposed APG components for Danish firms are reported in the first column of Table 4. The corresponding share of each component in APG is reported in square brackets. There, the share of firm type selection effect in the APG amounts to about 52%.

It can be seen that the benchmark results for Japanese firms, which are reported in second column in Table 4, are qualitatively different from Danish ones. First, the share of firm type selection effect in the APG is much smaller in Japan, which is about 12%. Second, the share of entry/exit in the APG is much larger than that of Denmark, which amounts to 63% in Japan. The share of average incumbent innovation effect in the APG in Japan is comparable to that of Denmark. In other words, productivity growth is achieved by active entry/exit in Japan while R&D by high-innovative incumbent in Denmark.

The smaller selection effect share in Japan is explained more precisely as follows. It can be seen from Tables 1 and 2 that the high type firms replace the low type ones less frequently in Japan than Denmark. This is implied by the changes in the share of goods supplied by type τ firm from entry to steady state, $(K_\tau - \phi_\tau)$, which is the component of the selection effect term in (24); Absolute values of $(K_\tau - \phi_\tau)$ is much smaller in Japan than that of Denmark. In other words, higher (lower) type firms rarely have opportunities to additional expansion (contraction) after entry. From Table1, the type distribution of start-up firms (ϕ_τ) is almost the same in both countries. On the other hand, K_1 in Japan is larger than that of Denmark whereas K_2 and K_3 in Japan are smaller than those of Denmark. In other words, the steady state type distribution (in terms of the product line) leans to the lower type in Japan.

On the other hand, a larger Entry/Exit effect in Japan can be attributed to a larger entry rate (η). From row 2 in Table 2, the estimated entry rate (η) in Japan (about 0.11) is higher than that of Denmark (about 0.05).

What drives such different results in two countries? Difference in cost structure, namely $(c_1, wc_e/Z)$, is a prominent candidate. Note that both c_1 and wc_e/Z are much smaller in Japan than in Denmark.

First, the enhanced entry due to lower entry costs directly stimulates creative-destruction through η (see (21)).[7] That is, lower entry costs $c_e w/Z$ is associated with higher η. As explained later, stimulated creative-destruction may also have a negative impact to the aggregate productivity growth in the economy with heterogeneous innovative-types. It reduces R&D return v_τ and intensity γ_τ of incumbents and let the lower innovative type be able to survive in the steady-state. This implies that a lower cost $c_e w/Z$ is also associated with a lower share of high-innovative type in the steady state (for example, higher K_1 and lower K_3). However in the current case, difference in δ in two countries is outweighed by the difference in π_τ which makes v_τ larger in Japan than in Denmark. Thus, the lower actual entry cost is the primary reason for the higher contribution of entry to the APG in Japan than in

[7] As noted earlier, the larger estimated entry rate in Japan results from the larger estimated mass of potential entrants (μ).

Denmark.

Second, because of a *smaller* cost elasticity c_1, the type conditional R&D intensity of incumbents γ_τ in Japan is smaller than that of Denmark. This, along with higher η, effectively inhibits the growth of $|K_\tau - \phi_\tau|$ in Japan.

6 Counterfactual simulations

With estimated parameters, we conduct counterfactual policy experiments. Specifically, we consider two supposedly innovation enhancing policies: the reduction of entry barrier and the increase in R&D tax credits.

6.1 Reduction in barrier to entry

It is non-trivial that the reduction of entry costs results in a productivity growth. If the entry cost is reduced, the Schumpeterian effect ensues: the stimulated entry of new firms suppresses the rent for the incumbent's innovation, and thus lowers the incentives for incumbent's R&D. Note that this Schumpeterian effect is not uniform across firms in our heterogeneous setup: the R&D intensity of high-innovative firms falls whereas that of low-innovative firms does not change, because the lowest type does not innovate at all under the estimated parameters. [8] This heterogeneous response effectively reduces the reallocation of market shares from low-innovative firms to high-innovative firms. Thus, the supposedly growth-enhancing policy such as the reduced entry costs may actually lower the average innovation size and result in a slower productivity growth.

