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A Simple Model of Competition Policies, Trade, and the Skill Premium*

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Abstract

How competition policies interact with international trade has been one of the so-called "new issues" in the WTO. By developing a simple, general equilibrium model, this paper examines the possible interaction between domestic competition policies and trade and argues that it can result in a change in wage inequality in a trading partner. Specifically, we first show, in a closed economy model, that entry deregulation that reduces the fixed costs of entry can increase the skill premium by increasing the number of firms and decreasing firm size, while an antitrust policy that reduces the size of cartels can decrease the skill premium by decreasing the number of firms and increasing firm size. We next extend the model to a two-country model. In the case of asymmetric countries, though the effects are not clear, our numerical examples show a possibility that entry deregulation and antitrust policy in one country, respectively, can increase and decrease the skill premia in both countries through trade; however, the domestic skill premium is changed by a greater percentage than the foreign one. Finally, available U.S. data show that our model does appear to be empirically relevant.

Keywords: WTO, Trade, Entry policy, Antitrust policy, Skill premium, Firm numbers, Firm size

JEL Classifications: F12, F16, J31, L13, L41, L51

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1 Introduction

How competition policies interact with international trade has been one of the so-called "new issues" in the World Trade Organization (WTO). In 1996, the Singapore Ministerial Conference of the WTO set up the Working Group on the Interaction between Trade and Competition Policy (WGTCP) to study this issue, with the participation of all WTO members. The provisional decision to start negotiations was taken at the Doha Ministerial Conference in 2001. In July 2004, however, the WTO General Council decided that this issue would no longer form part of the Work Programme set out in the Doha Ministerial Declaration and therefore no further work toward negotiations would take place within the WTO during the Doha Round. As a result, the WGTCP is currently inactive.

This paper now casts a doubt on this decision by the WTO and argues that the decision might have been premature. This is because the interaction between domestic competition policies and trade can result in a change in wage inequality in a trading partner even if it is not the purpose of the policies, which implies the essential necessity of international negotiations/coordination of competition policies among the trading countries.

To show this possible interaction between domestic competition policies and trade, this paper now develops a simple, general equilibrium model in which competition policies—both entry and antitrust policies—can change the skill premium for wages.[1] There are two sectors: a final goods sector and an intermediate goods sector. Final goods are produced under conditions of constant returns to scale and perfect competition. Intermediate goods are differentiated goods produced under conditions of increasing returns to scale and monopolistic competition. Monopolistically competitive firms are Cournot competitors, and cartels of firms are allowed in that a certain set of firms collude in decision-making. Efficiency gains from a cartel, however, exist in that the fixed costs are shared within a cartel.[2] There are also two types of labor: high-skilled labor and low-skilled labor. The production of final goods uses a variety of intermediate goods/tasks and high-skilled labor, and the production of intermediate goods uses low-skilled labor.[3] One might interpret that high-skilled labor manages a variety of tasks, and each of tasks is performed by low-skilled labor. A government can control the number and the size of monopolistically competitive firms by exogenously changing the fixed costs of entry (entry policy) or the size of cartels (antitrust policy).

We first show, in a closed economy model, that entry deregulation that reduces the fixed costs of entry can increase the skill premium by increasing the number of firms and

[1] We extend our initial work (Kurokawa, 2010), which examined the effects of entry policy on the skill premium in a closed economy model. We now examine the effects of entry and antitrust policies in closed and open economy models.

[2] As will be mentioned later, one might think of Nissan and Renault as an actual example that independent firms that collude share fixed costs.

[3] In this paper, a variety of intermediate goods are interpreted as a variety of tasks, a common interpretation in task-based model literature. For example, Mitchell (2005) and Grossman and Rossi-Hansberg (2008) adopt this interpretation.

decreasing firm size. It, however, shows that antitrust policy that reduces the size of cartels can decrease the skill premium by decreasing the number of firms and increasing firm size.

We next extend the model to a two-country model. The extended model shows that in the case in which the two countries are symmetric, entry deregulation that is conducted symmetrically in each country can increase the skill premia symmetrically in both countries while antitrust policy that is conducted symmetrically in each country can have the opposite effect. Then entry deregulation and antitrust polcy in each country contribute to this change in the skill premia by, respectively, increasing and decreasing the total number of varieties common to both countries. However, if the government in each country decreases the fixed costs and the cartel size by the same percentage, then competition policies in each country do not affect the skill premium in either country.

In the case in which the countries are asymmetric, though the effects of competition policies in one country on the skill premium in each country are not clear, our numerical examples illustrate a possibility that entry deregulation and antitrust policy in one country, respectively, can increase and decrease the skill premia in both countries through trade. The domestic skill premium, however, is changed by a greater percentage than the foreign one.

