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The Flocking Strategy and Vertical Disintegration

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Abstract: In the industry center of lighters in Wenzhou, China, lighters are produced by a large number of small, vertically specialized, and agglomerated firms. Some firms specialize in assembling lighters, while the others specialize in producing parts. A perfect-competition model is developed to analyze this phenomenon, and four related factors are revealed to be involved. First, compared with standard factories, household workshops have the cost advantage in producing the parts of lighters. Next, lighters are produced by firms owned mostly by those transferring from peasants and other occupations. Due to the difficulty in financing, each of them focus on a specific component part of the product. Last, a large extent of market and agglomeration lead to low transaction costs. This makes it beneficial for the specialized firms to coordinate the production through the market. In the presence of the agglomeration effect in lowering the transaction costs, a perfectly competitive industry may have multiple equilibria. The ability of the industry of lighters in Wenzhou to expand to the high-level equilibrium by capturing the world market helps to explain the huge decreases in prices.

JEL classification: D23; D41; L22; L25.
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1. Introduction

The objective of this paper is to analyze vertical disintegration in the industry centers of lighters in Wenzhou, China, where lighters are produced by a large number of small, vertically specialized, and agglomerated firms. Some firms specialize in assembling lighters, while the others specialize in producing different parts.

From the literature we sum up several determinants of vertical integration[3]. As shown below, different industries may be mainly affected by different factors.

The first three factors are the diversity of a product, the level of risk in a market, and agglomeration. In 1860, for example, Birmingham was the industry center of small-arms manufacturing. The gun-maker usually focused on assembling and finishing of the gun, and purchased the semi-finished parts and materials from various specialized makers (Allen, 1929 p116-7). "As far as the high-class sporting guns were concerned", Allen explained (p119), "the real reason (of high degree of division of labor) seems to be that each product was individual, in the sense that it was made to suit the special requirements of the purchaser. But in the military arms trade the cause lay in its liability to extreme fluctuations in demand". In addition, as the system of organization involved the frequent transportation of material from one workshop to another, conglomeration is an effective method of reducing the transportation costs in trade (Stigler 1951).

Besides the small-arms industry, the factors mentioned above also lead to vertical disintegration in many other industries, such as the clothing industry (Fraser 1983, Scott 1984, and Hiebert 1990), film industry (Storper and Christopherson 1987, Storper 1989, and Scott 2001), television industry (Mossig 2004), and culture-product industry (Scott 1983 and 1986).

The fourth factor is the extent of the market. Stigler (1951) has extended Adam Smith's famous theorem that "the division of labor is limited by the extent of the market" to the issue of vertical integration. From the perspective of industry life cycle, he suggests that vertical disintegration is the typical development in growing industries, but vertical integration is typical in declining industries. In terms of this idea, the dynamics of vertical disintegration in the cotton-textile industry (Stigler 1951) and in English ship-owning (Ville 1993) are explained. Besides the case studies, Tucker and Wilder (1977), Levy (1984), and Wright and Thompson (1986) test the conclusion with the data in a wide range of industries.

The fifth factor relates to asset specificity. The idea comes from the vertical merger of General Motors and Fisher Body in the automobile industry in the U.S.A. In the absence of vertical integration, the firm investing in effective but specialized assets may be at the mercy of its sellers/customers, and vertical integration (internal organization) is a method of reducing the transaction costs caused by the usage of specialized assets (Klein, Crawford and Alchian 1978, Klein 1988, and Langlois and Robertson 1989).

The sixth factor is the antitrust regulation. Since the first antitrust law was enacted in America in 1890, many giant firms have been vertically separated (Hale 1949 and Baker 2003). In the late 1940s, for example, a handful of major studios controlled the lion's share of the film market through their tight grip on cinema exhibition outlets. The anti-

[3] The vertical integration literature contains many papers on case study and empirical analysis, in which many factors are involved. Here we just summarize several important determinants and cite a few relevant papers.

trust action of the US Supreme Court (the *Paramount Decision*) forced the major studios to divest their cinema chains (Storper 1989).

The seventh factor relates to labor unions. Labor unions result in a wage gap between the unionized and non-unionized labor, which encourages entrepreneurs to reduce costs by external contracting to suppliers not subject to the influence of unions (Piore and Sabel 1984 p156, Collins 1990)).

In the lighter industry in Wenzhou, however, the main factors which induce vertical disintegration are quite different from those factors mentioned above. First, in the process of industrialization, a large number of surplus workers, mostly from the countryside, need to take up occupations in non-agricultural industries. With limited job vacancies, self-employment in an industry with low costs of entry becomes a possible way to earn a living. However, in China, it is difficult for private enterprises to get finance from banks and other financial institutions. With limited financing they can just focus on producing a narrow range of product, and the whole product is produced by a group of specialized firms coordinating through the market. Second, the parts of lighters are simple, and suitable to be produced by small household workshops. Moreover, with lower opportunity costs, the household workshops, compared with the standard enterprises, enjoy a significant cost advantage in producing the parts. This encourages the lighter enterprises to outsource the production of the parts to these household workshops. Last, agglomeration and the extent of the market, which are mentioned above, have an effect on the vertical disintegration in the lighter industry. As an industry center accounting for the major portion of global and household lighter market, a large number of firms agglomerate in this area. It leads to low transaction costs, with which firms prefer to specialize in a narrow range (usually one component part) of lighter production and coordinate the production through the market.

Besides case studies and empirical tests, there are many formal analyses on vertical integration, most of which are in the vein of transaction cost theory (Coase 1937, Williamson 1971). On the one hand, vertical integration is a method of avoiding the distortion in market transaction, resulting from many reasons, for example, the delay in information transfer between firms (Arrow 1975), the inability to write comprehensive contracts (Grossman and Hart 1986 and Hart and Moore 1990), the risk in input supply (Kranton and Minehart 2000), and demand uncertainty and price inflexibility (Carlton 1979). On the other hand, vertical disintegration is a way to avoid the diseconomies of internal organization. For example, the motive for vertical network is due to the idiosyncratic shock in demand (Bolton and Whinston 1993), and due to the improvement in transaction efficiency (Liu and Yang 2000).

