Is the Antitrust Policy Trustful? (I)

- Strategy Mechanism of Lockefeller's Monoploy

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I. Introduction

As one of most important concepts in politics and economics, the antitrust policy was not related to economics at first. In 1838 the french mathematician Antoine Cournot developed a duopoly (oligopoly) model to prove that the less the number (n) of competitors, the higher the equilibrium price and the lower the total production, thus the monopoly ($n = 1$) has the highest price and the lowest production.¹ In other words, monopoly minimizes the consumer welfare while perfect competition ($n \rightarrow \infty$) maximizes it with the lowest price and the largest production. The American government pioneered the first anti-monopolization law in 1890: Sherman Antitrust Act. However, it had nothing to do with Cournot's argument at that time – no economists have been involved in it and succedent acts for a few decades. But today the concept in Cournot's model has become the symbol of market economy and many other governments came into the world's antitrust family.

Cournot's work is also recongnized as fundamental in econometrics, particularly in equilibrium theory since Léon Walras' father is his student. In fact, both Cournot's model and Walras' equilibrium theory are applications of Nash equilibrium in game theory. Cournot thought the mathematical application in economics was not to produce numerical precision in a predictive fashion, but rather to provide clearer formulation of economic relationships. Let us give a modern form of Cournot's model to show the second half of his argument is illusory. Suppose in an independent market there are only two competitors who produce one good of the same quality, their marginal and average costs are equal, respectively as C_1 and C_2 (in Cournot's model, the good is mineral water with zero cost), with productions *per unit time*² as Q_1 and Q_2 . The market demand is a linear one with a constant P_0 and coefficient λ as

$$P = P_0 - \lambda(Q_1 + Q_2).$$

Thus their profits per unit time are respectively $T_1 = (P - C_1)Q_1$ and $T_2 = (P - C_2)Q_2$, i.e.,

$$\begin{aligned} T_1 &= (P_0 - C_1)Q_1 - \lambda(Q_1^2 + Q_2Q_1), \\ T_2 &= (P_0 - C_2)Q_2 - \lambda(Q_2^2 + Q_1Q_2). \end{aligned}$$

Suppose the above information is known to each other. Then the two competitors adjust their productions to maximize profits, i.e.,

¹ Antoine Augustin Cournot, *Recherches sur les principes mathématiques de la théorie des richesses*, 1838.

² Unlike static models of neoclassical economics, our models feature *time*, even if they share the same variables.

$$\begin{aligned}\partial T_1/\partial Q_1 &= (P_0 - C_1) - \lambda(2Q_1 + Q_2) = 0, \\ \partial T_2/\partial Q_2 &= (P_0 - C_2) - \lambda(2Q_2 + Q_1) = 0.\end{aligned}$$

Thus, we get the solutions

$$\begin{aligned}Q_1 &= (P_0 - 2C_1 + C_2)/3\lambda, \\ Q_2 &= (P_0 - 2C_2 + C_1)/3\lambda.\end{aligned}$$

If we take $C_1 = C_2 = C$, then the overall production $Q_c^{(2)} = Q_1 + Q_2 = (2/3)(P_0 - C)/\lambda$, and $P_c^{(2)} = (P_0 + 2C)/3$. If two competitors collude or only one is left, then we get

$$\begin{aligned}\min(Q_c^{(n)}) &= Q_c^{(1)} = (1/2)(P_0 - C)/\lambda, \\ \max(P_c^{(n)}) &= P_c^{(1)} = (P_0 + C)/2.\end{aligned}$$

Hence, $Q_c^{(2)} > Q_c^{(1)}$, $P_c^{(2)} < P_c^{(1)}$. Similarly, if $C_1 = C_2 = \dots = C_n = C$, $Q_c^{(n)} = [n/(n+1)](P_0 - C)/\lambda$, and $Q_c^{(k+1)} > Q_c^{(k)}$, $P_c^{(k+1)} < P_c^{(k)}$, and the average profit in perfect competition goes to zero:

$$\begin{aligned}\max(Q_c^{(n)}) &= Q_c^{(n \rightarrow \infty)} = (P_0 - C)/\lambda, \\ \min(P_c^{(n)}) &= P_c^{(n \rightarrow \infty)} = C.\end{aligned}$$

Let the return on sales $R = (P - C)/P$ and the profit-cost ratio $r = (P - C)/C$, e.g. $R_c^{(2)} = (P_0 - C)/(P_0 + 2C)$, $r_c^{(2)} = (P_0 - C)/3C$. But P_0 is *unknown* so that we can not verify the realism of R and r (of course, Cournot would think it was unnecessary). Thus we substitute another demand function for the linear one, that is $P = a/Q$, where a is a constant of expense on this good (we will prove its reality in Chapter II). Similarly, for two competitors we get $Q_1 = aC_1/(C_1 + C_2)^2$, $Q_2 = aC_2/(C_1 + C_2)^2$, $Q^{(2)} = a/(C_1 + C_2)$, and $P = C_1 + C_2$. If $C_1 = C_2 = C$, then $Q_c^{(2)} = a/2C$, $P_c = 2C$, $R_c^{(2)} = 50\%$, and $r_c^{(2)} = 100\%$.³ Then we have a few observations.