Finally, we show that available data from the U.S. are compatible with the main predictions and assumption of our model. It indicates that our model does appear to be empirically relevant.

The main contributions of this paper are as follows. First, we attempt to internationally link competition policies—both entry and antitrust policies—to the skill premium. It is widely recognized that skill-biased technological change (e.g., Berman et al., 1994; Katz and Autor, 1999; Krusell et al., 2000) or trade (e.g., Feenstra and Hanson, 1996; Dinopoulos and Segerstrom, 1999; Acemoglu, 2003; Kurokawa, 2011) is an explanation for changes in the skill premium in wages.[4] However, competition policies as a cause for changes in the skill premium have received little attention in the wage inequality literature, although there is an empirical fact that the number of firms and the skill premium increased in the U.S. after the Carter/Reagan deregulation was implemented in the late 1970s and early 1980s (e.g., see Kurokawa, 2010). We now link internationally both entry and antitrust policies to the skill premium in a two-country model.

Second, our paper adds to the literature on competition policies and trade. Probably the most related work is Neary (2003). While Neary (2003) analyzes the effects of an increase in the number of firms, due to a change in competition policy, on the relative wage between the trading countries in a model of general oligopolistic equilibrium, our paper analyzes the effects of both an increase in the number of firms and a change in cartel size on the relative wage of high- to low-skilled workers—the skill premium—in a general equilibrium model of monopolistic competition. To the best of our knowledge, our paper is the first to link

[4]For example, see Kurokawa (2014) for a survey of trade and wage inequality.

competition policies and trade to the skill premium.

Third, this paper emphasizes changes in both entry and antitrust policies as sources of changes in the firm size. Past studies have emphasized technological change. For example, Mitchell (2005) and Mobius and Schoenle (2006) argue that technological change, such as the introduction of new flexible machines, changes the organization of production from mass production to smaller customized batches, thus decreasing the size of plants/firms. We now argue, using a unified framework, that both entry deregulation and cartel restriction policies can change firm size and the number of firms.

The rest of this paper is organized as follows. Section 2 develops a simple model. In Section 3, we examine the possible effects of both entry and antitrust policies. Section 4 extends our model to a two-country model. In Section 5, we discuss the empirical relevance of our model. Section 6 concludes the paper and indicates opportunities for future research.

2 Model

2.1 The setup of the model

In this paper, we extend the Dixit and Stiglitz (1977) model of monopolistic competition and examine the possible effects of entry and antitrust policies in closed and open economy models.

Consider an economy with an intermediate goods sector and a final goods sector. There are two types of labor, high-skilled and low-skilled labor, with endowments of $\bar{H}$ and $\bar{L}$, respectively.

The intermediate goods sector is monopolistically competitive. There is a continuum $[0, n]$ of differentiated intermediate goods. Firms are Cournot competitors, and there is free entry and exit. Each variety uses low-skilled labor, and the technology of each variety is specified by the following increasing returns to scale production function:

$$x(j) = \max\left[\frac{1}{b}l(j) - f,\ 0\right], \forall j,$$

where $l(j)$ is the input of low-skilled labor to produce each variety j, f is the fixed costs in terms of output, and b is the (inverse) productivity parameter.

The final goods sector is perfectly competitive and uses a variety of intermediate goods/tasks and high-skilled labor. The technology is specified by the following constant returns to scale production function:

$$y = \left[\left(\int_0^n x(j)^\rho dj\right)^{\epsilon/\rho} + H^\epsilon\right]^{1/\epsilon},$$

where y is the output of final goods, and $x(j)$ and H are the inputs of differentiated intermediate goods/task j and high-skilled labor. We assume that $\epsilon < 1$ and that $0 < \rho < 1$.

The elasticity of substitution between varieties and high-skilled labor is $\sigma = 1/(1-\epsilon)$.

We note that one might interpret the above production structure of the intermediate and final goods as follows. High-skilled labor manages a variety of tasks, and each of tasks is performed by low-skilled labor. Lucas (1978) and Rosen (1982), for example, also build models in which managerial skill enters the production function. We also note that for simplicity, in our model the final goods sector uses only high-skilled labor; the intermediate goods sector only low-skilled labor. We can generalize the model to a model in which each sector uses both types of labor. It can be shown that as long as varieties and high-skilled labor are complementary, the main results hold.