In addition, some analyses in vertical integration are based on competitive effects. For example, through comparing four industry structures, Watterman (1982) shows the impact of vertical integration and/or monopoly in movie exhibition on the film industry. Moreover, Salinger (1988 and 1989), Ordover *et al*. (1990 and 1992), and Higgins (1999) analyze the impact of vertical integration on the foreclosure of rivals.

In this paper, a model is developed to analyze vertical disintegration in the lighter industry in Wenzhou. First of all, it is based on the transaction cost framework. A difference is that most transaction-cost models are game models, while ours, like Liu and Yang's (2000), is a perfect-competition model. Moreover, some factors, such as the extent of market, the cost advantage of outsourcing, and financial constraint, are

embedded into the model from which the effects of these factors on vertical disintegration will be analyzed using comparative statics. It is shown below that, in the presence of the agglomeration effect in lowering the transaction costs, a perfectly competitive industry may have multiple equilibria. The ability of the industry of lighters in Wenzou to expand to the high-level equilibrium by capturing the world market helps to explain the huge decreases in prices.

This paper is organized as follows. Section 2 gives a brief account of a specific case about the industry of lighters in Wenzhou. Section 3 develops a perfect-competition model to analyze vertical disintegration in the industry, and applications and discussions are undertaken in Section 4. This paper concludes in Section 5.

2. The industry of lighters in Wenzhou, China

2.1 The case

There are more than 700 lighter manufacturers in Wenzhou[4], a city in the southeast of China, which produce 850 million lighters with an output value of 2 billion yuans per year. (One US dollar exchanges for about 7.5 yuans.) With advantages in quality, price and variety, their production accounts for 70% of the global market and 95% of the household market of metal-shell lighters. Every day, an average of three new designs are published and there are now more than ten thousand designs. The industry of lighters in Wenzhou has become the industry center, the selling center and the information center of metal-shell lighters of the world.

The industry of lighters appeared in Wenzhou in the late 1980s. At the end of 1980s there were about five to six hundred workshops concentrated in a street in Wenzhou, which was called as "the street of the fittings of lighters". Zhongfang Li, a business man often tripping between Hong Kong and Wenzhou, found that the lighters produced in Wenzhou were so cheap and brought several thousand of lighters to Hong Kong. As a result, they became popular in Hong Kong. And from this free market, the lighters produced in Wenzhou have been rapidly sold to the world over.

During the first two years in 1990s, because of the huge extent of market for the industry of lighters in Wenzhou, the production scale of the industry increased rapidly. In the winter of 1992 there were about 3000 workshops in the industry. Most of them were household workshops in which the lighters were crudely produced largely by hand. They seized the occasion to reap profit, but it could not last long. After one year of market readjustment, most of the firms which produced inferior lighters shut down. In contrast, scores of firms which kept the quality in production entered into a stage in which the quality and the quantity of the products increased steadily.

There are about twenty eight fittings in a modern lighter. If a manufacturer produces all of these fittings, the cost of each lighter will be high. Through specialization and the market coordination mechanism, the industry of lighters in Wenzhou has successfully reduced the cost of each lighter to a level as low as 1/5 to 1/10 of the costs of foreign manufacturers, thereby advancing their competitive power in the global market.

From design and production to selling, each process is performed by very specialized organizations. In the manufacturing process, almost every single fitting of a lighter is

[4] The data of this case study come from Zhu (2002), He (2002), Chen and Zhang (2004, p. 129), and Zhu (2004).

produced by a specialized enterprise which is capable of meeting the requirements (with respect to quality, quantity, and/or delivery time) of the middlemen or the enterprises producing the final good.

For example, Tiger Lighter, one of the lighter enterprises in Wenzhou, was founded in 1991. After ten years of development, it had 1000 employees. Besides, it has developed into 45 firms with about 15,000 employees supplying fittings; they have independent property rights but coordinate well with each other. In this production chain, Tiger Lighter focuses on designing, casting patterns and assembling, while buying fittings from the market. It is the chosen process and the specialization and mass production contribute greatly to ensure high-quality products at low costs.

The following examples show the different prices with different production patterns. First, if the firms produce the screw by themselves, it costs 1 cent (One yuan equals 100 cents) per screw, but it just costs 0.45 cent from the market. Second, each lighter needs five to eight airproof rings of high quality. They cost 20 cents each if imported, as done in the past. Then they were produced by themselves at a cost of 5 cent each. Now the price is 0.5 cent in the market. Third, the price of the electric portfire was about four to five yuans ten years ago when imported. When produced in Wenzhou, the price first fell to one to two yuans; now with the increase in production scale, the price is 20 cents. In the past, the price of a kind of tiny-hole-slice for lighter was five to six yuans; after mass production, some manufacturers produce a set of fittings which includes the tiny-hole-slice at only 20 cents (Zhu 2002).

Besides the market function, some management institutions have been introduced into the industry. For example, the guild of Wenzhou smoking-set industry is a self-management organization which covers 95% of enterprises in this industry, and affects significantly the development of the industry of lighters in Wenzhou. First, intellectual property rights are protected. Intellectual property rights are granted by the guild; after investigation, testing and approval, a certificate is awarded and published in the local newspapers. Since many middlemen pay attention to whether the product has intellectual property rights, 887 products have applied for intellectual property rights in the whole decade of 1990s. Second, the protection facilitates product innovation. The protection of intellectual property rights encourages enterprises to invest in the development of new products and the improvement in the quality of the products. In recent years, there have been some 500 new products every year. Third, the property rights rationalize the product prices. The protection of intellectual property rights solves the problem that some enterprises offer a lower price by imitation or jerry-build and therefore ensures fair competition.

2.2 An analysis

The questions arising from this interesting case are: Why does the industry of lighters in Wenzhou consist of a large number of small firms with a high degree of vertical specialization? And how does it reduce the costs by such huge margins? From the case mentioned above, several factors are involved.

