The Impact of Trade Competition on Managerial Incentives and Productivity

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	ABSTRACT
<p>2022 Research Leap/Inovatus Services Ltd. All rights reserved.</p> <p>DOI: 10.18775/jibrm.1849-8558.2015.72.3002 URL: https://doi.org/10.18775/10.18775/jibrm.1849-8558.2015.72.3002</p>	<p>We study a model of monopolistic competition with firm heterogeneity –in terms of productivity– in which firms provide incentives to managers to reduce marginal cost. In our model managerial incentives are endogenously determined by firm's productivity and the intensity of competition. We show how tougher competition, generated by large market size or trade, induces stronger incentives to reduce marginal cost for the more-productive firms while the opposite holds for the less-productive firms; this further affects the selection of heterogeneous producers into the domestic and foreign markets. Aggregate productivity growth is decomposed in two sources, within-firm growth and between-firm growth, a decomposition that has not been theoretically analyzed before. We provide a useful theoretical model to analyze how exposure to competition leads to firm productivity growth and how this further affects aggregate performance measures and selection.</p>
<p>Keywords: <i>Competition, Heterogeneous Firms, Managerial Incentives, Productivity, Trade.</i></p>	

1. Introduction

Over the last decade, a number of studies have examined the relationship between trade openness and productivity finding major improvements in firm productivity as a result of trade liberalization (Amiti and Konings, 2007; Trefler, 2004; Pavcnik, 2002). However, there is a lack of theoretical and empirical literature on the precise mechanisms underlying this relationship. In this paper I will highlight a particular mechanism through which trade openness might affect productivity: managerial incentives.

The empirical literature on trade and productivity has revealed two facts: first, that increased exposure to trade leads to firm and industry productivity gains (Pavcnik, 2002; Schott et al., 2006; De Loecker, 2007) and second, that exporting firms are more productive than non- exporting firms (Bernard and Jensen, 1999; Clerides et al., 1998). These well documented empirical facts motivated the creation of trade models that incorporated firm heterogeneity to explain industry's productivity growth as those of Melitz (2003) and Bernard, Eaton, Jensen and Kortum (2003). These models indicate that

trade liberalization leads to industry productivity gains due to market share reallocation from the less productive to the most productive firms, what I call the “between-firms” effect. However, they assume firm productivity as given throughout the opening up to trade process, disregarding the possible within-firm productivity gains, what I call the “within-firm” effect, that further contribute to aggregate industry productivity growth. In our model, we will be able to capture both effects “between-firms” and “within-firm”, considering managerial incentives as the source of the within effect.

Managerial incentives (as stocks/equity-based-pay) can be used to alleviate the agency problem by aligning managers’ interests with those of the shareholders. Thus when firm owners’ provide stronger incentives, the manager exerts effort to reduce marginal cost,

increasing the productivity level of the firm as has been empirically tested by Bulan, Sanyal and Yan (2007).

A contribution of this paper is to provide a model that incorporates the standard principal-agent problem (to characterize the effect of manager's practices on firm productivity) into a heterogeneous firm model of trade with monopolistic competition. We characterize the way trade competition affects firm owners' optimal choice of managerial incentives and analyze in what measure aggregate industry productivity growth results from the interaction of the between-firms and within-firm effects.

The rest of the paper is organized as follows. In the next section, I present the setup of the model describing the role of consumers, firms and managers. In Section 3, I solve for the equilibrium of the model in a closed economy case. Section 4, presents the open economy case. Finally, Section 5 concludes and discusses further research.

2. The Model

In this section we present a monopolistically competitive model of trade with firm heterogeneity and managerial incentives based on Melitz and Ottaviano (2008). The timing of the events is as follows. First, firm's make a decision about whether or not to enter the market. Entering firms have to pay a fixed entry cost $f(R)$ observe their marginal cost c , which is drawn from a Pareto distribution with bound $[0, c(M)]$. Each entering firm has a manager. The firm owners decide how much incentive to offer their manager, the higher the incentive the higher the effort he/she exerts and hence the higher the probability that marginal cost will decrease. The effort of each manager is not directly observable, hence the firms are involved in a moral hazard problem where the manager is risk-averse and the firm's shareholders are risk-neutral and maximize their profits net of the manager's payment. Once the manager exerts effort, the firm can finally observe its realized marginal cost c , which takes into account the effort of the manager, this is the marginal cost at which the firms faces other competitors. Given the firm decides the optimal output and price in a monopolistic competitive market structure. To ease exposition, I consider first the closed-economy case and then extend my model to the open economy case.