Here, as in Seade (1980) and Ohyama (1999), we allow for cartels of firms in that a certain set of firms collude in their output decisions. For simplicity, we assume that the size of each cartel is symmetric and is given by m ($m \leq n$). Thus, the number of cartels is n/m. Each cartel is assumed to determine its output so as to maximize its total profit. Cartels are detrimental in that they directly decrease the degree of competition. In this paper, however, there also exist efficiency gains from a cartel in that the fixed costs f are shared within a cartel and thus become f/m per firm in a cartel. One might think of Nissan and Renault as an actual example that independent firms that collude share fixed costs. One might also think of airline industries.

The demand side is as follows. A representative consumer has the endowments of high-skilled and low-skilled labor: $\bar{H}$ and $\bar{L}$.[5] The utility function is given by:

$$u(c) = c,$$

where c is the consumption of the final goods. The budget constraint is given by:

$$p_y c = w_H \bar{H} + w_L \bar{L},$$

where p_y is the price of the final goods, w_H is the wage for high-skilled labor, and w_L is the wage for low-skilled labor.[6]

The market clearing conditions for high-skilled labor and low-skilled labor are:

$$H = \bar{H},$$

$$\int_0^n l(j)\, dj = \bar{L}.$$

Finally, let us assume that a government can control firm numbers, n, and firm size, $\bar{L}/n$, by exogenously changing the fixed costs of entry f (entry policy) and the size of the

[5] Note that the results for the case of a representative consumer (an aggregate consumer) are the same as those for the case of two types of consumers: high- and low-skilled labor.

[6] Note that as will be shown later, we consider the long-run economy where the profit of each firm becomes zero, and thus there is no profit in the consumer's budget.

cartels m (antitrust policy) in the intermediate goods sector.

2.2 Solving the Model

2.2.1 The intermediate goods sector

First, we derive the free-entry number of firms $\bar{n}$ in the intermediate goods sector with the regulated fixed costs at $\bar{f}$ and the regulated cartel size at $\bar{m}$.[7] For simplicity, we assume that firms are identical and equilibria symmetric. Thus, letting $p(j)$ denote the price of intermediate goods j, we have $p(j) = p$ and $x(j) = x, \forall j$.

Given an arbitrary n, a firm in a cartel, facing the inverse demand by the final goods sector, maximizes the total profit of the cartel $\bar{m}px - \bar{m}(w_L bx - w_L b\bar{f}/\bar{m})$. Since $\bar{n}$ is exogenously given, it is clear that this profit-maximization problem is equivalent to each firm's problem maximizing the profit $px - (w_L bx - w_L b\bar{f}/\bar{m})$. By setting $w_L = 1$ as the numeraire and noting that each firm's action is negligible in the aggregate economy,[8] the output $x\left(n; \bar{f}, \bar{m}\right)$, the price $p\left(n; \bar{f}, \bar{m}\right)$, and the profit $\pi\left(n; \bar{f}, \bar{m}\right)$ of each variety corresponding to this n are:

$$x\left(n; \bar{f}, \bar{m}\right) = \left[\left(\frac{b}{p_y n^{(\epsilon/\rho)-1}\rho}\right)^{\epsilon/(1-\epsilon)} - n^{\epsilon/\rho}\right]^{-1/\epsilon} H, \forall j;$$

$$p\left(n; \bar{f}, \bar{m}\right) = \frac{b}{\rho}, \forall j;$$

$$\pi\left(n; \bar{f}, \bar{m}\right) = \left(\frac{b}{\rho}\right) x\left(n; \bar{f}, \bar{m}\right) - bx\left(n; \bar{f}, \bar{m}\right) - \frac{b\bar{f}}{\bar{m}}, \forall j.$$

As the price is independent of the number of varieties n, the price when the profit of each variety reaches zero because of free entry and exit is also:

$$p = \frac{b}{\rho}.$$

Then, the zero profit condition $px\left(\bar{n}; \bar{f}, \bar{m}\right) - bx\left(\bar{n}; \bar{f}, \bar{m}\right) - b\bar{f}/\bar{m} = 0$, with $p = b/\rho$, specifies the output of each variety:

$$x\left(\bar{n}; \bar{f}, \bar{m}\right) = \frac{\bar{f}\rho}{\bar{m}(1-\rho)}.$$

[7] Mankiw and Whinston (1986) is one of the notable theoretical studies on the free-entry number of firms. It shows that there is a tendency toward excess entry from a social standpoint in homogeneous product markets and that product differentiation can reverse this tendency.

[8] Our model with symmetric firms cannot capture the cross-sectional fact that larger employers pay higher wages at a given point in time (Brown and Medoff, 1989). Extending our model to a heterogeneous firms model may capture this size-wage relationship in the cross-section. Holmes and Mitchell (2008) link the size-skill relationship in the cross-section (where larger plants employ a larger/smaller fraction of skilled workers) to changes in the skill premium over time. They show that if the size-skill relationship is positive, an expansion of markets due to increased trade can raise the skill premium without technological change.