First, most of the lighter parts are suitable to be produced by household workshops. The advantages of the production of parts in household workshops make the lighter factories outsource their parts. One of the advantages of modern production is the economies of scale, via division of labor and/or the usage of advanced machines. But for

a part of the lighter, it is usually produced with a simple machine. Thus in terms of the scale of production, it is suitable to be produced by a household workshop. Next, due to the simplicity in technology, household workshops are able to produce parts with high quality. Last, in comparison to modern production in a factory, production in household workshops save costs. For example, they can produce in their house or backyard; they can produce at any time, not just from 9 am to 5 pm; the producer may be anyone in the family who is free at the time; besides, they can also save management costs in coordinating the family members and/or close relatives in a household workshop.

The second factor is the flocking strategy. In modern production, manufacturers obtain their necessary investment funds from banks and other financial institutions. In China, however, private firms, especially the enterprises in rural and small town regions, have difficulties obtaining finance from banks and other financial institutions. They can only obtain limited funds from saving and/or the assistance of family members. However, these limited financing is not enough to support the production of the whole product. Under this circumstance they adopt the flocking strategy: each firm just focuses on producing a narrow range (typically a component part) of the product, and the whole product is produced by a group of specialized firms coordinating through the market.

The third factor is the agglomeration effect. The In the case of Wenzhou, there is the spatial conglomeration of enterprises of production and the emergence of specialized sale markets (such as “the street of the fittings of lighters” mentioned above). But what is the impact of agglomeration? According to Coase (1937), the boundary of a firm is affected by the trade-off between the costs operating in the market (transaction costs) and the costs operating within the firm (management costs). The lower the level of transaction costs (with the management costs unchanged), the more a firm wants to rely on the market and the more it wants to specialize in a narrow range of production. Agglomeration reduces the transaction costs, from whichmaking the flocking strategy is easier to be carryied out.

Last, in addition to the agglomeration effect, a large extent of the market also helps to reduce the transaction costs. If the extent of the market can only contain a few firms, the bargaining costs between these firms will not be significantly reduced from agglomeration. In the industry center of lighters in Wenzhou, in contrast, because of the high demands of global and household and global markets, a large number of firms agglomerate in this area, from whichreducing the bargaining costs between the firms are reduced remarkably (Williamson 1975, 1979), and the lighter enterprises tend to outsource more parts.

Our case shows similarities in many aspects to the small-arms industry Birmingham, for example, a large number of small, specialized firms agglomerate in an area. However, the diversity of products and market risks are two main factors of vertical disintegration in the small-arms industry. Are they still the main factors in the lighter industry in Wenzhou? Usually it is difficult to deny the effects of these two factors on any industry, but from the case study it is safe to say that these two factors are not the main reasons of the vertical disintegration in our case. As mentioned above, for example, Tiger Lighter is one of the leading lighter enterprises in Wenzhou, which has developed into 45 firms w ith about 15,000 workers supplying parts. It seems that outsourcing is not due to the market risk or the diversity of the lighters, but the benefits from specialization.

In the next section, a perfect-competition model is developed to analyze the impact of these factors on the industry of lighters in Wenzhou.

3. The model

3.1 The basic assumptions

Suppose thatDenote the market demand function for the final good *Y* ias

$$q_y = D(M, p_y) \tag{3.1}$$

where q_y is the quantity demanded of the market, p_y is the price, and M is an index of the extent of the market. As a demand function, we assume that q_y is increasinges in M and decreasinges in p_y.

We assume that Y hasthe production function of Y is given by:

$$q_y = \min\{q_x, f(l_y, k_y)\} \tag{3.2}$$

where q_x is the amount of intermediate input X; it this implies that a unit of the final good *Y*s needs a unit of intermediate input X; and l_y and k_y are labor and capital inputs, respectively. Similarly, we assume that X has the production function for X is:

$$q_x = g(l_x, k_x) \tag{3.3}$$

where l_x and k_{xy} are labor and capital inputs, respectively. As a necessary condition in our long-run perfect-competition model, we assume that production functions f and g have U-shape average cost curves.

We assume that the wage rate (w) and interest rate (i) are exogenous, and are not affected by the extent of marketsize of the industry under study. This is the normal small industry assumption and is especially justified in our case. by the fact that, inIn China and some other populous countries, the supply of labor is very large relative to any one industry. Thus, the increase in the extent of marketsize of an industry will not raise the wage rate appreciably. On the other hand, since the lighter industry is a labor intensive industry, interest rate will not be significantly affected by the extent of marketsize of the industry.

According to Coase, the boundary of the firm is determined by the trade-off between the management costs within the firm and transaction cost in the market. To analyse vertical disintegration, we assume that there are transaction costs in the market of intermediate goods, but for simplicity we ignore transaction costs in the markets of final goods and labor (as these latter costs are present whether we have integration or disintegration). We assume that the cost of transacting a unit of intermediate good is:

$$p_t = p(d, n_x, n_y) \tag{3.4}$$

Where p_t [consider changing the notation into c_t.] is the unit cost, d is the radius of the market, and n_x (n_y) are is the number of firms in iIndustry X (Y).

On the effects of agglomeration and the extent of market on transaction costs, we assume that p_t increases with d. Here d is an inverse index of the extent of agglomeration in a market. It implies that the higher the extent of agglomeration in a market, the lower the transaction cost. Second, we assume that p_t decreases as n_x and/or n_y increases. Why? In the market of intermediate goods, as the number of sellers (n_x) increases, the buyers will spend less time in looking for suitable sellers and this also makes it easier to reaching an agreement easier (as alternative sources are nearby), and hence less transaction cost is needed in trade. The situation is similar for an increase in the number of buyers (n_y).

Besides the assumptions on transaction costs, we also need to specify how the management cost changes when the production of the intermediate input market is internalized (i.e. produced by the firm itself). We assume that the average cost curve $AC(q_y)$ of the integrated firm satisfies:

$$AC(q_y) = kAC_y(q_y) + kAC_x(q_x) \tag{3.5}$$

where $AC_y(q_y)$ is the average cost function of f and $AC_x(q_x)$ is the average cost function of g [see (3.2) and (3.3)] and coefficient $k>1$.

What does the coefficient k means? We assume that there are no economies or diseconomies of scope in the production of the intermediate and final goods. Under this condition, if $k=1$, the average cost of an integrated firm equals the sum of the average costs in two separate production stages, which means that management costs do not increase with vertical integration. Thus k ($k>1$) is a management cost coefficient, where the excess over unity represents the proportionate increase in management costs associated with the vertical integration of the two firms.