To examine the effect of the reduction of entry costs on the growth, we conduct the fol-

[8] It is a well known and widely observed fact that substantial portion of manufacturing firms conduct no R&D investment. See Klette (1996). LM also reports $\gamma_1 = 0$ in their Danish estimates.

lowing counterfactual simulation: We set c_e as 90% of actual entry cost, i.e. $c_e = 1.1822$, and then we solve the equilibrium. We defer the explanation of the algorithm used in counterfactual simulations to Appendix. Results are summarized in the first column of Table 5.

Table 5 shows that the aggregate productivity growth rate is increased by 2 basis points (from 1.15% to 1.17%). The source of this additional growth is revealed by the productivity growth decomposition. First, as is expected, the contribution of selection channel to the aggregate productivity growth is decreased by more than 17% (from 0.14% to 0.12%). As explained earlier, the impact of reduced entry cost is heterogeneous across the different types of firms in this economy. Table 2 shows that the reduction in c_e reduces the innovation incentives of middle and high innovative incumbents (γ_2 and γ_3), while that of low-innovative incumbents (γ_1) is stick to be 0. In fact, Table 2 shows that the reduction in c_e raises the products share of low-innovative type in the steady state (K_1).

However, these growth-hampering effects of reduced entry cost is outweighed by the enhanced entry effect in the current experiment under the estimated parameters. Almost all the effects of the positive growth effect is attributed to the spur of creative-destruction by potential entrants. In fact, the entry/exit effect under the lower c_e becomes about 63.0 to 66.4%, while both the selection and within effects become smaller.

6.2 Increase in R&D tax credit

To compare with the above consequences of the reduction in entry cost, we next examine the effect of increasing R&D tax credit by 10%. This policy stimulates R&D incentives for any type of incumbents and entrants, which is the particularly different feature from the entry deregulation policy that only affects entrants. Note that c_0 can be regarded as the true cost parameter times the gross tax rate on R&D expenditure. Thus, we can interpret a reduction in c_0 as an increase in the R&D tax credit, that is, a reduced cost piled on the profit. We suppose that tax credit is funded by the lump-sum tax from the representative household.

We simulate the model with *actual* entry costs and 90% of actual c_0 (column 2 of Table5). This increases the APG by about 5 basis points (from 1.15% to 1.20%). Interestingly, APG decomposition is almost unchanged. This contrasts with the case of reducing entry barrier in which each channel is unevenly affected.

6.3 Interference of the two policies

From column 3 of Table 5, we observe that reducing both c_e and c_0 by 10% drives up the APG by 7 basis points (from 1.15 to 1.22%), which is exactly the sum of two consequences of respective counterfactual policy if conducted uncombined. This shows that two innovation enhancing policies, reducing barrier to entry and R&D tax credit, are neither complements nor substitutes.

7 Conclusion

In this paper, we studied the impact of entry deregulation on the aggregate productivity growth. In a Schumpeterian endogenous growth model, a reduction in entry cost decreases the equilibrium rent for innovators, and thus reduces the incentive for R&D. In the economy where innovation efficiency is heterogeneous across firms, this incentive-hampering effect is stronger for high innovative types than low innovative types. Thus, the reduced entry cost may have a negative impact not only on the average R&D investments but also on the reallocation of market share from the low-innovative firms to the high innovative firm.

In the framework of the aggregate productivity decomposition, these two effects correspond to the within and the selection channels. To quantify the effect of the reduced entry barrier on the aggregate productivity growth and the differential effects on the within and selection channels, we incorporated the entry cost into an endogenous growth model with heterogeneous innovative efficiency proposed by Lentz and Mortensen (2008). We estimated the underlying structural parameters including entry cost by applying their estimation algorithm to Japanese firm-level dataset. Using the estimated parameters, we then conducted counterfactual simulations of the policy intervention on the entry cost.