Substituting this output into the equality of labor demand and supply in the intermediate sector, $\bar{n}\left[bx\left(\bar{n};\bar{f},\bar{m}\right)+b\bar{f}/\bar{m}\right]=\bar{L}$, gives the free-entry number of firms $\bar{n}$:

$$\bar{n}=\frac{\bar{L}\bar{m}\left(1-\rho\right)}{b\bar{f}}. \tag{1}$$

2.2.2 The final good sector

Next, we derive the solutions for the final sector.

Here, we find it useful to define a composite good

$$X=\left(\int_0^n x\left(j\right)^{\rho}dj\right)^{1/\rho}$$

and its price p_X. Then the profit of the final good sector becomes:

$$p_y\left(X^{\epsilon}+H^{\epsilon}\right)^{1/\epsilon}-p_X X-w_H H.$$

By solving the cost minimization problem for the good X, the good's price p_X becomes:

$$p_X=\left(\int_0^n p\left(j\right)^{\rho/(\rho-1)}dj\right)^{(\rho-1)/\rho}.$$

By symmetry $p\left(j\right)=p$, p_X becomes:

$$p_X=n^{(\rho-1)/\rho}p.$$

The market clearing condition for the final good and the first order conditions with respect to X and H thereby yield:

$$w_H=\left(n^{(\rho-1)/\rho}p\right)^{\epsilon}\left(\frac{\bar{L}}{\bar{H}}\right)^{1-\epsilon}.$$

As we have normalized $w_L=1$, the relative wage of high-skilled to low-skilled labor—the skill premium—is w_H.

2.2.3 The skill premium

Finally, by combining the above solutions in the intermediate sector and in the final sector, we obtain the skill premium $w_H\left(\bar{f},\bar{m}\right)$ corresponding to the regulated fixed costs at $\bar{f}$ and the regulated cartel size at $\bar{m}$:

$$w_H\left(\bar{f},\bar{m}\right)=\left(\bar{n}^{(\rho-1)/\rho}p\right)^{\epsilon}\left(\frac{\bar{L}}{\bar{H}}\right)^{1-\epsilon}, \tag{2}$$

where $\bar{n} = \bar{L}\bar{m}(1-\rho)/b\bar{f}$ and $p = b/\rho$.

3 Competition Policies and the Skill Premium

We now establish the possible relationship between competition policies and the skill premium. From (1) and (2), we derive the following two propositions.

Proposition 1 *(Entry deregulation, firm numbers/size, and the skill premium) Suppose that the government decreases the fixed costs $\bar{f}$. Then, we have the following.*

(a) The number of firms increases, while the firm size decreases.

(b) The skill premium w_H decreases if $\epsilon > 0$, remains unchanged if $\epsilon = 0$, and increases if $\epsilon < 0$.

Proof. (a) It is evident from (1) that decreasing the fixed costs $\bar{f}$ increases the number of firms $\bar{n}$, thereby decreasing firm size $\bar{L}/\bar{n}$.

(b) Differentiating (2) with respect to $\bar{f}$ yields:

$$\frac{dw_H\left(\bar{f},\bar{m}\right)}{d\bar{f}} = \overbrace{+ \text{ or } 0 \text{ or } -}^{\epsilon} \overbrace{\left(\bar{n}^{(\rho-1)/\rho}p\right)^{\epsilon-1}\frac{(\rho-1)^2}{\rho}\bar{n}^{-1/\rho}p\left(\frac{\bar{L}}{\bar{H}}\right)^{1-\epsilon}\bar{L}\bar{m}b^{-1}\bar{f}^{-2}}^{+}.$$

■

Proposition 2 *(Antitrust policy, firm numbers/size, and the skill premium) Suppose that the government decreases the cartel size $\bar{m}$. Then, we have the following.*

(a) The number of firms decreases, while the firm size increases.

(b) The skill premium w_H increases if $\epsilon > 0$, remains unchanged if $\epsilon = 0$, and decreases if $\epsilon < 0$.

Proof. (a) It is evident from (1) that decreasing the cartel size $\bar{m}$ decreases the number of firms $\bar{n}$, thereby increasing firm size $\bar{L}/\bar{n}$.

(b) Differentiating (2) with respect to $\bar{m}$ yields:

$$\frac{dw_H\left(\bar{f},\bar{m}\right)}{d\bar{m}} = \overbrace{+ \text{ or } 0 \text{ or } -}^{\epsilon} \overbrace{\left(\bar{n}^{(\rho-1)/\rho}p\right)^{\epsilon-1}\frac{-(\rho-1)^2}{\rho}\bar{n}^{-1/\rho}p\left(\frac{\bar{L}}{\bar{H}}\right)^{1-\epsilon}\bar{L}b^{-1}\bar{f}^{-1}}^{-}.$$

■

In these propositions, we have shown that entry deregulation that lowers the fixed costs of entry $\bar{f}$ increases the variety of intermediate goods/tasks $\bar{n}$ used by the final good.