In terms of the lighter industry in Wenzhou, we add two assumptions relating to vertical disintegration. The first is the cost-advantage assumption. We assume that the household workshop, compared with the standard firm, has a cost-advantage in producing intermediate goods (component parts).

The second is the financial-constraint assumption. We assume that firms cannot borrow money from banks and other financial institutions; with limited financing, they are inefficient in producing the whole product in optimal production scale (the lowest point of average cost curve), but large enough to support the production in any section (typically a component part) of the product.

3.2 Equilibrium analysis

For explaining vertical integration in the lighter industry in Wenzhou, we consider a long-run equilibrium under perfect competition. This is because of two reasons. First, the fact that over 700 firms congregate in the industry of lighters in Wenzhou implies that a firm has no significant monopoly power in the market. Thus a perfect-competition model is suitable. Next, since the industry is in simple manufacturing, where the thresholds in technology and financing are not high, it is relatively easy for new firms to enter. Thus the long-run free entry/exit assumption is reasonable.

Now the question is: can the integrated and the disintegrated firms coexist in a long-run equilibrium? The answer is no. Why? First, assume that there is an equilibrium in which the two kinds of firms coexist in the market and sell the final good at different prices, say, the price of the disintegrated firms is less than that of the integrated firms. Since people want to buy the final good at a lower price, some integrated firms will exit the market, while some disintegrated firms will enter the market. It is not an equilibrium state. Next, let's assume that there is a long-run equilibrium in which the two kinds of firms coexist in the market and sell the final good at the same price. What will happen if an integrated firm disintegrates into two specialized firms, one produce X and the other produces Y? With more firms entering into the intermediate goods market, the amount of transaction costs needed in the market decline. Given the price of the final good, all disintegrated firms will earn positive profits, while all integrated firms still earn zero profit. As a consequence, more integrated firms will disintegrate, and the equilibrium is broken.

The analysis above shows that in long-run equilibrium there are only two potential structures, the integration structure where all firms choose integration and the disintegration structure where all firms choose disintegration. We first analyze the equilibrium in the two potential structures, and then analyze which structure is the equilibrium structure.

However, we do not just analyze an integration structure and a disintegration structure. In the next subsection, we will analyze the impact of the financial-constraint assumption and the cost-advantage assumption on disintegration. Our method is comparing the equilibrium with the control equilibrium where these factors are not considered. For this purpose two integration structures and two disintegration structures are studied bellow.

(1) Integration structure without a financial constraint

The firm in this structure is the integrated firm. From (3.3), producing a unit of the final good requires a unit of intermediate good (q_x=q_y). Thus from (3.5) the average cost curve $AC(q_y)$ of the integrated firm satisfies:

$$AC(q_y) = k[AC_y(q_y) + AC_x(q_y)] \tag{3.6}$$

In a long-run equilibrium, the price and the quantity take place at the lowest point of the average cost curve AC (see Figure 1). Thus the equilibrium price p_y^i and quantity q_y^i satisfy (3.7), where superscript i denotes vertical integration.

$$p_y^i = AC(q_y^i) = k[AC_y(q_y^i) + AC_x(q_y^i)] \tag{3.7}$$

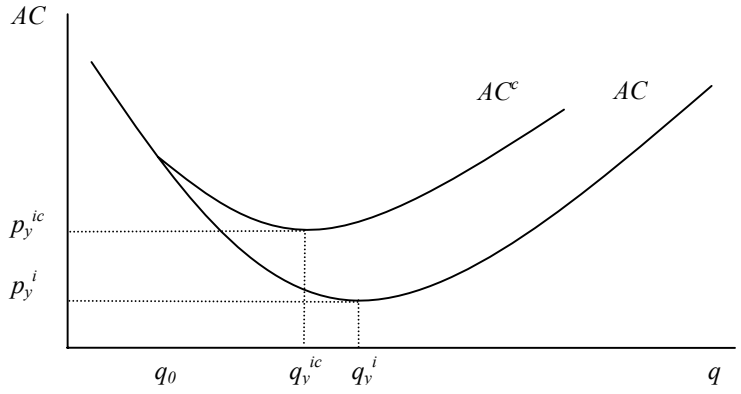

Figure 1: The average cost curves of an integrated firms

(2) Integration structure under the financial-constraint assumption

As shown in Figure 1, with the financing constraint, an integrated firm is inefficient less efficient (in comparison to the case of no constraint) to produce the quantity beyond q_0, revealing resulting in that the average cost curve depart diverging above from the unconstrained average cost curve in the interval $q>q_0$. ThisIt is because with the limited financing a firm cannot buy enough capital equipment to support the production that is efficient at a high output level. Instead she it uses more labor to compensate the capital. In this caThus,se the factors are not in optimal ratio proportion and hence more a higher average cost is neededincurred. Moreover, when the limited amount of finance is not large enough to support the optimal production scale ($q_0<q_y^i$), the constrained average

cost curve AC^c has a higher lowest-point than that of the unconstrained average cost AC. where the superscript c denotes the situation with the financial constraint.

In a long-run equilibrium, the equilibrium price p_y^{ic} and quantity q_y^{ic} take place at the lowest point of the average cost curve, where superscript ic denotes the integration structure with the financial constraint (see Figure 1). Thus,

$$p_y^{ic} = AC^c(q_y^{ic}) \tag{3.8}$$

(3) Disintegration structure without the cost-advantage assumption

There are two typess of firms in this structure, the firm producing the intermediate good and the firm producing the final good. Without the cost-advantage assumption, all the intermediate-good firms are standard firms.