First, such high return only can occur in the initial phase of a market, e.g. the first 10 years of oil industry, but it must have attracted so many competitors to enter the business that the case of only two oligarches would be unreasonable. Second, in a complicated case with large numbers of competitor, it is hard to imagine that any one of them can possess the complete information of all others instantly and calculate the production exactly by the rule of game theory without any intention to change unilaterally – at least small entrepreneurs have the incentive to increase production since each one has little impact on the market price (but the total one does). Human beings only have limited intelligences, let alone the cost of information. Third, running business is not playing bridge – production adjustment takes time and cost much, thus mixed strategies are almost impossible in reality.

Cournot did contribute to econometrics, but he also initiated the “blackboard” economics that many economists followed. The equilibrium concept based on game theory does not work in most cases of economic actions since the implied assumptions of complete information and

³ Proofs omitted. Even for three competitors, $Q_1 = 2a(C_2 - C_1 + C_3)/(C_1 + C_2 + C_3)^2$, $Q_2 = 2a(C_3 - C_2 + C_1)/(C_1 + C_2 + C_3)^2$, $Q_3 = 2a(C_1 - C_3 + C_2)/(C_1 + C_2 + C_3)^2$, then $Q = Q_1 + Q_2 + Q_3 = 2a/(C_1 + C_2 + C_3)$, $P = (C_1 + C_2 + C_3)/2$. If $C_1 = C_2 = C_3 = C$, then $Q_c^{(3)} = (2/3)(a/C)$, $P_c^{(3)} = (3/2)C$, we still have high return as $R_c^{(3)} = 33.3\%$ and $r_c^{(3)} = 50\%$. And $Q_c^{(n)} = [(n-1)/n](a/C)$, $P_c^{(n)} = [n/(n-1)]C$, while $n = 1$ is a singular point, which does not make sense.

unlimited calculation do not hold in reality. And even in oligopoly models, exclusion of other possible competitors is far away from reality. It only applies to some simple cases – its role in economy has been overstated. We have three comments on its problems:

- 1) hypothesis of “completely rational person” though such person does not exist;
- 2) static and isolated views of economic action that is actually dynamic and interactive;
- 3) arbitrary selections of model schemes (demand and utility functions etc.).

Though such simplifications often work well in natural laws, it does not apply to human actions – people have *consciousness* and *intent*. Economics has its own features quite different from natural sciences and mathematics. The pursuit of mathematical perfection runs counter to the pursuit of truth. Arbitrary transplants are to think of people as inanimate objects. But there is no such thing as fixed point (Nash equilibrium is based on Kakutani fixed point theorem) in animate actions – game theory is just a game, though it has some obscure applications to advertising auction, but no more than that. Or worse, the concept of “perfect competition” in equilibrium theory offers excuses for government intervention since reality is always “imperfect”, i.e. “market failure”, thus curbing monopolies is necessary to ensure “more competitions”. The “s” implies competition is a countable entity, but it is a *process* that individuals and firms supply goods on the market without using *force*.⁴

There were a few economists who criticized certain antitrust procedures but very few questioned its principle. Austrian School did punch the key problem, and others as John McGee concluded there was almost no predatory price-cutting in Rockefeller’s monopoly,⁵ but both without any *quantitative* analysis of monopoly’s nature. “As is true of many other measures, evaluation of the antitrust laws has not proceeded from an analysis of their nature or of their necessary consequences, but from an impressionistic reaction to their announced aims.”⁶ – ironically, Austrian School’s own reaction was impressionistic without substantial models responding to neoclassical economics. Thus in this paper we design two models, one for monopoly achievement in Chapter III, and its case analysis in chapter IV; another for monopoly maintenance with its case study in chapter V; their premises are explained in chapter II; the conclusion is reached in chapter VI.

II. Basic hypotheses and corollaries

There are three axiomatic hypotheses for our models, two general ones and one of monopoly:

- 1) Hypothesis one: Each person has *unique* and *limited* rationality.
- 2) Hypothesis two: The law of *decreasing* marginal utility of consumers holds.
- 3) Hypothesis three: Natural monopolists do not act on *force*.

⁴ Friedrich A. Hayek, *Individualism and Economic Order*, University of Chicago Press, 1948, Chapter V.

⁵ John McGee, *Predatory Price Cutting: The Standard Oil (N.J.) Case*, *Journal of Law and Economics*, Vol.1. (Oct., 1958).

⁶ Murray Rothbard, *Power and Market: Government and Economy*, Chapter 3.

Hypothesis one means that one person makes a decision to maximize the benefits always in his own ability and measure. It is quite different from that of “completely rational person” in neoclassical economics, that supposes people possess complete internal and (the same) external information, have the same unlimited ability to analyze such information, and maximize the benefits in the same measure. It seems that people are uniform super-robots made by God. It not only sounds absurd, but also accounts for absurd arguments as the Cournot model we have showed in chapter I.

An entrepreneur (including his partners and employees) must try to maximize the profit, which is not based on the ability of superman but on his (their) own limited rationality. Since the rationality levels, or business abilities differ from person to person, competitors shall have different productivity and profit margins in the same market. The diversity does not bring on the equilibrium of perfect competition but may triggers front-runners’ desire for monopoly, which is proved in chapter III. And there are two methods of maximizing the profit in competing market: to get more market shares by increasing production or to reduce costs by improving productivity. The preference of one to another are different among competitors, e.g. Rockefeller preferred to the latter.