Then, the skill premium increases if $\epsilon < 0$, that is, if varieties and high-skilled labor are complementary (i.e., fulfilling variety-skill complementarity).[9] However, antitrust policy that reduces the size of cartels $\bar{m}$ decreases the variety of intermediate goods/tasks $\bar{n}$ used by the final good, thereby decreasing the skill premium under variety-skill complementarity. We have also shown that entry deregulation decreases firm size measured by employment, $\bar{L}/\bar{n}$, while antitrust policy increases it. We note that firm size measured by sales, px, is also decreased by entry deregulation and increased by antitrust policy. As do the skill premia and the size of firms, the welfares also move to the opposite directions in these two cases. An increase in n due to a decrease in f increases the quantity of the composite good X (as pointed out by Ethier, 1982) and thus the quantity of the final good y.[10] This increases the consumption c and thus the welfare u.[11] On the other hand, a decrease in n due to a decrease in m decreases the quantity of the composite good X and thus the quantity of the final good y. This decreases the consumption c and thus the welfare u.

The key mechanism driving the above results is very simple. Here, let us focus on the case of entry deregulation. An increase in the number of varieties n, due to a decrease in the fixed costs of entry f, increases the quantity of the composite good X through an increase in productivity. This directly increases the marginal products and thus the demand of high-skilled labor. If varieties and high-skilled labor are complementary ($\epsilon < 0$), it also increases the relative demand and thus the relative wage of high-skilled to low-skilled labor w_H. In other words, an increase in the number of varieties n lowers the price of the composite good P_X. Under the complementarity, it causes the demand and thus the wage of high-skilled labor w_H to increase. The similar argument also holds for the case of antitrust policy.

Thus far, we have considered the case in which the government changes either the fixed costs of entry $\bar{f}$ using an entry policy or the size of cartels $\bar{m}$ with an antitrust policy. We now consider the case in which the government changes both the fixed costs of entry $\bar{f}$ and the size of cartels $\bar{m}$. Of course, the net effect on the skill premium depends on which policy dominates in changing the number of firms $\bar{n}$. We thus obtain the following proposition regarding this net effect.

Proposition 3 *(Entry and antitrust policies, firm numbers/size, and the skill premium) If the government decreases the fixed costs $\bar{f}$ by a greater percentage than does the cartel size $\bar{m}$, and if varieties and high-skilled labor are complementary ($\epsilon < 0$), then the skill premium w_H increases because of an increase in the number of firms and a decrease in firm size.*

[9] Kurokawa (2011) defines the case $\epsilon < 0$ ($\sigma < 1$) as the case in which varieties and high-skilled labor are complementary. The number of inputs has a related role in other papers. For example, Blanchard and Kremer (1997) define the index of complexity that relates the increased number of inputs to more complexity in production processes. Kremer (1993) theoretically shows that higher skilled workers will use more complex technologies that incorporate a greater number of tasks.

[10] Ethier (1982) documented that the increased number of inputs translates into higher productivity.

[11] Note that as shown by a model developed by Vives (1988), policies that lower the cost of entry need not increase the welfare.

Proof. From (1), it is evident that if the fixed costs $\bar{f}$ decrease by a greater percentage than does the size of cartels $\bar{m}$, then the number of firms $\bar{n}$ increases, thus decreasing the firm size $\bar{L}/\bar{n}$. Then, given (2), it is evident that if $\epsilon < 0$, then an increase in $\bar{n}$ increases w_H, noting that $0 < \rho < 1$. ■

4 A Two-Country Model: Competition Policies, Trade, and the Skill Premium

We consider two countries, country 1 and country 2. Let these two countries trade varieties with each other. Then the number of varieties that the final sector can use increases; in fact, it increases merely from $\bar{n}^i$ to $\bar{n}^1 + \bar{n}^2$ (the sum of the autarky levels) in each country i, $i = 1, 2$. This increase is because the number of varieties $\bar{n}^i$ produced in each country remains unchanged before and after trade, with the constant endowment of low-skilled labor $\bar{L}^i$.