2.1 Consumers

There are L consumers in the economy. Each consumer has one unit of labor which they sell in the market at wage w . Consumers have quasilinear-quadratic preferences which are defined over a continuum of differentiated varieties indexed by $i \in \Omega$, and a homogenous good chosen as numeraire. All consumers share the same utility function given by,

$$U = q_0^{\alpha} + \alpha \int_{i \in \Omega} q_i^{\gamma} di - \frac{1}{2} \gamma \int_{i \in \Omega} [K q_i L \bar{p}]^2 di - \frac{1}{2} \eta \left(\int_{i \in \Omega} q_i^{\gamma} di \right)^2 \quad (1)$$

where q_0 and q_i respectively represent the individual consumption levels of the numeraire good and each variety i . The degree of product differentiation between varieties is $\gamma > 0$, as increases the consumer prefers to diversify his/her consumption across varieties. The parameters $\alpha > 0$ and $\eta > 0$ index the substitution pattern between the differentiated varieties and the numeraire good. The introduction of the numeraire good implies that marginal utilities are bounded; hence a consumer may have zero demand for some goods. We will assume that the consumption of the numeraire good q_0 is always positive. The market demand for each variety is then given by

$$q_i = L q_i^{\gamma} = \frac{\alpha L}{\eta N + \gamma} - \frac{L}{\gamma} p_i + \frac{\eta N}{\eta N + \gamma} \frac{L}{\bar{p}} \quad (2)$$

where $\Omega^* \in \Omega$ is the subset of varieties that are consumed ($q_i^{\gamma} > 0$); p is the average price of the consumed varieties and N is the measure of consumed varieties in Ω^* . Since marginal utilities are bounded, consumers can demand zero of a particular good. In other words, there is a threshold price level $p(\max)$, where, if a good's price is less than this threshold price $p_i \leq p_{\max}$ then the good will have positive demand otherwise it will have zero demand.

This maximum price is defined by,

$$p_{\max} = \frac{\gamma \alpha + \eta N \bar{p}}{\eta N + \gamma} \quad (3)$$

Then we can write the price-elasticity of demand as,

$$\epsilon = \left[\frac{p_{\max}}{p_i} - 1 \right]^{-1} \quad (4)$$

In contrast with the CES case, the elasticity of demand is not constant and will depend negatively on $p(\max)$ and positively on the price of the good. This is, the 'tougher' the competitive environment -lower average price $\bar{p}$ or larger number of competing varieties N - the lower $p_{\max}$ and hence the higher the price-elasticity of demand at any given price $p(i)$.

2.2 Production and Firm Behavior

We assume labor is the only factor of production and is inelastically supplied in a competitive market. The numeraire

good is produced under constant returns to scale at unit cost; its market is also competitive. These assumptions imply a unit wage. Entry in the differentiated product sector is costly as each firm incurs product development and production start-up cost, f_e . Subsequent production exhibits constant returns to scale at a marginal cost $c(R)$. Labor input is a linear function of output, $l = c_g q$, where the realized marginal cost of the firm $c(g)$, is defined as

$$c_g = c - g(c)(s + u) \quad (5)$$

Where c is the marginal cost draw that firms learn after making the irreversible investment f_e required for entry. This draw is from a common (and known) distribution $G(c)$ with support on $[0, c_M]$. The observed cost reduction induced by manager's effort is c , this term is decomposed in agent's effort and a pure noise term u with mean 0 and variance. Function $g(c)$ measures the degree at which the observed cost reduction $(s + u)$ affects firm's realized marginal cost. We will assume that $g(c)$ is a differentiable increasing function. The latter property implies that c is sub-modular in c and e , i.e the marginal decrease in the realized cost for a given increase in effort is higher for low-productivity firms. This assumption is necessary to avoid negative realized marginal cost.