Hypothesis two relates to the utility maximization of consumers. Based on it, we show that demand curve is always monotone decreasing and derive a general function of market demand. Suppose one person has the market baskets of n kinds of goods subject to a budget constraint of fixed income I per unit time. Assume the total utility $U = U(x_1, x_2, \dots, x_n)$ is monotone increasing in the domain, where $x_i \in \mathbf{R}^+$ ($i \in [1, n]$) is the consumption of the i th good, and its corresponding marginal utility function is $\partial U / \partial x_i = U_i(x_1, x_2, \dots, x_n)$. For the price set $p = (p_1, p_2, \dots, p_n)$, the consumer has the market baskets $a = (a_1, a_2, \dots, a_n)$, which maximizes the total utility U subject to

$$I = \sum_{i=1}^n a_i \cdot p_i,$$

then from the method of Lagrange Multiplier it follows that⁷

$$\frac{U_1(a)}{p_1} = \frac{U_2(a)}{p_2} = \dots = \frac{U_i(a)}{p_i} = \dots = \frac{U_n(a)}{p_n} = \lambda. \quad (\text{II.1})$$

Then suppose the price of the i th good falls to q_i and its consumption changes to b_i , while other prices remain unchanged. Assume $b_i \leq a_i$, then $q_i b_i < p_i a_i$. Thus there is a spare income $(p_i a_i - q_i b_i)$ spent on all other goods, and suppose the consumer has a new market baskets $b = (b_1, b_2, \dots, b_n)$ maximizing U , with $q_i < p_i$ and $b_i \leq a_i$, $q_j = p_j$ and $b_j > a_j$ ($j \neq i$). From the law of decreasing marginal utility and the assumption of monotone increasing U , it follows that all items of $U_i(b)$ increase while the same items of $U_j(b)$ go up but two different ones with respect

⁷ Milton Friedman, *Price Theory*, The Richest Man in Babylon Publishing, 2008, P.40.

to b_i and b_j decrease or do not change, i.e. $U_i(b)/U_i(a) > U_j(b)/U_j(a)$.⁸ Since $U_i(a) = \lambda p_i$ and $U_j(a) = \lambda p_j$, thus $U_i(b)/p_i > U_j(b)/p_j$. With $q_i < p_i$ and $q_j = p_j$, we must have

$$\frac{U_i(b)}{q_i} > \frac{U_j(b)}{q_j},$$

which does not maximize the total utility. Hence, we must have $b_i > a_i$ when $q_i < p_i$, and vice versa. So does market demand by adding individual ones.

Theorem 1 (Demand Theorem). *Demand curve is rigorously monotone decreasing under Hypothesis one and two.*

Thus the consumer must buy more of this good. Suppose he continues to do that until the budget I is spent, i.e. $b_i = (p_i/q_i)a_i$, which follows three kinds of expenses that depend on the types of U .⁹ For the market baskets $a' = (a_1, a_2, \dots, a_{i-1}, b_i, a_{i+1}, \dots, a_n)$, if $U_i(a')/q_i = \lambda$, then $q_i b_i = p_i a_i$, i.e. the expense on the good remains unchanged. There are two other possibilities: first, if $U_i(a')/q_i > \lambda$, by the law of decreasing marginal utility, he has to transfer some expenses from other goods to this one until the condition of (II.1) is satisfied, then $q_i b_i > p_i a_i$, which means he spends more on the good; second, if $U_i(a')/q_i < \lambda$, then similarly $q_i b_i < p_i a_i$, thus he spends less.

For the market of this good, we consider a stable period satisfying the following conditions: 1) the period is not so long that the budget I is fixed; 2) the market is big, i.e. the number m of consumers is large enough; 3) the price changes not too much, say $|(q_i - p_i)/p_i| < 50\%$ (we show this value is not a willfull choice in chapter III). Thus, the initial or last phase is not the case but the developing and developed phases satisfy the conditions. During these phases, consumers' types of U are meant to be uniformly distributed. Therefore, the two opposite possibilities are supposed to cancel out each other. Then, denote $p_i a_i$ as α_k and $q_i b_i$ as β_k , the total expense on the good per unit time

$$A = \sum_{k=1}^m \alpha_k = \sum_{k=1}^m \beta_k,$$

is a *constant* when the price changes. Thus we get a short-term function of market demand:

⁸ E.g. $U = x^a y^b z^c$, $a, b, c \in (0,1)$, $I = xP_x + yP_y + zP_z$, $\partial U/\partial x = ay^b z^c/x^{(1-a)}$, $\partial U/\partial y = bx^a z^c/y^{(1-b)}$, and $\partial U/\partial z = zx^a y^b/z^{(1-c)}$. If P_x and x decrease, all items of $\partial U/\partial x$ increase but others do not. Rigorous proof omitted.