For the intermediate-good firm, the equilibrium price (p_x) and quantity (q_x) take place at the lowest point of the average cost curve AC_x (see Figure 2).

$$p_x = AC_x(q_x) \tag{3.9}$$

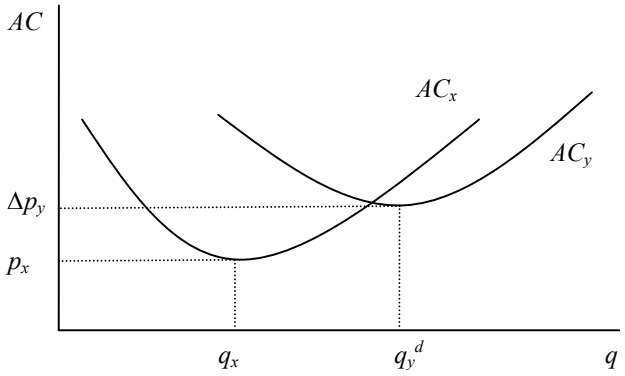

Figure 2: The average cost curves of disintegrated firms

For the final-good firm, since producing a unit of Y requires a unit of X, the net price from selling a unit of Y is $\Delta p_y = p_y - p_x - p(d, n_x, n_y)$, where the firm has to pay the input price as well as transaction price, $p_t(d, n_x, n_y)$, in the intermediate-good market. For similar reason, the equilibrium price p_y^d and quantity q_y^d in the final-good firm satisfy:

$$\Delta p_y = p_y^d - p_x - p_t(d, n_x, n_y) = AC_y(q_y^d) \tag{3.10}$$

where the net price (Δp_y) and quantity (q_y^d) take place at the lowest point of the average cost curve, and superscript d denotes disintegration structure (see Figure 2).

Although the price p_x, net price Δp_y, and the quantity each firm produces, q_x and q_y^d, are determined, the price p_y^d is not determined until we know the numbers of firms, n_x and n_y, in equilibrium. Since producing a unit of Y requires a unit of X, in equilibrium we have

$$n_x q_x = n_y q_y^d \tag{3.11}$$

In equilibrium, the market-clearing condition is satisfied. Thus, from (3.1), (3.10), and (3.11), we have

$$n_y q_y^d = D(M, p_x + p_t(d, \frac{n_y q_y^d}{q_x}, n_y) + AC_y(q_y^d)) \tag{3.12}$$

where the relevant quantities are at the respective points of lowest AC. From (3.12) we can solve n_y and then from (3.11) we get n_x.

There could be a unique solution or multiple solutions in Equation (3.12). Figure 3 shows the former case. Curve MD represents the function in the right hand side of Equation (3.12), the quantity of market demand increases with the number of final-good firms in the market, and the straight line MS represents the function in the left hand side the equation, the quantity of market supply increases in proportion with the number of the firms in the market. Why is the curve MS a straight line? This is so because q_y^d is independent of n_y. The value of q_y^d is determined by the minimum point of the AC_y curve. Though this minimum point may not be independent of n_y as a change of n_y may affect the full AC (which equals $AC_y+p_x+p_t$) by affecting p_t. However, this effect is independent of q_y, leaving the minimum point of the full AC at the same vertical line (i.e. same value of q_y) as the minimum point of AC_y. To see the point in a different way, note that when each firm (producing y) chooses the output level, it takes variables such as n_y and p_t as exogenous and maximizes only with respect to q_y. Thus, the value of q_y^d is determined by the minimum point of the AC_y curve which occurs at the same value of q_y as the minimum point of the full AC.

Why does the quantity of market demand also increase with of number of firms? This is due to the agglomeration effect. As more firms enter into the market, the unit cost of transaction and hence the price of the final good decline, thus the quantity of market demand increases. In Figure 3, the point of crossing represents indicates market clearingclearance.

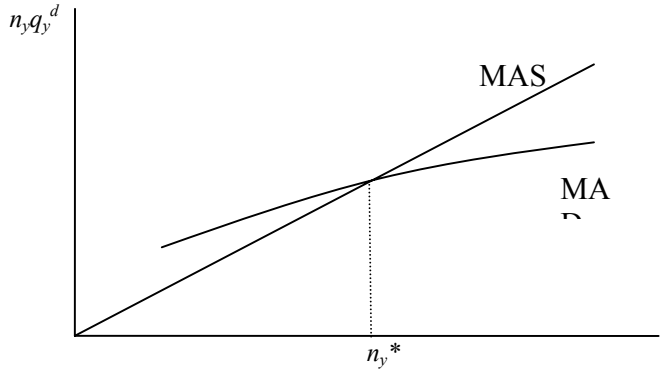

Figure 3: The unique equilibrium solution

In addition, there could be multiple solutions in for Equation (3.12). As showing shown in Figure 4, there are multi-solutions. Which is the solution of long-run equilibrium? There are two types of points of crossing. First, Point n_{y2} is not a stable equilibrium solution. From this point, suppose firms enter into the market, increasing the number of firms to the right of n_{y2}. This is becauseAs the MD curve lies above the MS curve over this range, there is an excess demand..T as some firms enter into the market, thus more firms will enter the market. , and oOn the other side, there is an excess supply as some firms exit from the market,; thus more firms will exit from the market. Hence, the equilibrium point n_{y2} is unstable. Second, the point n_{y1} or n_{y3} is a stable equilibrium

solution because the situation mentioned above will not occur at these points but the reverse situation is true.

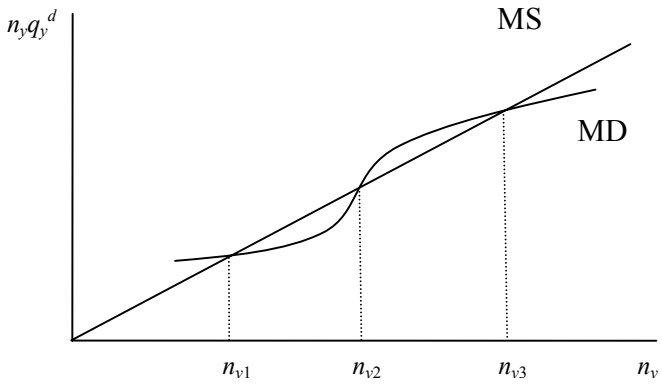

Figure 4: Stable and unstable equilibrium solutions

There are two properties. First, the unique solution or the solution with the largest number of firms in multi-solution case is a stable solution (n_y* in Figure 3 and n_{y3} in Figure 4). This is because, on the one hand, the quantity of market supply will increase in proportion as the number of firms increase. On the other hand, no matter how manylarge is the number of firms in the market, the price of the final goods, ofto which the unit cost of transaction is one of components, is higher than that in the case of zero unit cost of transaction. In other words, no matter how large the number of firms becomes, at most the transaction cost component cannot fall below zero. Thus, the price of the final good has to remain positive. , and tThus the quantity of market demand cannot be infinite. This means that the MD curve has to cut the MS curve eventually from above, i.e. is less than that in the case. As a result, the slope of MD curve is less than the slope of MS curve in the region of the equilibrium point with the largest number of firms. It implies that thisThis largest equilibrium is always a stable solution.