4.1 Symmetric Countries

First, we consider the case of symmetric countries. Then, the skill premium corresponding to the regulated fixed costs and the regulated cartel size in each country i, $i = 1, 2$, is:

$$w_H^1\left(\bar{f}^1, \bar{f}^2, \bar{m}^1, \bar{m}^2\right) = \left(\left(\bar{n}^1 + \bar{n}^2\right)^{(\rho-1)/\rho} \frac{b}{\rho}\right)^{\epsilon} \left(\frac{\bar{L}^1}{\bar{H}^1}\right)^{1-\epsilon}, \tag{3}$$

$$w_H^2\left(\bar{f}^1, \bar{f}^2, \bar{m}^1, \bar{m}^2\right) = \left(\left(\bar{n}^1 + \bar{n}^2\right)^{(\rho-1)/\rho} \frac{b}{\rho}\right)^{\epsilon} \left(\frac{\bar{L}^2}{\bar{H}^2}\right)^{1-\epsilon}, \tag{4}$$

where $\bar{n}^1 = \bar{L}^1 \bar{m}^1 (1-\rho)/b\bar{f}^1$ and $\bar{n}^2 = \bar{L}^2 \bar{m}^2 (1-\rho)/b\bar{f}^2$. Note that due to the symmetry, each of variables with superscript i is equal, for $i = 1, 2$ (e.g., $\bar{L}^1 = \bar{L}^2$). Note also that due to the symmetry, we have set $w_L^1 = w_L^2 = 1$ as the numeraire.

We now determine the possible effects of competition policies on the skill premium through trade. Since the two countries are symmetric, we consider the case in which both countries conduct competition policies simultaneously and symmetrically. First, we determine the effects of entry deregulation.

Proposition 4 *(Entry deregulation, trade, and the skill premium) Suppose that the government in each country i decreases the fixed costs $\bar{f}^i$ symmetrically. Then, the skill premia in both countries w_H^1 and w_H^2 symmetrically decrease if $\epsilon > 0$, remain unchanged if $\epsilon = 0$, and increase if $\epsilon < 0$.*

Proof. Suppose that the government in each country i decreases the fixed costs $\bar{f}^i$ symmetrically. Then the number of firms $\bar{n}^i$ increases symmetrically in each country i. Hence, due to $(\rho - 1)/\rho < 0$ the term $\left(\bar{n}^1 + \bar{n}^2\right)^{(\rho-1)/\rho} (b/\rho)$ symmetrically decreases in equations

(3) and (4). Thus it is evident from equations (3) and (4) that the skill premia in both countries w_H^1 and w_H^2 symmetrically decrease if $\epsilon > 0$, remain unchanged if $\epsilon = 0$, and increase if $\epsilon < 0$. ■

As can be seen from equations (3) and (4), entry deregulation in one country can contribute to a change in the skill premium in both countries through a change in $\bar{n}^1 + \bar{n}^2$. We note that even if both countries decrease the fixed costs without trading varieties, the skill premium can change in both countries. In that case, however, entry deregulation in each country contributes only to the change in the skill premium in own country.

Similarly, we can also determine the effects of antitrust policy.

Proposition 5 *(Antitrust policy, trade, and the skill premium) Suppose that the government in each country i decreases the cartel size $\bar{m}^i$ symmetrically. Then, the skill premia in both countries w_H^1 and w_H^2 symmetrically increase if $\epsilon > 0$, remain unchanged if $\epsilon = 0$, and decrease if $\epsilon < 0$.*

Proof. The proof is similar to that for Proposition 4. ■

As does entry deregulation, through a change in $\bar{n}^1 + \bar{n}^2$ because of trade, antitrust policy in one country can also affect the skill premium in both countries. However, the effects are opposite to those of entry deregulation.

Thus, it follows that if the government in each country decreases the fixed costs and the cartel size by the same percentage, then competition policies do not affect the skill premium in either country. This lack of change is because the number of firms does not change in either country and thus, neither does the total number of varieties.

4.2 Asymmetric Countries

Next, we consider the case of asymmetric countries. We assume that the two countries have identical technologies and preferences but differ in their endowments of high-skilled labor and low-skilled labor, $\bar{H}^i$ and $\bar{L}^i$, $i = 1, 2$. Then $w_L^1 = w_L^2$ does not necessarily hold. Therefore, we only set $w_L^1 = 1$ as the numeraire.