⁹ One example of increasing expense: $U = x^a + y^b$, $a, b \in (0,1)$, $I = xP_x + yP_y$, $\partial U/\partial x = ax^{a-1}$ and $\partial U/\partial y = by^{b-1}$, from $ax^{a-1}/P_x = by^{b-1}/P_y$ it follows that

$$P_x = \frac{I}{x + \frac{b}{a}x^{(1-a)}y^b} \quad (1), \quad P_y = \frac{I}{y + \frac{a}{b}x^a y^{(1-b)}} \quad (2).$$

If P_x decreases and P_y remains changed, then by the Demand Theorem, x increases and from (2) it follows that y decreases. The expenses on x and y are respectively

$$I_x = xP_x = \frac{I}{1 + \frac{b}{a} \cdot \frac{y^b}{x^a}} \quad (3), \quad I_y = yP_y = \frac{I}{1 + \frac{a}{b} \cdot \frac{x^a}{y^b}} \quad (4).$$

Then, y^b/x^a decreases, thus I_x increases. Similarly, when P_y decreases and P_x remains changed, I_y also increases.

$$P = A/Q. \quad (\text{II.2})$$

where P is the price and Q is the demand quantity per unit time.

Lemma 1 (Market Demand Lemma). *In a short and stable period of large market, the function of market demand is such a hyperbola as $P \cdot Q = A$, A is a constant of budget.*

It applies to two cases: 1) an *independent* market, 2) a *relatively large* dependent market (say its share is greater than 25%) that has significant impact on the whole market, then the former could be approximately treated as the latter. Small dependent market is not the case. By the way, its demand elasticity is 1, but which does not require every individual one's elasticity to be 1. The function is not an arbitrary choice but a general one that applies to most markets, except for indivisible mass such as cars, usually with a few consumptions of each family (piecewise functions works in such cases). It will play a key role in the proofs of this paper. The function works because consumers can possess *all* price information and approach the maximum utility by test at *low costs*. On the other hand, the equilibrium theory fails in most cases of economic actions indicates that a steady supply function *does not exists*.

Austrian economists may argue that we can not assume continuity¹⁰ and use cardinal utility function¹¹ in human action, or even prohibit mathematical reasoning in economics. But they hit the wrong target – though water or air molecules are discrete, we employ calculus in hydrodynamics since the continuity of liquid is assured at the macro level, which also applies to economics for the same reason. Even as a tool, mathematics is the king of kings. Just as the joke shows, both worlds of mathematics and economics are happy when a third-rate mathematician becomes an economist because the average levels of both circles are enhanced.

The significant differences between the researches on human actions and natural ones does not lie in the application of mathematical tools but in these two factors: 1) Because of limited rationality and heterogeneity, we can not take it for granted that all people have the same utility function. Even for one person, it may be time-varying. 2) Unlike natural laws, the exact personal utility function is implicit – it only reflects its type on the visible demand function. In fact, Milton Friedman showed that under some conditions different utility functions may generate identical demand functions and indifference curves¹², which implies the ordinal essence of cardinal utilities. Thus, it is *arbitrary* to use uniform explicit utility functions and compare absolute utilities among persons. However, we can see a host of such arguments in economics – the problem is not the use of mathematics but the abuse of it.

In sum, the exact utility function is unknown – similarly, we do not know the exact velocity of any single air molecule. The approximations we can get are such things as the function (II.2) of market demand at the macro level, which is analogy to air temperature. Like imaginary number, utility function is just a roundabout in which the real world is reached. Without it, we get much less. In economic actions an individual may not follow hypotheses or

¹⁰ Ludwig von Mises, *The Theory of Money and Credit*, Indianapolis, IN: Liberty Classics, 1980, p.57.

¹¹ Murray Rothbard, *Man, Economy, and State*, Los Angeles: Nash Publishing, 1962, p.222.

¹² Milton Friedman, *Price Theory*, The Richest Man in Babylon Publishing, 2008, P.43.

laws exactly, but a mass statistically present such characteristics. As in physics, these *eigen* behaviors are focused in our researches, rather than diversely individual actions in Austrian School or uniformly rational ones in neoclassical economics.

As for monopoly, the prevailing view has a few points: 1) Monopolists are able to dominate the market by their brazenness, cruelty and conspiratorial means¹³. 2) With the monopoly position, monopolists must hike prices and degrade quality to “exploit” consumers. 3) Monopoly lessens and even eliminate competition. None of them is true.

When they try to achieve and maintain the dominance, it is impossible for natural monopolists to keep out competitors by erecting bars in industry as government, since the latter is based on *force* while the former is subject to the market. On the other hand, anti-trust laws argue that monopolists establish the dominance and preserve it through the systematic use of predatory price-cutting to squeeze competitors out. Suppose it is true, e.g. one company launches a price-cutting war, then others are bankrupt and quit; and then it raises the price even higher than before (assume the cost remains unchanged). Then how the previous and current competitors will react? Some of them shall (re)enter the industry because at this price it is profitable (again) and even more than before. Historical records noted that such things did happen all the time in the case of Standard Oil¹⁴ though the kerosene price might not pick up much. In fact, the number of independent refineries grew steadily during the monopoly period of Standard Oil.¹⁵ And other competitors came from *outside* the oil industry, e.g. Thomas Edison’s electric light, which was not common concern of economists.

