Fixed cost, number of firms, and skill premium: an alternative source for rising wage inequality

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Abstract

The number of firms and the wage inequality increased in U.S. manufacturing industries after the Carter/Reagan deregulation was implemented. By extending a variety model, this paper provides a possible theoretical explanation for this observation on the basis of fixed cost.

Keywords: Entry deregulation; Fixed cost; Number of firms; Skill premium; Variety-skill complementarity; Firm size

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1 Introduction

One interesting fact in regards to the U.S. economy is that both the number of firms and the skill premium showed a rising trend in U.S. manufacturing industries after the late 1970s and early 1980s. Note that firm size was decreasing while the number of firms was increasing and that the real wage of low-skilled workers did not show a declining trend despite the increase in wage inequality.[1]

A second interesting fact is that the timing of entry deregulation lowering the fixed cost of entry is similar to the timing of the increase in the number of firms and the skill premium. For example, the so-called "Carter/Reagan deregulation" was implemented in the late 1970s and early 1980s. Data indicate that this entry deregulation has been prevailing in U.S. product markets since the late 1970s: the index of entry costs in U.S. product markets remarkably decreased from 5.2 to 0.6 during the period 1978-1997 (Ebell and Haefke, 2009).[2]

Due to these similarities, we should no longer ignore the possible relationship between the fixed cost of entry, the number of firms, and the skill premium. This, however, poses a theoretical challenge to us because no past research has related the number of firms to the skill premium. Most of the past research has related technological change (Berman et al., 1994; Katz and Autor, 1999; Krusell et al., 2000) or international trade (Feenstra and Hanson, 1996; Dinopoulos and Segerstrom, 1999; Acemoglu, 2003; Zhu and Trefler, 2005) to the skill premium. This paper now links the number of firms to the skill premium.

We formulate a simple general equilibrium model to provide a possible theoretical explanation for the observed relationship between the number of firms and the skill premium on the basis of fixed cost. By extending a well-known variety model due to Dixit and Stiglitz (1977), we show that lowering the fixed cost in the intermediate sector increases the variety of inputs used by the final good. The skill premium then

[1] The number of firms which is defined by the number of establishments in U.S. manufacturing industries increased from 358,061 to 373,548 over 1982-1997. The relative wage of high-skilled to low-skilled workers which is defined by the relative wage of non-production to production workers in U.S. manufacturing industries also increased from 1.58 to 1.88 over the same period. The size of a firm which is defined by workers per establishment decreased from 53.37 to 48.40; the real wage of production workers in U.S. manufacturing industries which is deflated by the CPI slightly increased from 100 (1982=100) to 102.07 over the same period. The source of data is the U.S. Annual Survey of Manufactures (ASM). Note that the ASM uses census data for the number of establishments, and this census is conducted at 5-year intervals.

[2] Ebell and Haefke (2009) calculate the index of entry costs by adding the entry delay (as a fraction of a year) and the fees (as a fraction of annual per capita GDP) and then converting to months by multiplying by 12 to obtain a composite entry cost measure. Many papers provide evidence on the costs of entry. For example, see Djankov et al. (2002).

rises if we assume variety-skill complementarity. We also show that the size of a firm decreases and the real wage of low skill does not necessarily decline, which are compatible with the U.S. observations.

A value-added of this paper is our attempt to link firm numbers to skill premium. It should be noted, however, that this paper is similar to Mitchell (2005) and Mobius and Schoenle (2006) in that a rise in skill premium can be accompanied by a fall in firm/plant size. In those studies, technological change, such as the introduction of new flexible machines, changes the organization of production from mass production to smaller customized batches, making the size of plants/firms smaller. In our model, on the other hand, entry deregulation lowers the fixed cost of entry, causing a decrease in firm size as well as an increase in firm numbers. Hence, it is policy changes that can lead to the fall in firm size in our model, while it is technological change in Mitchell (2005) and Mobius and Schoenle (2006). Thus another value-added of this paper is to stress policy changes as an alternative source of changes in firm/plant size.[3]

The rest of this paper is organized as follows. In Section 2, we formulate a two-sector variety model with fixed cost and show that our model can qualitatively explain the observed facts if we assume variety-skill complementarity. We finally conclude and mention future research in Section 3.