Since the entry cost is sunk, firms that can cover their marginal cost survive and produce. All other firms exit the industry. Surviving firms maximize their profits using the residual demand function (2). In doing so, given the continuum of competitors, a firm takes the average price level $\bar{p}$ and number of firms as given. This gives us the monopolistic competition outcome. Firm maximize $\pi(c_g) = p(q)q - c_g q$. Hence, the profit maximizing quantity $q(c_g)$ is

$$q(c_g) = \frac{L}{\gamma[p(c_g) - c_g]}$$

Let $c(N)$ be the reference cost at which the firm is indifferent between operating or shutting down. This firm earns zero profit as its price is driven to its marginal cost $c_D = c_N = p_{max}$, and its demand level $q(c_D)$ is driven to 0. We assume that $c(D) < c(M)$ so the firms between these two levels will exit. All firms with $c(E) < c(N)$ earn positive profits (gross of the entry and managerial cost) and remain in the industry. The threshold cost is a sufficient statistic that summarizes the effect of both, the average price and the number of firms on the performance

measure of all the firms. Hence the performance measure of the firms can be written as a function of their realized marginal cost and the cut-off. From (3) we have that,

$$\begin{aligned} p(c_g) &= p_{max} - \frac{q(c_g)\gamma}{L} \\ \text{thus,} \\ q(c_g) &= \frac{L}{2\gamma[c_D - c_g]} \\ p(c_g) &= \frac{1}{2[c_D - c_g]} \\ \mu(c_g) &= \frac{1}{2[c_D - c_g]} \\ \pi(c_g) &= \frac{L}{4\gamma} [c_D - c_g]^2 \end{aligned}$$

Finally, firm's shareholders choose optimally the manager (CEO) total compensation scheme. Following the CEO compensation literature, managers compensation is decompose on a fixed salary, s , and a performance or incentive-pay b . Thus total compensation for the manager is,

$$W = s + b(s + u)$$

2.3 Managers Behavior

All managers simultaneously choose effort levels given their linear compensation. If we let the random variable W denote the financial wealth of the CEO in the firm, then the CEO's pay-off is represented by the usual additively separable utility function:

$$E[u(W)] - \psi(s)$$

where ψ is the CEO's hidden cost of effort function, which we

assume to take the simple quadratic form $\psi(s) = \frac{ds^2}{2}$. We make an additional simplifying assumption, that the CEO's attitude towards risk can be summarized by the following mean variance preferences:

$$E[u(W)] = E[W] - \frac{r}{2} \text{Var}[W]$$

where $r > 0$ measures the CEO's aversion to risk. CEOs chose effort level to maximize their utility given by the mean-variance preferences:

$$\max_s E[W] - \frac{r}{2} \text{Var}[W] - \frac{ds^2}{2} \quad \square$$

The first-order condition to this problem fully characterized the CEO's optimal action choice:

$$e = \frac{b}{d} \quad (6)$$

Managers accept any contract (s, b) with an expected utility of at least his/her reservation utility. Hence the manager's fixed salary has to satisfy

$$s = U - \frac{b^2}{2d[1 - r d \sigma^2]} \quad (7)$$

2.4 Optimal Incentive Contract

The shareholders' (firm owners) problem is to choose the contract (s, b) that maximizes profits net of agent cost, subject to satisfying the manager's participation and incentive constraint. Formally the shareholder's problem is given by,

$$\max_{s, b} E_{\pi}[\Pi(c)] = E_{\pi} \left[\frac{L}{4\gamma} (c_D - c_{\theta})^2 - s - b(c + u) \right]$$

Subject to

$$\max_{c \in \Theta} [E[W] - r/2 \text{Var}[W]] - (d s^2)/2 \geq U$$

Combining equations (5), (6) and (7) we can formulate the shareholder's optimal contracting problem as follows,

$$\max_{s, b} E_{\pi}[\Pi(c)] = E_{\pi} \left[\frac{L}{4\gamma} (c_D - c + g(c) \left(\frac{b}{d} + u \right))^2 - \bar{v} + \frac{b^2}{2d} [1 - r d \sigma^2] - b \left(\frac{b}{d} + u \right) \right] \quad (8)$$

For expression (8) to be strictly concave in the incentive-pay b for any c , we need to make the following assumption,

Assumption 1 $\frac{L}{2\gamma} < d(1 + d r \sigma^2)$

This assumption ensures that the optimal incentive-pay b is small enough so that the manager will not cut costs to a level that makes marginal costs negative. The optimal incentive contract in this way is described in the following proposition,

Proposition 1 When the cost draw of the firm is less than the cut-off $c < c(D)$ the optimal level of effort is given by

$$s = \frac{\frac{Lg(c)}{2\gamma d(c_D - c)}}{1 + r d \sigma^2 - \frac{Lg^2(c)}{2\gamma d}} = \frac{2(c)(c_D - c)}{\lambda(c)} \quad (9)$$

$$\lambda(c) = \frac{\frac{Lg(c)}{2\gamma d}}{1 + r d \sigma^2 - \frac{Lg^2(c)}{2\gamma d}}$$

otherwise $e=0$. Proof: See Appendix.