In addition, most of his rivals were not bankrupt – Rockefeller purchased or rented their refineries and even employed them.¹⁶ And he “forced these refiners to sign restrictive contracts that prohibited them from sneaking back into the oil business...on several occasions Rockefeller hauled violators into court.”¹⁷ In 1873, Rockefeller were frustrated by rampant cheating and freeloaders: “To complicate matters, new refiners now entered the business expressly to blackmail him into buying them out.”¹⁸ If Rockefeller lived in today’s world, say in China, he would envy the Beijing government who makes way for state-run enterprises by shutting down private factories on the pretext as “small size, low efficiency, and severe pollution” etc – contrary to accusations of the American antitrust court. Without force, the most efficient way of preventing competitors is to keep low prices at which others are unable to make profit. Rockefeller noted: “This fact the Standard Oil Company always kept in mind: that they must render the best service and be the content with a largely increasing volume of business, rather than increase the profit so as to tempt others to compete with them.”¹⁹ It implied that he had a profit margin much higher than competitors, which is the cause of *natural* monopoly: productivity. Though he noted Standard’s low cost several times, Ron Chernow did not recognize its key part in monopoly.

¹³ Ron Chernow, *Titan, The Life of John D. Rockefeller*, Vintage eBooks, chapter 8.

¹⁴ John McGee, *Predatory Price Cutting: The Standard Oil (N.J.) Case*, Journal of Law and Economics, Vol.1. Oct., 1958, P.146, Mr. Emery’s testimony; P.147, Mr. Reighard’s testimony.

¹⁵ Id., P.156-157.

¹⁶ Id., P.148, Mr. Castle’s and Mr. Wilhoit’s testimonies; P.152, Mr. Cram’s and Mr. Teagle’s testimonies.

¹⁷ Ron Chernow, *Titan, The Life of John D. Rockefeller*, Vintage eBooks, chapter 8.

¹⁸ Id., chapter 9.

¹⁹ Id., chapter 14.

Rockefeller also blocked competitors in other ways, e.g. of signing agreements with crude oil producers to reduce the supply of raw material,²⁰ or controlling transportation through the monopoly of railroad cars and pipelines²¹ etc. Such means were regarded as “crooked”,²² but his competitors might fight back with violence²³. Standard was never involved in violence except for once in 1913, the strike of Colorado Fuel and Iron (CFI) in which Rockefeller and his son were interested. Because of their credulity on the vice president Bowers’ lies, it resulted in “massacre” – the guards and strikers opened fire on each other. Actually, CFI “brought in gunmen from the Baldwin-Felts Detective Agency and had them *deputized by county sheriffs*.”²⁴ The strike was finally quashed in bloodshed by the army – the big boss was not Rockefeller but the federal government. Though the lines of animation movie *Cars* say: “Oil companies control the government...”, the opposite is true – only gun can dominate money. Capitalists harm the society only when they collude with the government.

These axioms reflect the principle of keeping a subtle balance between the simplicity and the realism of mathematic model, e.g. the linearity feature of our models. Another one is that we try as can as possible to reduce demensions of models through the combination (substitution) of variables – unlike the string theory, we do not expect to have 10^{500} universes of 11 demensions. According to group theory, simplicity is equivalent to symmetry that makes substitution of variables possible. It lowers the difficulty of analysis and generates clear results but shall not twist the reality too much. We employ the principle in all proofs of this paper. In addition, since our models feature *time*, their solutions are not equilibriums of equations but constraints of inequalities. Finally, though they are inspired by Rockefeller’s practice in the oil industry, our models apply to most traditional goods and services. On the other hand, we will explore telecom, software and internet in other papers.

III. Model A of achieving monopoly

A. Monopoly threshold

We suppose there are two kinds of entrepreneurs in a *production* market satisfying the condition of Lemma 1, one is a would-be monopolist and another is a competitor. The latter is a group of enterprises with different productivities lower than the former. For simplification and realism, they are roughly treated as a single one with a mean profit margin.²⁵ The profit margin refers to R defined as before in chapter I. For the case of oil business, $R = (P - C)/P$, $C = c + e + f$, $c = \mu g/h$, where P is the price of kerosene, C is the gross cost without regard to refinery depreciation d and debt service i . In the breakdown of C , c is the cost of raw material in which g is the price of crude oil, h is the refining yield, and μ is the price discount; e is the

²⁰ John McGee, *Predatory Price Cutting: The Standard Oil (N.J.) Case*, Journal of Law and Economics, Vol.1. Oct., 1958, P.146, Mr. Emery’s testimony.

²¹ Id.

²² Ron Chernow, *Titan, The Life of John D. Rockefeller*, Vintage eBooks, Chapter 9: John Ellis Company’s case.

²³ Id., Chapter 8: the incident of South Improvement Company.

²⁴ Id., Chapter 29.

²⁵ As chapter I shows, people only can deal with limited information and calculation in economic actions.

refining cost; and f is the transportation fee. All units are per barrel, and C is supposed to be fixed (the assumption could be relaxed later). Finally, $r = (P - C)/C$ is the profit-cost ratio, and $R = r/(1 + r)$ and $r = R/(1 - R)$.