2 Model

2.1 The Ingredients of the Model

In this paper, we extend the standard one-sector variety model (Dixit and Stiglitz, 1977) to a two-sector model. Consider an economy with a final good sector and an intermediate goods sector. There are two types of skills: high-skilled and low-skilled labor. Their endowments are given by $\bar{H}$ and $\bar{L}$, respectively. These skills differ in that the high-skilled labor can handle a variety of tasks but the low-skilled labor cannot.

The production side is as follows. The final good sector is perfectly competitive. It uses a continuum $[0, n]$ of intermediate goods and the high skill, and the technology

[3]Boeri et al. (2000) and Pissarides (2001) show evidence on regulation and employment size.

is given 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 good and $x(j)$ and H are the inputs of differentiated intermediate good j and high skill. We assume that $\epsilon < 1$ and $0 < \rho < 1$. The elasticity of substitution between the varieties and high skill is given by $\sigma = 1/(1-\epsilon)$.

On the other hand, the differentiated intermediate goods sector is monopolistically competitive. Firms are symmetric and follow Cournot pricing rules. There is also free entry and exit. Each variety uses the low skill, and the technology of each variety is given by the following increasing returns to scale production function:

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

where $l(j)$ is the input of low skill to produce each variety j, f is the fixed cost in terms of low skill, and b is the unit low-skill requirement.

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

$$u(c) = c,$$

where c is the consumption of the final good. 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 good, w_H is the wage for the high skill, and w_L is the wage for the low skill.

The feasibility 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 fixed cost for firms in the intermediate goods sector. We note that a decrease in the fixed cost may be caused

by technological progress as well as a policy such as entry deregulation.

2.2 Free Entry and the Skill Premium

First, we derive the free-entry number of firms $\bar{n}$ in the intermediate sector with the regulated fixed cost at $\bar{f}$.[4]

Given an arbitrary n, each producer of varieties facing the indirect demand by the final good sector maximizes the profit $p(j)x(j) - w_L bx(j) - w_L\bar{f}$ where $p(j)$ is the price of intermediate good j. By setting $w_L = 1$ as numeraire and using the symmetry $x(j) = x$, the output $x(n)$, price $p(n)$, and profit $\pi(n)$ of each variety corresponding to this n can be given by:

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

$$p(n) = p = \frac{b}{\rho}, \forall j;$$

$$\pi(n) = (b/\rho)x(n) - bx(n) - \bar{f}, \forall j.$$

Since the price does not depend on the number of varieties n, the price when the profit of each variety becomes zero by the free entry and exit is also given by $p = b/\rho$, and the zero profit condition $px(\bar{n}) - bx(\bar{n}) - \bar{f} = 0$ with $p = b/\rho$ gives the output of each variety, $x(\bar{n}) = \left(\bar{f}\rho\right)/\left[b(1-\rho)\right]$. The equality of labor demand and supply in the intermediate sector, $\bar{n}\left[bx(\bar{n}) + \bar{f}\right] = \bar{L}$, gives the free-entry number of firms $\bar{n}$:

$$\bar{n} = \frac{\bar{L}(1-\rho)}{\bar{f}}.$$

As we can see, lowering the fixed cost $\bar{f}$ is accompanied by an increase in the equilibrium free-entry number of firms $\bar{n}$.

Second, we derive the solutions in the final sector.

Let us solve the maximization problem for the final good sector by means of the

[4] In regards to the free-entry number of firms, Mankiw and Whinston (1986) is one of the most notable theoretical studies. They show that there is a tendency toward excess entry from a social standpoint in homogeneous product markets and that product differentiation can reverse this tendency.

following short-cut method. Define a new good

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

and its price p_X. The profit of the final good sector now 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, we find that the price of X is:

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

By symmetry $p(j) = p$, this 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 then give:

$$w_H = p_X^\epsilon \left(\frac{\bar{L}}{\bar{H}} \right)^{1-\epsilon},$$

where $p_X = n^{(\rho-1)/\rho} p$. Since we have normalized $w_L = 1$, the relative wage of high-skilled to low-skilled labor—skill premium—is simply given by w_H.

Finally, by combining the solutions in the intermediate sector and in the final sector, we get the skill premium $w_H\left(\bar{f}\right)$ corresponding to the regulated fixed cost $\bar{f}$:

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

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

2.3 The Control of Fixed Cost, the Number of Firms, and the Skill Premium

We now see the possible relationship between the number of firms and the skill premium on the basis of fixed cost. From (1) in Section 2-2, we get the following lemma.