The optimal level of effort follows an inverse U-shaped pattern in terms of the cost draw c . This is shown in chart 1a, where the optimal effort is graphed against the initial cost draw c or the initial productivity draw in chart 1b. Chart 2 shows the expected realized cost as a function of the initial cost draw. In a model with no incentives the productivity of each firm will be the same as the productivity draw of each firm (the 45 dashed line in chart 2), while in a model with incentives each firm's productivity depends on the degree of managerial incentives which is different across firms. At extreme values of productivity, either very high- productive or low-productive firms, it is optimal to provide low level of incentives. High productive firms find it optimal to provide low level of incentives due to little expected productivity gains of an additional unit of effort, and low productive firms provide low incentives due to their lack of profits. Thus, only firms in the middle of the distribution of productivity will provide the highest level of incentives, as we can observe in Chart 1a and Chart 2.

Chart 1: Equilibrium Level of Effort

Chart 2: Expected Realized Cost

Given the optimal effort level, we can rewrite the expected value of a firm profit net of agent costs, as a function of the initial cost draw and the parameters of the model.

$$E_{\pi}[\pi(c)] = c_D - c + \frac{L}{4\gamma} + \frac{L}{4\gamma} 2g(c)\sigma^2 + \frac{L}{4\gamma} g^2(c)\sigma^4 - \frac{L^2(c)^2}{2} [d\sigma^2 + 1] + \frac{L}{4\gamma} g^2(c)\sigma^2 \quad (11)$$

2.5 Free Entry Equilibrium

Firm expected profit -net of entry cost- is

$$\int_0^{c_D} E_{\pi}[\pi(c)] dG(c) - f_E$$

Firms will enter the market until profit is zero. This yields the equilibrium free entry condition

$$\int_0^{c_D} E_{\pi}[\pi(c)] dG(c) = f_E \quad (12)$$

which determines the cost cut-off $c(N)$. Given a production technology $g(c)$, from equation (12) we can determine the behavior of in terms of the fundamentals

$$c_D = h(\bar{L}, \bar{\gamma}, \bar{f}_E, \bar{c}_M)$$

The larger the market size or the lower the sunk cost f_E , the 'tougher' is the competitive environment ($c(D)$ lower) as more firms enter the market and average price decreases. In all these cases, firm exit rate is also higher (since the pre-entry probability of survival $G(c_D)$ is lower). We will analyze in more detail the comparative statics in Section 3.

2.6 Parameterization of Technology

Our results so far do not rely on the particular parameterization of technology. In order to simplify the analysis we use a specific parameterization for the cost distribution. Following Melitz and Ottaviano (2008) we assume that the distribution of cost draws given by,

$$G(c) = \left(\frac{c}{c_M}\right)^k \text{ for } c \in [0, c_M]$$

The higher the shape parameter k , the larger is the fraction of firms with marginal cost close to the bound $c(R)$. As k goes to infinity the distribution becomes degenerate at $c(M)$. The productivity distribution of surviving firms will therefore also be Pareto with shape parameter k , given by,

$$G_D(c) = \left(\frac{c}{c_D}\right)^k \text{ for } c \in [0, c_D]$$

Hence given the Pareto distribution and equation (11) the solution for the cut-off $C(D)$ will be obtained by solving,

$$\int_0^{c_D} \left[c_D - c + \left(\frac{L}{4\gamma} + Z\right) + \left(\frac{L}{4\gamma}\right) g^2(c)\sigma^2 \right] dG(c) = f_E \quad (13)$$

Where

$$Z = \frac{L}{2\gamma} f'(c) + \frac{L}{4\gamma} f''(c) - \frac{L^2(c)^2}{2} [1 + d\sigma^2] > 0$$

. By

Leibniz rule this implies that the

cut-off point in an economy with incentives is lower than the cut-off point in an economy without incentives. The cut-off point of an economy with no incentives is given by the solution

$$\frac{L}{4\gamma} \int_0^{c_D} (c_D - c)^2 dG(c) = f_E$$

, as

in the Melitz-Ottaviano (2008) model. Hence, the inclusion of incentives makes the economy more competitive since now every surviving firm will have the option to endogenously affect its own productivity, making all surviving firms in the market more productive than before. We also assume that to ensure

In order to simplify our analysis and do comparative static we include two additional parameterization assumptions in our model. We assume that $g(c) = c$, and that u is uniformly distributed with mean 0 and variance. These two assumptions ensure that the realized costs are always positive for any surviving firm (i.e. $c_i \geq 0$).