For one independent market, we assume in a stable period it keeps an average market price P_0 ²⁶ when the would-be monopolist has market share U_1 , return R_1 , and cost C_1 ; the competitors have such set as (U_2, R_2, C_2) that could be estimated by the monopolist to make strategy decisions. Then $R_1 > R_2$, $C_1 < C_2$, $U_1 + U_2 = 1$, and $R_1, R_2, U_1, U_2 \in (0, 1)$. The model actually has three independent variables C_1 , C_2 , and U_1 , since R_1 , R_2 , and U_2 depend respectively on the formers, i.e. a 4-dimension one. Let Q_0 be the supply or production per unit time, then the monopolist's part is $U_1 Q_0$ and the competitors' one is $U_2 Q_0$. Denote the expense on this good per unit time as a , then $P_0 = a/Q_0$ by Lemma 1.

Then suppose the market goes down until P_0 reaches the competitors' cost $C_2 = P_0(1 - R_2)$. Assume the competitors shall quit at $R_2 = 0$ (this assumption could be adjusted later), then the monopolist purchases their capacities and takes all the market shares as $Q = a/C_2 = P_0 Q_0 / C_2 = (1 + r_2)Q_0$, where $r_2 = (P_0 - C_2)/C_2$. Though in reality the (average) price may pick up somewhat after the monopolist obtains the dominance, for simplification we suppose it remains unchanged to prevent competitors from reentering. From Hypothesis one, it follows that the monopolist's profit per unit time at C_2 must be greater than that at P_0 . Thus we have

$$(C_2 - C_1)(1 + r_2)Q_0 > (P_0 - C_1)U_1 Q_0. \quad (\text{III.1})$$

But the monopolist is unable to take all shares for some realistic reasons: in some areas his marginal cost soars or some of his rivals can sell at higher prices due to their specific products etc. Thus we suppose he only can take over the previous Q_0 , and the new share after monopolization $U_1' =$

$$\frac{Q_0}{(1 + r_2)Q_0} = \frac{1}{1 + \frac{P_0 - C_2}{C_2}} = \frac{C_2}{P_0} = \frac{P_0 - (P_0 - C_2)}{P_0} = 1 - R_2,$$

while the competitors preserve the remaining $U_2' = R_2$. Then by removing r_2 in (III.1) we get the following constraints²⁷

$$U_2 > R_2/R_1, \quad (\text{III.2.1})$$

$$(1 - R_2/R_1)/U_1 > 1. \quad (\text{III.2.2})$$

Let $W = (1 - R_2/R_1)/U_1$ be called *Monopoly Critical Ratio*, i.e. the ratio of the profit after monopolization to that before. Then let $V_1 = 1 - R_2/R_1$, $V_2 = R_2/R_1$, $V_1, V_2 \in (0, 1)$ and $V_1 + V_2 = 1$, V is called *Monopoly Threshold Value*, that represents the relative profit rate. Thus $W =$

²⁶ Since historical data are annual averages, we employ them in case analysis in stead of continuous ones.

²⁷ Proof. By removing r_2 from the inequality (III.1), we get $C_2 - C_1 > (P_0 - C_1)U_1$, then divide it by P_0 on both sides, $C_2/P_0 - C_1/P_0 > U_1(P_0 - C_1)/P_0$, $R_1 - R_2 > U_1 R_1$. And then, $(1 - U_1)R_1 > R_2$, $U_2 R_1 > R_2$, thus $U_2 > R_2/R_1$. Equivalently $(R_1 - R_2)/U_1 R_1 > 1$, thus $(1 - R_2/R_1)/U_1 > 1$.

V_1/U_1 , which substitutes one variable (V_1 or V_2) for two (R_1 and R_2), and simplifies the model into a 3-dimension one. Hence, the trigger condition of monopolization is

$$U_2 > V_2 (U_1 < V_1) \quad \text{or} \quad W > 1. \quad (\text{III.2.3})$$

Theorem 2 (Monopoly Threshold Theorem). *The monopoly is possible iff the competitors' share U_2 is greater than their monopoly threshold value V_2 , i.e. $U_2 > V_2$ (the would-be monopolist's share U_1 is lower than his monopoly threshold value V_1 , i.e. $U_1 < V_1$), or equivalently the monopoly critical ratio $W > 1$.*

Then $U_1' > U_1$ follows from Theorem 2, i.e. the monopolist's share after the monopolization must be greater than before.²⁸ It only depends on the competitors' previous profit margin: the lower the R_2 , the higher the U_1' , and vice versa, since the strength that the competitors could accumulate in the previous stable period relies on their profit margin, then it also affects the shares they could preserve after the monopolization.

From the function $W(V_1, U_1) = V_1/U_1$, we observe that: 1) if U_1 is fixed, then the higher the V_1 , the higher the W , 2) if V_1 is fixed, then the lower the U_1 , the higher the W . Thus for the would-be monopolist, the impetus of monopoly is directly proportional to his monopoly threshold value and inversely proportional to his market share. But if his share is too low, he will be too weak to dominate the market successfully. Thus he must have a minimum share U_m that depends on the market. Since the model is 3-dimension, we can see its images:

Fig.1

Fig.2

As Fig.1 shows, monopoly is possible only in the feasible domain ($U_m < U_1 < 1$, and $U_1 < V_1 < 1$ or $W > 1$), and $W = V_1/U_1$ is hyperbolic paraboloid since it is equivalent to $V_1 = W \cdot U_1$.²⁹ Thus it is ruled surface and its contours form a family of lines as $V_1(U_1) = W \cdot U_1$, where W is

²⁸ Proof. Since $R_1 < 1$, then $R_2 < R_2/R_1$, $1 - R_2 > 1 - R_2/R_1$, thus $U_1' = 1 - R_2 > V_1 > U_1$.