Lemma 1 *If the government decreases the fixed cost $\bar{f}$, then the skill premium w_H decreases if $\epsilon > 0$, remains unchanged if $\epsilon = 0$, and increases if $\epsilon < 0$.*

Proof. Differentiating (1) in Section 2-2 with respect to $\bar{f}$ gives:

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

■

From the above lemma, we get the following proposition.

Proposition 1 *Suppose that the government decreases the fixed cost. Then the number of firms increases. The skill premium, the real wages of high- and low-skilled workers, and the size of a firm also change as shown in Table 1.*

Table 1 Effects of entry deregulation.

ϵ	Skill Premium w_H	Real Wage of H	Real Wage of L	Firm Size
$\epsilon > 0$	$\downarrow$	$\uparrow$	$\uparrow\uparrow$	$\downarrow$
$\epsilon = 0$	Unchanged	$\uparrow$	$\uparrow$	$\downarrow$
$\epsilon < 0$	$\uparrow$	$\uparrow\uparrow$	$\uparrow$	$\downarrow$
$\epsilon << 0$	$\uparrow$	$\uparrow$	$\downarrow$	$\downarrow$

Notes: "$\uparrow$" and "$\downarrow$" refer to an increase and a decrease, respectively. "$\uparrow\uparrow$" refers to a greater increase than "$\uparrow$" in each row.

Sketch of Proof.

1. The signs of a change in w_H were proven in Lemma.
2. Since $\rho < 1$, the effect of $\bar{n} \uparrow$ is greater than the effect of $x \downarrow$. Thus the marginal product of high-skilled labor (MPH), that is, w_H/p_y increases.
3. The rate of $y \uparrow$ is greater than (equal to/smaller than) the rate of $MPH \uparrow$ if $\epsilon > 0$ ($\epsilon = 0/\epsilon < 0$). This relationship and $y = (w_H/p_y)\bar{H} + (w_L/p_y)\bar{L}$ imply that the rate of change in w_L/p_y is greater than (equal to/smaller than) the rate of $w_H/p_y \uparrow$ if $\epsilon > 0$ ($\epsilon = 0/\epsilon < 0$).
4. The size of a firm in the intermediate sector, $\bar{L}/\bar{n}$, decreases due to $\bar{n} \uparrow$. ■

In this proposition, we have shown that lowering the fixed cost $\bar{f}$ for firms in the intermediate sector increases the variety of inputs $\bar{n}$ used by the final good. Then the skill premium w_H rises if $\epsilon < 0$, that is, if the varieties and high skill are complements.[5] We have also shown that the size of a firm decreases and the real wage of low skill does not necessarily decline, which are compatible with U.S. observations. We note that the decrease in the fixed cost is here caused by the control of the government, though it can also be caused by technological progress.

3 Conclusion and Extensions

We have shown some interesting facts in regards to the number of firms, the skill premium, and the fixed cost in the U.S. after the late 1970s and early 1980s, when the Carter/Reagan deregulation was implemented. Section 2 has shown that our simple model can qualitatively explain these U.S. observations if we assume the variety-skill complementarity. This indicates that the number of firms can be a possible source of the increased skill premium in the U.S. after the late 1970s and early 1980s.

Of course, several next steps could be taken for future research since this paper is only the first step to add an alternative theoretical explanation for the rising inequality to the literature. First, our simple model cannot capture the cross-sectional fact that larger employers pay higher wages at a point in time (Brown and Medoff, 1989). Thus a next logical step is to extend our model to a model with heterogeneous firms in order to capture this size-wage relationship in the cross-section.[6]

Second, we can extend this closed economy model to a two-country model. We can thus analyze the possible effects of domestic entry policy on the skill premium in a foreign country through variety trade.

[5]Here, we define the case $\epsilon < 0$ ($\sigma < 1$) as the case in which the varieties and the high skill are complements as does Kurokawa (forthcoming). In some papers, the number of inputs plays a related role. Blanchard and Kremer (1997) define the index of complexity which relates the increased number of inputs to more complexity in production processes. Kremer (1993) theoretically shows that higher skill workers will use more complex technologies that incorporate more tasks.

[6]Holmes and Mitchell (2008) connect the size-skill relationship in the cross-section (where larger plants employ a larger/smaller fraction of skilled workers) to changes over time in the skill premium. They demonstrate that if the size-skill relationship is positive, an expansion of markets due to increased trade can increase the skill premium without technological change.

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