Second, if there are more than one stable equilibria, the equilibrium with more firms is more efficient. The reason is that the equilibrium with more firms in the market will have a lower unit cost of transaction due to the agglomeration effect discussed above, and hence will have a lower price for the final good. This makes the consumers better off. On the other hand, the producers side is always neutral due to the zero profits condition under long-run equilibrium of a small industry. However, the actual situation of an industry need not necessarily be at the equilibrium with the largest number of firms; it may be stuck at a low-level equilibrium. Assume that an industry is at the stable equilibrium point n_{y1} initially. As shown in Figure 4, n_{y3} is a more efficient equilibrium point, but there is a hurdle moving from n_{y1} to n_{y3}. In the interval between n_{y1} and n_{y2}, a firm will get negative profits from entering into the industry independently. However, beyond n_{y2}, a firm will earn positive profits from entering into the industry, and thus the industry will expand from any point beyond n_{y2} to n_{y3}. If there is an incentive, no matter from market mechanism or government intervention, from which the industry can jump over n_{y2}, the market will expand from n_{y1} to n_{y3} successfully; otherwise the market will be stuck at n_{y1}.

To get the situation of multiple equilibria illustrated in Figure 4, we need to have the MD curve be steeper than the MS curve over some middle range. Will such a case be applicable in some situations in the real world? We examine this interesting question below.

The slope of the MS curve is independent of n_y, being dependent on the value of q_y^d, as already discussed above. The slope of the MD curve depends on two factors. First, as n_y increases, the full AC may decrease through the agglomeration effect in reducing the unit transaction costs. The larger is the amount of this reduction, the steeper is the MD curve. Secondly, as the full AC and hence the price of the final good decreases, the market quantity demanded increases. The faster larger is the size of this increase, the steeper is the MD curve. To get multiple equilibria as illustrated in Figure 4, we need to have the slope of the MD curve relatively (to the slope of the MS curve) flat at low value of the number of firms n_y and becomes rather steep at some higher range and then finally flatten back again when n_y increases further. It may be possible that, at least for some cases, the first factor (the agglomeration effect) may possess this property, i.e. the agglomeration effect is relatively modest small as the number of firms increases from a low value and becomes much larger at some intermediate range, and then decreases back at a much higher value of n_y. For the second factor, there is a specific consideration that may in fact make this S-shape of the MD curve to be applicable.

Consider the market demand curve of the relevant final good (lighters in our specific example). When the price decreases from a high level, the market quantity demanded increases. However, this may consist mainly in attracting more buyers in the local market, making the increase in quantity relatively modestsmall. Nevertheless, when the price decreases to a level that is competitive enough for entrepreneurial middle persons to introduce the product to the world market, it may lead to a huge increase in quantity demanded. This was in fact the situation for the market for lighters when Hong Kong businessmen spread lighters made from Wenzhou to the world market as discussed above. However, as the world market has been largely conquered, further decreases in prices may again lead to relatively small increase in the quantity demanded. Thus, the market demand curve may well looks like the one depicted in Figure 5. With the demand curve like this (which is quite likely due to the local/world market consideration just discussed), the MD curve in Figure 4 may well be of the S-shape as depicted, giving rise to a situation of multiple equilibria as discussed above.

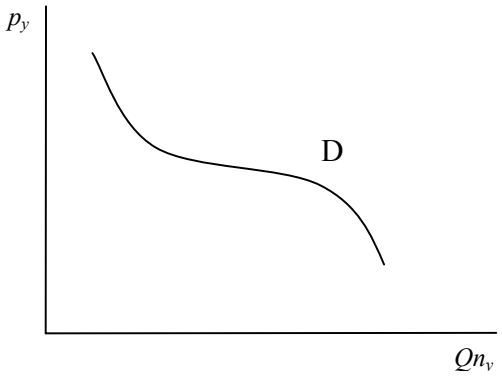

Figure 5: The demand curve extending from the local to the world market

Our discussion above may be summarized into a proposition.

Proposition 1: In the presence of the agglomeration effect, even a perfectly competitive industry without other external effects may possess multiple long-run equilibria. The highest equilibrium is most efficient. If the agglomeration effect is strong enough to allow an industry to lower the price of the product to capture a wider (e.g. world instead of just the local) market, the jump to the high and more efficient equilibrium may be possible.

The jump to the high equilibrium mentioned in Proposition 1 may partly explain the fast expansion of the industry center of lighters and the big fall in prices. However, there is only one industry center of lighters of Wenzhou in the whole world. There are many towns in China and none of them has succeeded in developing an industry center of lighters of comparable size. Thus, there must also be some other factors including possibly historical, geographical, and cultural factors specific to Wenzhou that may account for their success. On the other hand, there are hundreds if not thousands of different industries. Which industry is more suitable for which town? This is normally sorted out by free competition in the market.

After solving for the numbers of firms, n_x and n_y, we know the value of the final-good price (p_y^d), which satisfies (3.13). We have thus solved for the equilibrium values of all variables in the disintegration structure.

$$p_y^d = AC_x(q_x) + AC_y(q_y^d) + p_t(d, \frac{n_y q_y^d}{q_x}, n_y) \tag{3.13}$$

(4) Disintegration structure under the cost-advantage assumption

There are two kinds of firms in this structure, the intermediate-good firm and the final-good firm.

For the intermediate-good firm, we assume that the household workshop, compared with the standard firm, has some cost advantage in the production of the intermediate good. As shown in Figure 6, the average cost curve of the household workshop (AC_x^h) is located under that of the standard intermediate-goods enterprise (AC_x), and hence the household workshop has lower zero-profit price (p_x^h) than the standard intermediate-goods enterprise has (p_x), where superscript h denotes the household workshop.