²⁹ The standard form of hyperbolic paraboloid $z = x^2/a^2 - y^2/b^2$ could be converted to $z = xy$ by rotating $\pi/4$ on the axis z and let $a = b = \sqrt{2}$. Then let $x = W$, $y = U_1$, $z = V_1$, thus $V_1 = W \cdot U_1$ is equivalent to $z = xy$.

some constant of monopoly critical ratio and also represents the slope of line. Obviously, the maximum slope equals to $1/U_m$, i.e. $W < 1/U_m$.

From function $W(P_0) = (1 - R_2/R_1)/U_1$, we get another observation. If C_1 , C_2 and U_1 are fixed, since $C_1 < C_2$, let $C_2 = C_1 + \Delta C$, $\Delta C = C_2 - C_1$, then $R_2/R_1 = (P_0 - C_1 - \Delta C)/(P_0 - C_1) = 1 - \Delta C/(P_0 - C_1)$, thus $W(P_0) = \Delta C/[(P_0 - C_1)U_1]$. Hence the lower the P_0 , the higher the W , i.e. if the market keeps a very low market price, the impetus of monopoly will be much great. That is the major reason that most M&A (Mergers and Acquisitions) occur when the market is depressing.

B. Active/passive price-cutting

For the monopolist, there are two ways that P_0 comes down to C_2 : 1) the active price-cutting (or “predatory price-cutting” in anti-trust laws) – the monopolist slashes *his* price *directly*³⁰ to the cost of competitors; 2) the passive price-cutting – the *market* price falls gradually because of capacity expansion. The strategy decision depends on which gain is larger during the monopolization³¹, or which loss is less.

Then we show the best strategies for competitors and monopolist in active price-cutting, and then compare the monopolist’s total profit during the monopolization with that in passive price-cutting. For simplification, we assume that during this period no new competitors enter the business, and the rate of capacity expansion is a constant directly proportional to the current share since the available loan to build new capacity depends on the size of enterprise. Denote the monopolist’s rate as b_1 and the competitors’ one as b_2 , thus

$$b_1/b_2 = U_1/U_2. \quad (\text{III.3})$$

If the monopolist employs an active price-cutting, he shall expand capacity if his goal is monopolization³², otherwise the competitors will not respond since they still can sell out their productions at P_0 because the mean price decreases and then the total demand increases. Furthermore, they may (or may not) enhance the price or the productions to meet the new demand and raise their total profit. Thus, let $Q_1(t)$ be the monopolist’s production per unit time, then $Q_1(t) = U_1Q_0 + b_1t$. On the other hand, since the monopolist has exposed his cards, the competitors must take the slowest profit-shrinking strategy so that the monopolist may fail halfway. They have three typical ways to meet the new demand: 1) keep the P_0 unchanged but *adjust* the production, 2) *adjust* the price but keep the production unchanged, 3) expand capacity and reduce the price. The third one is much similar to the monopolist’s passive strategy and not the case here. The italic “*adjust*” means to raise at first³³ and then reduce (see details in Fig.3).

³⁰ It is an approximation to the reality for simplification – monopolists may take a few large steps to cut price, but not pretty small steps because 1) if the rivals do not follow, it will take longer time to accomplish the monopolization than the direct one; 2) if the rivals follow, it will be equivalent to the passive strategy.

³¹ “Monopolization” in this paper means the process of monopoly achievement.

³² If the monopolist seeks advertising effects, it will be another problem. But we can not tell them apart in reality, so does the discrimination between monopoly and competitive prices – an important argument in chapter VI.

³³ The reason has been showed in the previous paragraph, and for simplification we suppose they can increase the

1) Let $Q_2(t)$ be the competitors' production and $x(t)$ be the adjusted production with respect to the initial one ($t_0 = 0$), $Q_2(t) = U_2Q_0 - x(t)$. Then using Lemma 1 gives the mean price

$$P(t) = \frac{C_2Q_1(t) + P_0Q_2(t)}{Q_1(t) + Q_2(t)} = \frac{a}{Q_1(t) + Q_2(t)},$$

where $a = P_0Q_0$, then substituting it into the above equation gives us³⁴

$$x(t) = -R_2U_1Q_0 + (1 - R_2)b_1t, \quad (\text{III.4})$$

and the profit $T_2(t)_1 = (P_0 - C_2)(U_2 + R_2U_1)Q_0 - R_2C_2b_1t$. (III.5)³⁵

When $t'_A = U_2Q_0/b_1$, the monopolist's production reaches Q_0 and the monopolization is accomplished. At this time $x(t'_A) = U_2Q_0 - (U_1 + U_2)R_2Q_0 = (U_2 - R_2)Q_0$, thus the competitors remains capacity $U_2Q_0 - (U_2 - R_2)Q_0 = R_2Q_0$ at the price P_0 . Then If their cost drops below C_2 , they may reduce the price to C_2 and raise production to r_2Q_0 with the new share $r_2Q_0/[(1 + r_2)Q_0] = r_2/(1 + r_2) = R_2$.