Then, the skill premium corresponding to the regulated fixed costs and the regulated cartel size in each country i, $i = 1, 2$, is:

$$w_H^1\left(\bar{f}^1, \bar{f}^2, \bar{m}^1, \bar{m}^2\right) = \left(\left(\bar{n}^1 + \bar{n}^2 (w_L^2)^{\rho/(\rho-1)}\right)^{(\rho-1)/\rho} \frac{b}{\rho}\right)^{\epsilon} \left(\frac{\bar{L}^1}{\bar{H}^1}\right)^{1-\epsilon}, \tag{5}$$

$$\frac{w_H^2}{w_L^2}\left(\bar{f}^1, \bar{f}^2, \bar{m}^1, \bar{m}^2\right) = \left(\frac{\left(\bar{n}^1 + \bar{n}^2 (w_L^2)^{\rho/(\rho-1)}\right)^{(\rho-1)/\rho} \frac{b}{\rho}}{w_L^2}\right)^{\epsilon} \left(\frac{\bar{L}^2}{\bar{H}^2}\right)^{1-\epsilon}, \tag{6}$$

where $\bar{n}^1 = \bar{L}^1 \bar{m}^1 (1-\rho)/b\bar{f}^1$ and $\bar{n}^2 = \bar{L}^2 \bar{m}^2 (1-\rho)/b\bar{f}^2$. Note that we have set $w_L^1 = 1$ as the numeraire.

We now want to see the possible effects of competition policies in one country on the skill premium in the other country through trade. If the government in one country i decreases the fixed costs $\bar{f}^i$, the number of firms in that country $\bar{n}^i$ surely increases. In this asymmetric case, however, as can be seen there is now an extra term $(w_L^2)^{\rho/(\rho-1)}$ in equation (5), and there are now extra terms $(w_L^2)^{\rho/(\rho-1)}$ and w_L^2 in equation (6). Due to these extra terms, it is not clear whether the term $\left(\bar{n}^1 + \bar{n}^2(w_L^2)^{\rho/(\rho-1)}\right)^{(\rho-1)/\rho}(b/\rho)$ decreases in equation (5) or whether the term $\left(\bar{n}^1 + \bar{n}^2(w_L^2)^{\rho/(\rho-1)}\right)^{(\rho-1)/\rho}(b/\rho)/w_L^2$ decreases in equation (6). Thus the effects of entry deregulation in one country on the skill premium in each country are not clear. For the same reason, the effects of antitrust policy in one country are not clear, either.

Here, we resort to a concrete numerical example to illustrate that there is a case in which entry deregulation and antitrust policy in one country, respectively, increases and decreases the skill premia in both countries and to also show the quantitatively different effects of a domestic policy on the domestic and foreign skill premia.

Example Consider the numerical example of asymmetric countries in which

$$b = 1, \bar{f}^1 = \bar{f}^2 = 4, \bar{m}^1 = \bar{m}^2 = 2, \rho = \frac{1}{2}, \epsilon = -1, \bar{H}^1 = 200, \bar{L}^1 = 100, \bar{H}^2 = 75, \bar{L}^2 = 50.$$

Then, from (5) and (6), we obtain:

$$w_H^1 = 4.6875, \frac{w_H^2}{w_L^2} = 8.33.$$

We consider the following three cases.

1. If the government in country 1 decreases the fixed costs $\bar{f}^1$ from 4 to 1, then w_H^1 increases from 4.6875 to 15.625 and w_H^2/w_L^2 also increases from 8.33 to 13.89. This shows that the decrease in the fixed costs in country 1 raises the skill premium in country 1 by a greater percentage than that in country 2.

2. If the government in country 1 decreases the cartel size $\bar{m}^1$ from 2 to 1, then w_H^1 decreases from 4.6875 to 2.67 and w_H^2/w_L^2 also decreases from 8.33 to 6.69. This shows that the decrease in the cartel size in country 1 decreases the skill premium in country 1 by a greater percentage than that in country 2.

3. If the government in each country i simultaneously decreases the fixed costs $\bar{f}^i$ from 4 to 1, then w_H^1 increases from 4.6875 to 18.75 and w_H^2/w_L^2 also increases from 8.33 to 33.33. As we can see, the increase in the skill premium in each country is greater than that in the first case in which only country 1 conducts entry deregulation.

5 Empirical Relevance

In this section, we discuss the empirical relevance of our model, although a definitive answer must wait for serious empirical work.

Are the main predictions of our model empirically relevant? Table 1 shows available empirical evidence from the U.S. for entry costs, cartels, firm numbers/size, and the skill premium. The data for the entry cost index and the total cartel cases are from Nicoletti and Scarpetta (2003) and the Workload Statistics provided by the Antitrust Division at the U.S. Department of Justice (DOJ), respectively. Nicoletti and Scarpetta (2003) compiled an index on product market regulation, and we measure the total cartel cases by the total criminal cases (filed). The data for firm numbers/size and the skill premium are from the U.S. Annual Survey of Manufactures (ASM). We measure firm number and firm size by the number of establishments and the number of workers per establishment, respectively. The skill premium is measured by the relative wage of non-production to production workers. We note that the table provides the data on the entry cost index and the total cartel cases for 1978 and 1998, while it provides the ASM data for 1977 and 1997. This is because the Nicoletti and Scarpetta (2003) index's starting date is 1978 and its ending date is 1998, while the ASM uses census data for the number of establishments and this census is conducted at 5-year intervals including the years 1977 and 1997.