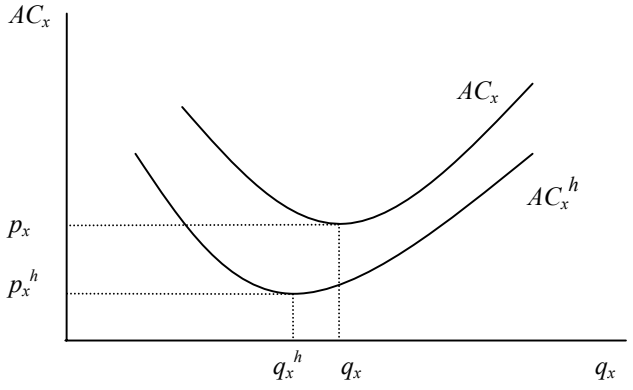

Figure 6: The average cost curves of intermediate-good firms

As a result, the standard intermediate-good firm is completely substituted by the household workshop, to which the equilibrium price (p_x^h) and quantity (q_x^h) take place at the lowest point of the average cost curve AC_x^h (see Figure 6).

$$p_x^h = AC_x(q_x^h) \tag{3.14}$$

For the final-good firm, the deduction of the equilibrium variables is similar to that in Structure (3), the only difference is that the production of intermediate good takes place at (3.14) instead of at (3.9). For simplicity we ignore the deduction, and just show the equilibrium price:

$$p_y^d = AC_{hx}(q_x^h) + AC_y(q_y^d) + p_t(d, n_y \frac{q_y^d}{q_x^h}, n_y) \tag{3.15}$$

where the numbers of firms, n_x and n_y, satisfy the following equations:

$$n_x q_x^h = n_y q_y^d \tag{3.16}$$

$$n_y q_y^d = D(M, p_x^h + p_t(d, \frac{n_y q_y^d}{q_x^h}, n_y) + AC_y(q_y^d)) \tag{3.17}$$

After discussing the equilibrium in potential structures, the question is what mode of production will they choose, integration or disintegration? Now let's assume that the structure, say disintegration structure, with a higher final-good price is the long-run equilibrium. Since the prices in long-run equilibrium are zero-profit prices (all firms earn zero profits at these prices), the assumption means that the zero-profit price of the integrated firm is lower than the final-good price of the disintegration structure. In this case the integrated firm will earn positive profits in the disintegration structure, and hence some integrated firms are encouraged to become disintegrated and rely on the market for intermediate goods. It means that the structure with lower final-good price is the long-run equilibrium, thus we have the conclusion below.

Under different assumptions the integration and disintegration considered may be in different structures. In the industry without the assumptions of cost advantage and financial constraint, for example, if the firm chooses integration [Structure (1)], the equilibrium price for the final good is (3.7). If the firm chooses disintegration [Structure (3)], on the other hand, the equilibrium price for the final good is (3.13). Thus the equilibrium structure is the one with a lower price in (3.7) and (3.13).

While in the industry under the financial-constraint assumption but without the cost-advantage assumption, the equilibrium price for the final good is (3.8) if the firm chooses integration [Structure (2)]. Since the financial-constraint assumption does not change the disintegration structure, the equilibrium price for the final good is (3.13) if the firm chooses disintegration [Structure (3)]. Thus the equilibrium structure is the one with a lower price in (3.8) and (3.13).

The equilibrium in the other cases are similar, thus we have the proposition below.

Proposition 2: There isAt a long-run equilibrium,.

(1) Without the cost-advantage and financial-constraint assumptions, the firm will choose vertical integration (disintegration) if and only if the price in (3.7) is lower (higher) than the price in (3.13).
(2) Under the cost-advantage assumption but without the financial-constraint assumption, the firm will choose vertical integration (disintegration) if and only if the price in (3.7) is lower (higher) than the price in (3.15).
(3) Under the financial-constraint assumption but without the cost-advantage assumption, the firm will choose vertical integration (disintegration) if and only if the price in (3.8) is lower (higher) than the price in (3.13).
(4) Under the cost-advantage and financial-constraint assumptions, the firm will choose vertical integration (disintegration) if and only if the price in (3.8) is lower (higher) than the price in (3.15).

3.3 Comparative statics

Proposition 21 contains several determinants of vertical disintegration. Here we will discuss the comparative statics of each of them.

Corollary 1 The larger the extent of the market, the more likely the firms choose vertical disintegration.

The larger the extent of the market, the more firms the market contains and hence the easier it is to find a firm to deal with and to bargain with in trade. According to Coase's theory of the firm, the boundary of the firm is determined by the trade-off between the management cost within the firm and the transaction cost in the market. In this case, the decline in transaction costs encourages disintegration.

The conclusion is shown in Figure 3 and 4. As the extent of market (M) increases, the curve shifts up while the straight line is unchanged; thus the number of firms contained in the market (n_{y1} or n_{y3}) increases. From (3.13), the more firms entering into the market, the lower the transaction cost, and hence the higher the advantage disintegrated firms have, compared with the integrated firms.

Corollary 2 Agglomeration increases the chance of vertical disintegration.

Agglomeration reduces the transaction costs, the costs of material transport and/or information transfer in the intermediate-good market. According to Coase's firm theory, the firm tends to outsource the production of its intermediate goods.

The conclusion is shown in Figure 3 and 4. Through agglomeration (d declines), the curve shifts up while the straight line is unchanged, thus the number of firms contained in the market increases. From (3.13), transaction cost declines as more firms enter into the market and/or as firms agglomerate more. It means that disintegrated firms dominate the integrated firms.

Corollary 3 Financial constraint increases the chance of vertical disintegration.

Under the financial constraint, the firm cannot support effective production in the whole product, but can produce a component part of the product efficiently. It encourages disintegration.

The conclusion is verified by comparing the equilibrium with the control equilibrium where no financial-constraint assumption is imposed. As shown in Proposition 2 1, the financial-constraint assumption does not change the disintegration structure but increases the equilibrium price for the final good from (3.7) to (3.8) in the integration structure. Thus, disintegration is easier to occur with the financial constraint.

Corollary 4 The cost advantage of the household workshops in producing intermediate goods encourages the firm producing the final good to outsource the production of its intermediate goods.