3. Closed Economy Analysis

In this section we discuss some of the predictions of the model regarding the relationship between competition, managerial incentives and aggregate productivity. In contrast to previous theoretical models our model suggests two channels through which competition affects industry's aggregate productivity: the entry cut-off (same as in Melitz, 2003 and Melitz-Ottaviano, 2008 model) and the incentives level of each firm which affect within-firm productivity.

Proposition 2 An increase in market size (L) or in product substitutability (lower γ) leads to stronger incentives for sufficiently high productive firms and lower incentives for low productive firms. While a decrease in the sunk entry cost (lower f_E) leads to lower incentives for all the firms.

Taking partial derivatives of equation (9) we obtain,

Where $\frac{\partial \lambda(c)}{\partial L} \geq 0$ for all the surviving firms (i.e. all) and $\frac{\partial c_p}{\partial L} < 0$ (see proof in the Appendix). Hence for sufficiently high values of c (low-productive firms) the first term on the right hand side of equation (14) will approach zero and thus the second term will dominate, making $\frac{\partial b}{\partial L} < 0$, the opposite holds for sufficiently low values of (high- productive firms).

Intuitively, an increase in the toughness of competition -caused either by an increase in market size or in product substitutability- leads to two effects that work in opposite directions: business-stealing effect and scale effect. First, an increase in market size will make the demand faced by each firm more elastic, making it easier for each firm to increase its quantity demanded by cutting its price. In this environment, is optimal for firms to provide stronger incentives to the manager in order to reduce marginal costs, this is known as the business-stealing effect. Second, an increase in market size makes firm rivals charge lower prices, which makes average price, p fall, resulting in a decrease in firm demand. A lower demand leads firm to provide weaker managerial incentives, this is known as the scale effect. In previous literature, the net effect of these two forces was ambiguous; however in the particular model studied here the net effect will depend on each firm initial cost draw. For firms with sufficiently high cost draw the business-stealing effect will dominate the scale effect, otherwise the scale effect dominates the business-stealing effect. Chart 3, shows how each firm optimal level of incentives reacts given a 1% increase in market size. As can be observed from the graph below, firms that have a sufficiently low cost, increase their level of incentives (b) and thus their effort level

($b = \frac{b}{a}$), while the opposite holds for firms that have high cost.

Furthermore, Chart 4 shows the change in firm's quantity sold when market size increases. In the case of high-productive firms, an increase in market size will bring an increase in quantity sold, due to two factors, the larger market and the increase in productivity due to stronger incentives. On the contrary, low-productive firms will decrease their quantity sold losing market share, mainly because they face higher competition ($c(N)$ lower) and provide lower level of incentives.

On the other hand a decrease in the sunk entry cost, f_e incentivizes firms entry, resulting in more firms in the market. Since market size remains constant, each active firm faces a reduction in market share. Hence the scale effect dominates the business-stealing effect and all the firms provide weaker managerial incentives to reduce cost (See proof in the Appendix).

Chart 3: Change in optimal effort due to change in market size

Chart 4: Quantity sold and market size

In order to evaluate the aggregate effects of an increase in competition, we examine a number of numerical calculations over the threshold $c(D)$. The following comparative statics hold -at any parameterization of the model- when assumption 1 is satisfied. However, for illustration purposes we report on the numerical calculation of a benchmark case.

First we analyze the effect of market size on the entry cut-off level. Results are shown in Chart 5, as we can observe the entry cut-off is a decreasing function of the market dimension (L). This result emphasizes the pro-competitive effect of an increase in market size which is consistent with previous literature on

heterogeneous firms (Melitz, 2003; Ottaviano and Melitz, 2008; Yeaple, 2005). Comparing the effect of market size in the managerial incentives scenario versus the original model of Ottaviano and Melitz (2008) we found that the pro- competitive effect is stronger in presence of managerial incentives, since productive firms find it profitable to increase their productivity by means of stronger incentives.