Our estimates showed that a 10% reduction in the entry cost increases the aggregate productivity growth rate by 2 basis points. While this is a modest number, we note that this is a growth effect rather than a level effect. Our estimates also revealed that the reduced entry cost actually hampers the reallocation of market shares from less productive to more productive firms. Moreover, the average incumbent innovation effect was found to be reduced by the reduction of entry cost, which confirmed the Schumpeterian effect quantitatively under the estimated parameters. Finally, we found the reduced entry cost greatly enhanced the entry effect, which turned out to outweigh the other two negative effects on the aggregate productivity growth.

There are some issues left for future research. In our model, the fitting of some moments was not sufficiently achieved as we reported in Section4.4.2. Especially, our model did not capture the fat tail of the firm size distribution, resulting in an underestimate for the standard deviation of the size. Some theoretical works such as Luttmer (2007) have succeeded in establishing the micro foundation of the Pareto distribution of firm size. Acemoglu and Cao (2009) make one step further, with achieving the Pareto distribution, by incorporating the qualitative difference of entrants that they are "radical" innovators in the sense that they replace the incumbents. Incorporating this type of research to generate Pareto firm size distribution in the fully endogenous growth model can enhance the literature on growth and firm size distribution.

Appendix A: Model specification

Distributional assumptions and functional forms are drawn from Lentz and Mortensen (2008) as summarized as follows.

- Type conditional quality step size distributions follow Weibull that share a common shape parameter β_q and a unit point origin, type conditional scale parameter $\xi_{q\tau}$,
- Demand realization distribution $G(.)$ follows Weibull where o_z is the origin, β_z is the shape parameter, and ξ_z is the scale parameter.

R&D cost function is specified as follows:

$$c(\gamma) = c_0\gamma^{1+c_1} \tag{28}$$

Then, the free entry condition and the first order condition for entrant are written as follows;

$$w\hat{c_0}\gamma_e^{1+c_1} + wc_e/Z = \gamma_e\bar{v} \text{ (Free entry condition)} \tag{29}$$

$$w\hat{c_0}(1+c_1)\gamma_e^{c_1} = \bar{v} \text{ (First order condition)} \tag{30}$$

Labor market clearing condition is represented as follows;

$$\ell = \sum_\tau K_\tau \ell_\tau + \mu(c_0\gamma_e^{1+c_1} + c_e), \tag{31}$$

$$\ell_\tau = \frac{Z(1-\bar{\pi}_\tau)}{(w+\kappa)} + c_0\gamma_\tau^{1+c_1}. \tag{32}$$

Appendix B: Algorithm for counterfactual simulation

In this section, we describe the details of computation for the counterfactual simulations. Any policy that changes the level of c_e affects equilibrium through the free entry condition and the first order condition. The stimulated entry affects the labor demand, and thus, w in the counterfactual simulation no longer coincides with the value computed in the data. Therefore, the original LM algorithm for the model solution is no longer applicable and we have to solve the entire model. The modified algorithm is following.

Step 1 Compute γ_e by solving (29) and (30) with new c_e and without w:

$$\gamma_e = \left(\frac{c_e}{c_0 c_1}\right)^{\frac{1}{1+c_1}}. \tag{33}$$

Step 2 Set initial $\mu = \mu^{(0)}$.

Step 3 Update aggregate entry rate with new γ_e:

$$\eta^{(1)} = \mu^{(0)} \gamma_e. \tag{34}$$

Step 4 Set initial $w = w^{(0)}$.

Step 5 Compute $(\delta^{(1)}, g^{(1)}, K_\tau^{(1)}, \gamma_\tau^{(1)})$ from $(\eta^{(1)}, w^{(0)})$ by fixed point search (see APPENDIX C in LM for details).

Step 6 Compute ν_τ from (10) and $\bar{\nu}^{(1)} = \sum_\tau \phi_\tau \nu_\tau^{(1)}$.

Step 7 Rewriting (30) gives an update wage:

$$w^{(1)} = \frac{\bar{\nu}^{(1)}}{c_0(1 + c_1)\gamma_e^{c_1}}. \tag{35}$$

Step 8 Check for convergence: if

$$d_w \equiv |w^{(1)} - w^{(0)}| \leq \epsilon_w \in \boldsymbol{R} \tag{36}$$

then proceed to Step 9; else return to Step 5.