As shown in Table 1, from the late 1970s to the late 1990s entry costs decreased and cartel activities became more active. Over the same period, firm numbers increased, firm size decreased, and the skill premium increased. These observations are indeed compatible with the predictions that our model has derived under the assumption that varieties and skill are complementary ($\epsilon < 0$). Recall that Proposition 1 has predicted that a decrease in entry costs f is accompanied by an increase in firm numbers, a decrease in firm size, and an increase in the skill premium, under the assumption of variety-skill complementarity. Proposition 2 has implied that more active cartel activities (an increase in m) are also accompanied by an increase in firm numbers and the skill premium and a decrease in firm size. Thus the main predictions under the assumption of variety-skill complementarity does appear to be empirically relevant.

What about the assumption of variety-skill complementarity? Is this assumption also empirically relevant? Intuitively, it is plausible to assume that higher skilled workers are more complementary to varieties of tasks than lower skilled workers are. Indeed, this assumption can be compatible with the data on Stanford business school alumni. Using data on Stanford business school alumni, Lazear (2005, 2012) empirically confirmed that leaders are generalists who need not excel in any one skill but are competent in many. He defines leaders as individuals who have a position defined as a "C" level position (CEO, COO, CFO, etc.), a managing director, or similar, which would be a high-skill position.

6 Conclusion and Extensions

This paper has developed a simple, general equilibrium model to examine the possible effects of both entry and antitrust policies on the skill premium in wages through a change in firm numbers/size. The closed economy model has shown that entry deregulation that reduces the fixed costs of entry can increase the skill premium by increasing the number of firms and decreasing the firm size. However, an antitrust policy that reduces the size of cartels can decrease the skill premium by decreasing the number of firms and increasing the firm size. We have also extended the model to a two-country model. The extended model has shown that in the case of symmetric countries, entry deregulation that is conducted symmetrically in both countries can increase the skill premia symmetrically in both countries while antitrust policy that is conducted symmetrically in both countries can have the opposite effect. In the case of asymmetric countries, though the effects are not clear, our numerical examples have shown a possibility that entry deregulation and antitrust policy in one country, respectively, can increase and decrease the skill premia in both countries through trade; however, the domestic skill premium is changed by a greater percentage than the foreign one. Thus, in both symmetric and asymmetric cases, the interaction between domestic competition policies and trade can change wage inequality in a trading partner even if it is not the purpose of the policies. This implies that the international coordination of competition policies are essentially necessary among the trading countries.

Several next steps could be pursued for future research. First, our model has implied the essential necessity of international coordination of competition policies. We can thus extend our model to explicitly analyze international policy coordination. Second, our paper has focused on the interaction between competition policies and free trade. It would be interesting to introduce tariffs/trade costs into our model and analyze the interaction between the competiton and trade policies. Third, in our model the fixed costs are in terms of low-skill intensive output. Thus an extension of our model is to introduce the high-skill intensive fixed costs, as well.

Fourth, this paper has provided a simple model with symmetric firms as a first step. It would also be interesting to extend our model to a heterogeneous firm model. The results regarding entry deregulation in a closed economy will remain unchanged. Upon application of the well-known argument by Melitz (2003), firms whose productivities are above the cutoff productivity stay and produce in the intermediate goods market. If the fixed costs of entry are decreased due to entry deregulation, then the number of producing firms will increase, which increases the number of varieties available to the final goods. It raises the skill premium if varieties and high-skilled workers are complements, and it decreases the average size of firms measured by emloyment. However, the results regarding entry deregulation in an open economy might not be clear even in the case of symmetric countries. Suppose that fixed costs are decreased due to entry deregulation in each country. Then the total number of producing firms in each country will increase, but the number of exporters in each country

might decrease. Hence, the total number of the domestic and imported varieties available to the final goods in each country might not increase. As for antitrust policy, it would not be safe to assume that cartels are formed symmetrically among firms in a heterogeneous firm setting. Modeling how cartels are formed among heterogeneous firms will be a challenge.

Finally, we have discussed the empirical relevance of our model in Section 5, but a definitive answer must wait for serious empirical work.

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	1978	*1998*
Entry cost index (Nicoletti and Scarpetta, 2003)	4.0	1.4
Total cartel cases (DOJ)	31	62
	1977	*1997*
Firm numbers (ASM)	359,928	373,548
Firm size (ASM)	54.4	48.4
Skill premium (ASM)	1.58	1.88

Table 1: Indirect evidence from the U.S.