Chart 5: Market size and entry cut-off

Second, we analyze the effect of an increase in market size (L) or increase in product substitutability (lower γ) over the aggregate effort of surviving firms. As we mentioned in proposition 1, productive firms find it profitable to provide higher incentives (thus obtaining more effort from managers) given an increase in market size, while less productive firms optimize reducing their incentives. Our various simulations have proven conclusively that the increase in incentives by the more-productive firms over-compensates the decrease in incentives of the less-productive firms, leading to an overall increase in the industry's aggregate effort. Given our baseline parameters, a 1% increase in market size increases aggregate effort by 0.27%. This holds consistently for different values of market size.

Finally, we analyze the effect of an increase in market size over the industry's aggregate productivity. The expected aggregate marginal cost (which is proportional to industry's aggregate productivity) is decomposed into two sources between and within:

$$c_g = \underbrace{\int_0^{c_D} c dG_D(c)}_{\text{Between}} - \underbrace{\int_0^{c_D} g(c)\lambda(c)[c_D - c]dG_D(c)}_{\text{Within}}$$

In contrast with previous literature on heterogeneous firms (that attributes changes in aggregate productivity to only the between-firm, or reallocation, effect as in Melitz (2003) and Melitz-Ottaviano (2008) our model goes one step forward and incorporates within-firm productivity changes through the inclusion of managerial incentives. The industry's aggregate productivity is higher ($\bar{c}_g$ smaller) in a model with incentives than in a model without incentives due to: (i) the cut-off with incentives is smaller than the cut-off with no incentives (as in Chart 5), thus the between effect is smaller (ii) in a model with incentives each firm has the option to increase its productivity by providing incentives to his/her manager, this is the within effect (see chart 2). Table 1 presents a decomposition of the aggregate marginal cost for different levels of market size.

Table 1: Decomposition of Aggregate Marginal Cost

L	Between Mean	Within Mean	$\bar{c}_g$
20	0.46	-0.13	0.33
30	0.42	-0.11	0.3
40	0.39	-0.1	0.28
50	0.37	-0.098	0.27
60	0.35	-0.093	0.26
70	0.34	-0.089	0.25

We claim that an increase in market size (L) or in product substitutability (lower γ) leads to a decrease in aggregate marginal cost (i.e. a proportional increase in the industry's aggregate productivity). Our claim is in-line with previous literature, but in our case the aggregate effect is intensified due to the inclusion of managerial incentives. All the numerical calculations we have made provide support to this claim. Table 2 presents the effect of a 1% increase in L over the aggregate marginal cost showing both the between and within effects. Intuitively, increases in market size, increase the toughness of competition (lower γ), generating first, a reallocation of market share from the less-productive firms to the more-productive firms (between effect); and second, an increase in expected productivity of the more-productive firms (within effect). Both effects lead to an increase of industry's aggregate productivity.

Table 2: Decomposition of Aggregate Marginal Cost

% Δ Between	% Δ Within	% $\Delta \bar{c}_g$
-0.42	-0.27	-0.69

*These values hold for different levels of market size L .

5. Conclusion

We present a model that predicts how industry responds to changes in the competitive environment. In contrast to previous

work that considered firm productivity as given, in our model firm productivity is endogenously affected by firm's incentives to their manager. The higher the incentives, the higher the probability the firm's marginal cost will be reduced. Our model characterizes the way competition affects firm owners' optimal choice of managerial incentives and how aggregate productivity growth results from the interaction of the between-firm and within-firm productivity growth.

We show how market size affects within-firm productivity: larger markets induce the more-productive firms to provide stronger managerial incentives, increasing the probability of higher level productivity; but reduce the incentives and hence the likelihood of higher productivity for low-productive firms. We then analyze how the introduction of incentives affects the selection of heterogeneous producers into the market. A model with incentives generates lower entry cut-off level of marginal cost than a model with no incentives. This is because in the former, each surviving firm can increase its productivity by providing incentives to the manager, hence making the market more competitive.

The model predicts that an increase in market size or increase in product substitutability leads to an increase in the industry's aggregate productivity. Beside the reallocation effect, studied in previous works as the single channel of how market competition affects aggregate productivity, our model adds the within-firm productivity channel as another possible source of aggregate productivity change. The relevance of each channel will depend on the main cause of change in the competitive environment (market size, entry cost, product substitutability or trade) and the parameters of the model. Consequently, empirical calibration is needed to fit the model to the data.

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