Step 9 Solve (31) for μ as

$$\mu^{(1)} = \left(\frac{\ell - \sum_\tau \check{K}_\tau \check{\ell}_\tau}{c_0 \gamma_e^{(1+c_1)} + c_e} \right)^{\frac{1}{c_1}}, \tag{37}$$

where $\check{K}_\tau$ and $\check{\ell}_\tau$ is the converged value obtained from Step3-Step8.

Step 10 Check for convergence: if

$$d_\mu \equiv |\mu^{(1)} - \mu^{(0)}| \leq \epsilon_\mu \in \boldsymbol{R} \tag{38}$$

then STOP; else update μ and return to Step 3.

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Table and Figures

	Denmark	Japan
c_e	[1.1971]	1.3125
wc_e/Z	[0.0135]	0.0043
c_0/Z	175.8159	17.0479
c_1	3.7281	1.9229
Z	16859.4212	20345.9785
β_q	0.4275	31.8357
o_z	608.2725	159.8082
β_z	0.9577	0.6472
ξ_1	0.0000	0.0006
ξ_2	0.3524	0.7550
ξ_3	0.4168	1.2806
σ_Y^2	0.0323	0.0014
σ_W^2	0.0254	0.0008
ϕ_1	0.8478	0.8622
ϕ_2	0.0952	0.0812
ϕ_3	0.0570	0.0567
ϕ_1^*	0.7387	0.8338
ϕ_2^*	0.1614	0.0962
ϕ_3^*	0.0999	0.0700
κ	150.0126	25.8790
$E[\tilde{q}_1]$	1.0000	1.0006
$E[\tilde{q}_2]$	1.9848	1.7421
$E[\tilde{q}_3]$	2.1648	2.2586
$E[\ln \tilde{q}_1]$	0.0000	0.0000
$E[\ln \tilde{q}_2]$	0.4094	0.5549
$E[\ln \tilde{q}_3]$	0.4529	0.8145
$\text{Med}[\tilde{q}_\tau]$	1.0000	1.0006
$\text{Med}[\tilde{q}_\tau]$	1.1495	1.7464
$\text{Med}[\tilde{q}_\tau]$	1.1769	2.2659
$\bar{\pi}_1$	0.0000	0.0000
$\bar{\pi}_2$	0.2499	0.4258
$\bar{\pi}_3$	0.2690	0.5570
ℓ	[47.3445]	216.1716

Table 1: Estimated structural parameters. Estimated entry cost c_e and labor supply ℓ in Denmark are recovered with our model from the LM estimates of the other parameters.

	Denmark	Japan			
		Baseline	90% c_e	90% c_0	Both policy
g	0.0138	0.0115	0.0118	0.0120	0.0124
η	0.0451	0.0788	0.0865	0.0835	0.0916
δ	0.0707	0.0851	0.0912	0.0893	0.0956
w	190.2400	65.8607	66.6210	66.2825	67.0335
μ	1.3406	7.0544	7.9230	7.1510	8.0206
R&D share	[0.0517]	0.0719	0.0717	0.0730	0.0727
γ_1	0.0000	0.0000	0.0000	0.0000	0.0000
γ_2	0.0553	0.0292	0.0282	0.0303	0.0292
γ_3	0.0566	0.0341	0.0328	0.0353	0.0340
γ_e	0.03360	0.0112	0.0108	0.0116	0.0112
K_1	0.5408	0.7981	0.8082	0.8000	0.8096
K_2	0.2776	0.1144	0.1095	0.1135	0.1088
K_3	0.1816	0.0875	0.0824	0.0865	0.0817
ν_1	0.0000	0.0000	0.0000	0.0000	0.0000
ν_2	3.2392	3.6748	3.4394	3.5452	3.3174
ν_3	3.5332	4.9442	4.6132	4.7698	4.4497
$E[\tilde{k}_1]$	1.0000	1.0000	1.0000	1.0000	1.0000
$E[\tilde{k}_2]$	2.3503	1.2430	1.2061	1.2361	1.2008
$E[\tilde{k}_3]$	2.4833	1.3057	1.2554	1.2962	1.2484

Table 2: Endogenous variables of the estimated model. R&D share in Denmark are re-estimated with our model and the LM estimates for the other parameters.