The conclusion is also verified by comparing the equilibrium with the control equilibrium where no cost-advantage assumption is imposed. As shown in Proposition 1, the cost-advantage assumption does not change the integration structure but reduces the equilibrium price from (3.13) to (3.15) in disintegration structure. Thus, disintegration is easier to occur under the financial-constraint assumption.

4. Applications and discussions

In this section we will answer two questions. Why does the industry of lighters in Wenzhou consist of a large number of small firms with a high degree of vertical specialization? And how does it reduce the product prices by such huge margins? From the analyses above we come up with several factors.

First, in the process of industrialization, a large number of peasants as well as other surplus personnel have to find occupation in non-agricultural industries. However, existing job opportunities can far from admit all the surplus labor force. In this circumstance self-employment is a possible way to work. They can play a minor supporting role and accept a lower price in any industry they could enter.

In addition, in modern production, manufacturing producers typically obtain their necessary capital from banks and other financial institutions. In China, however, private enterprises, especially the enterprises in rural and small town regions, have difficulties obtaining finance from banks and other financial institutions. The private firms can only obtain limited funds from saving and/or the assistance of family members. However, these limited funds are not enough to support the efficient production of whole products. Under this circumstance they adopt the flocking strategy: each firm just focuses on producing a narrow range (typically a component part) of a product, and the whole product is produced by a group of specialized firms coordinating through the market. To lower the transaction costs, they usually agglomerate in an area, sometimes even localize in a building or a street, which is usually called a “specialized market”.

In China, private enterprises, relative to the state-owned enterprises and foreign investment enterprises, adopt a higher degree of vertical disintegration in production. In China, banks and other financial institutions mainly support the production of state-owned and foreign investment enterprises, but not domestic private enterprises. State-owned enterprises and foreign investment enterprises are easy to obtain the required

capital to produce with advanced equipments and in optimal production scope and scale. Besides, being used to administrative management rather than coordination through the market, state-owned enterprises still remain highly vertically integrated. In contrast, without getting support from banks and other financial institutions, private enterprises prevalently use the flocking strategy. For example, Murakami, Liu and Otsuka's (1996) empirical analysies shows that, in the machine tool industry in China, the township-village enterprises which use older machines have higher degrees of vertical specialization. In contrast, the state-owned enterprises which also use old machines do not show this tendency. It suggests that the high degree of vertical specialization is not due to technical factors. For the township-village enterprises, financing is one of their bottle-necks. By using old machines and focusing on a narrow range in the production chain, small enterprises find it easier to produce.

Second, the cost-advantage of household workshops in the production of simple parts increases the degree of vertical disintegration and lowers the prices.

As shown in the case study in section 2 above, from the specialization in the production of component parts, many household workshops in the rural area take part in the production process. This is one of the important factors explaining the vertical disintegration and price decreases in the industry of lighter in Wenzhou. The lighter parts, say a screw, may be produced with a simple machine. Its scale of production is small enough to be suitable for a household workshop. Moreover, relative to the standard factories in a city, the household workshops, especially those in the rural area, have lower opportunity costs. For example, they can produce in their house or backyard, from which they can save some capital expenditure; in addition, compared with the standard factories, they require fewer costs in providing incentives and coordinating production. Therefore, the owner of a household workshop would is able to accept a lower price, and the lighter manufacturers would prefer to outsource the parts from the market.

Third, the degree of vertical disintegration in the industry increases with the extent of the market and/or the degree of agglomeration in the market. According to Coase, the boundary of the firm is determined by the trade-off between the management costs within the firm the transaction costs in the market. The larger the extent of a market, the larger the number of firms in the market. With a large number of firms agglomerated in the market, it is easy to find a firm to deal with and to bargain with in trade. As transaction costs decrease, firms prefer to choose vertical disintegration.

The conclusion is helpful in understanding the vertical disintegration in the industry of lighters in Wenzhou. From the case study, we find that the industry has two important characteristics. First, it has a large extent of market, their production accounts for 70% of the global market and 95% of the household market of metal-shell lighters. The second is the high extent of agglomeration which reflects not only in spatial conglomeration, but also in some mechanisms such as guilds and specialized markets. As a consequence, a large number of firms conglomerate in this area. As shown in the case study, there are about 700 firms in the industry of lighter in Wenzhou, which makes the firms easier to buy and/or sell the intermediate products through the market. Therefore, the lighter enterprises prefer to outsource their intermediate products instead of producing by themselves.

5. Conclusion

The paper first studies the case of the industry center of lighters in Wenzhou, China. Lighters are produced by a large number of small, vertically specialized and agglomerated firms. Among them some specialize in assembling lighters, and the others specialize in producing parts. Then, a perfect-competition model is developed to explain why the firms use the flocking strategy in production and how they succeed in reducing the prices of products by huge margins.

Several correlated factors are revealed to be mainly involved. First, due to the simplicity, the parts of lighters are suitable, both in technology and in costs, to be produced in household workshops. Second, in the process of industrialization, a large number of peasants as well as other surplus workers need to take up an occupation in non-agricultural industries. With limited job vacancies, self-employment in an industry with low costs of entry becomes a possible way. However, in China, private enterprises are hard to obtain finance from banks and other financial institutions. With limited financing they can only focus on producing a narrow range of a product, and the whole product is produced by a group of specialized firms. Last, as an industry center accounting for the major portion of global and household lighter market, a large number of firms agglomerate in this area. It leads to low transaction costs, with which firms prefer to specialize in a narrow range of lighter production and coordinate the production through the market. In the presence of the agglomeration effect in lowering the transaction costs, a perfectly competitive industry may have multiple equilibria. The ability of the industry of lighters in Wenzou to expand to the high-level equilibrium by capturing the world market also helps to explain the huge decreases in prices.

While we focus on studying the industry of lighters, the flocking strategy is, due to the similar reasons, prevalently used in the provision of services, such as retail trade and the services associated with people's daily life, and other 'small-goods' industries, such as plastics articles, leatherworks, shoes and clothing industries (Xiwang, 2004). These phenomena deserve attention, not only because they occur in an economy where industrialization and transformation are in progress, but also because they contribute to the employment of many workers.

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