	Data	Simulation
Survivors_T	9631.00	9151.06
$E[Y]_1$	40874.51	21274.37
$\text{Std}[Y]_1$	210646.89	33602.46
$\text{Med}[Y]_1$	9351.57	8934.69
$\text{E}[W]_1$	25442.24	13974.58
$\text{Std}[W]_1$	127357.90	22093.92
$\text{Med}[W]_1$	6767.98	5949.72
$\text{E}[Y/N]_1$	95.47	97.23
$\text{Std}[Y/N]_1$	35.30	23.72
$\text{Med}[Y_1/N_1]$	88.42	92.32
$\text{E}[Y]_T$	51898.65	22497.46
$\text{Std}[Y]_T$	259265.92	35456.01
$\text{Med}[Y]_T$	11046.51	9462.52
$E[W]_T$	27996.45	14672.32
$\text{Std}[W]_T$	126276.33	23098.93
$\text{Med}[W]_T$	7357.29	6288.40
$E[Y/N]_T$	107.01	102.18
$\text{Std}[Y/N]_T$	58.35	25.36
$\text{Med}[Y_T/N_T]$	95.03	96.70
$\text{Corr}[Y, W]_1$	0.95	0.97
$\text{Corr}[Y/N, N]_1$	0.06	0.08
$\text{Corr}[Y/N, Y]_1$	0.14	0.25
$\text{Corr}[Y, W]_T$	0.93	0.96
$\text{Corr}[Y/N, N]_T$	0.06	0.09
$\text{Corr}[Y/N, Y]_T$	0.15	0.26
$\text{Corr}[(Y/N)_1, (Y/N)_2]$	0.79	0.95
$\text{Corr}[(Y/N)_{T-1}, (Y/N)_T]$	0.56	0.94
$\text{Corr}[(Y/N)_2 - (Y/N)_1, (Y/N)_1]$	-0.22	-0.10
$\text{Corr}[(Y/N)_T - (Y/N)_{T-1}, (Y/N)_{T-1}]$	-0.35	-0.13
$E[(Y_2 - Y_1)/Y_1]$	0.00	-0.01
$\text{Std}[(Y_2 - Y_1)/Y_1]$	1.63	2.30
$\text{Corr}[(Y_2 - Y_1)/Y_1, Y_1]$	0.00	-0.01
$\text{Corr}[(Y_2 - Y_1)/Y_1, Y_1/N_1]$	-0.04	-0.04
$\text{Corr}[(N_2 - N_1)/N_1, Y_1/N_1]$	0.18	-0.01
Within	0.90	0.63
Between	0.13	-0.03
Cross	-0.07	0.29
Distance	2496.20	

Table 3: Data and estimated moments.

	Denmark(LM)		Japan(Benchmark)	
Entry/Exit	0.0030	[0.211]	0.0072	[0.6265]
Within	0.0037	[0.261]	0.0029	[0.2519]
Selection	0.0073	[0.523]	0.0014	[0.1216]
g	0.0140	[1.000]	0.0115	[1.0000]

Table 4: Aggregate productivity growth rate (g) and its decomposed components. Column 1 reproduces the LM estimates for Denmark and column 2 presents our estimates for Japan. Corresponding share of each component in g is presented in square brackets.

	(1)90% c_e		(2)90% c_0		(3)90% c_e &90% c_0	
Entry/Exit	0.0078	[0.6639]	0.0075	[0.6310]	0.0082	[0.6677]
Within	0.0028	[0.2377]	0.0030	[0.2503]	0.0029	[0.2361]
Selection	0.0012	[0.0984]	0.0014	[0.1187]	0.0012	[0.0962]
g	0.0117	[1.0000]	0.0120	[1.0000]	0.0122	[1.0000]

Table 5: Aggregate productivity growth rate (g) and its decomposed components under counterfactual environments. Columns 1, 2, and 3 show the results for the entry cost reduction alone, the tax credit increase alone, and both, respectively. Corresponding share of each component in g is presented in square brackets.