2) Let $y(t)$ be the competitors' price function, and $Q_2 = U_2Q_0$ is fixed, similarly,

$$P(t) = \frac{C_2Q_1(t) + y(t)Q_2}{Q_1(t) + Q_2} = \frac{a}{Q_1(t) + Q_2},$$

then the profit $T_2(t)_2 = (P_0 - C_2)Q_0 - C_2b_1t$. (III.6)³⁶

The ratio of (III.5)'s slope to (III.6)'s slope is $(-R_2C_2b_1)/(-C_2b_1) = R_2 < 1$, which means $T_2(t)_1$ decreases much slower than $T_2(t)_2$. Though at first $T_2(0)_1 = (P_0 - C_2)(U_2 + R_2U_1)Q_0 < T_2(0)_2 = (P_0 - C_2)Q_0$ since $U_2 + R_2U_1 < 1$, $T_2(t)_1$ will be greater and greater than $T_2(t)_2$ after $t'_c = r_2U_1Q_0/b_1$ and the former total profit from t_0 to t'_A is much higher than the latter one (proof omitted). According to Hypothesis one, the competitors shall take the first strategy.

On the other hand, the monopolist's profit function is $T_1(t)_A = (C_2 - C_1)(U_1Q_0 + b_1t)$. But the competitors may sell or lease their spare capacity to the monopolist if they quit, which will accelerate the monopolization, i.e. a more favorable condition for the active strategy. Assuming the linear continuity of such behaviors, thus from (III.4) and ignoring the item $R_2U_1Q_0$ ³⁷ it follows $T_1(t)_A \approx (C_2 - C_1)(U_1Q_0 + b_1t + (1 - R_2)b_1t) = (C_2 - C_1)[U_1Q_0 + (2 - R_2)b_1t]$. To approximate the reality, we assume the aspiration of sale or lease is inversely proportional to the competitors' profit margin R_2 , thus only a part of spare capacity is sold or

production instantly.

³⁴ Proof. $C_2Q_1(t) + P_0Q_2(t) = P_0Q_0$, $C_2Q_1(t)/P_0 + Q_2(t) = S_0$, $(1 - R_2)Q_1(t) + Q_2(t) = Q_0$, $(1 - R_2)(U_1Q_0 + b_1t) + U_2Q_0 - x(t) = Q_0$, $(U_1 + U_2)Q_0 - R_2U_1Q_0 + (1 - R_2)b_1t - x(t) = Q_0$, since $U_1 + U_2 = 1$, thus we get (III.4).

³⁵ Proof. Since $(P_0 - C_2)(1 - R_2) = (P_0 - C_2)C_2/P_0 = R_2C_2$, then $T_2(t)_1 = (P_0 - C_2)Q_2(t) = (P_0 - C_2)(U_2Q_0 + R_2U_1Q_0 - (1 - R_2)b_1t) = (P_0 - C_2)(U_2 + R_2U_1)Q_0 - (P_0 - C_2)(1 - R_2)b_1t = (P_0 - C_2)(U_2 + R_2U_1)Q_0 - R_2C_2b_1t$.

³⁶ Proof. $C_2(U_1Q_0 + b_1t) + y(t)U_2Q_0 = P_0Q_0$, $y(t) = [(P_0 - C_2U_1)Q_0 - C_2b_1t]/U_2Q_0$, substituting it into $T_2(t)_2 = (y(t) - C_2)U_2Q_0$, then $T_2(t)_2 = (P_0 - C_2U_1)Q_0 - C_2b_1t - C_2U_2Q_0 = [P_0 - (U_1 + U_2)C_2]Q_0 - C_2b_1t = (P_0 - C_2)Q_0 - C_2b_1t$.

³⁷ The competitors may not build this capacity, i.e. when $t \in [0, t_c]$ the demand is not fully satisfied (but it is an unusual exception), and we suppose in this period the monopolist has the same expansion rate as that $t \in [t_c, t_A]$.

leased, and suppose the rate is full when $R_2 = 0$ and zero when $R_2 = 50\%$ ($r_2 = 100\%$). Hence, the slope of $T_1(t)_A$ becomes $(C_2 - C_1)(2 - R_2 - R_2)b_1 = 2(C_2 - C_1)(1 - R_2)b_1$, and

$$T_1(t)_A = (C_2 - C_1)(U_1Q_0 + 2(1 - R_2)b_1t), 0 < R_2 < 1/2. \quad (\text{III.7})$$

Fig.3

Fig.4

If the monopolist anticipates his rivals are about to expand capacity, he may take the passive strategy – just wait and see the price falls, then purchase their capacity when they are in hot water. During this period, he has two choices: to expand capacity with the competitors or not.

For the former, $T_1(t)_P = (P(t) - C_1)U_1Q(t)$, where $P(t) = P_0Q_0/Q(t)$, $Q(t) = Q_0 + bt$, $b = b_1 + b_2$ is the overall expansion rate. Then, $T_1(t)_P = P_0Q_0 - C_1U_1Q(t) = P_0Q_0 - C_1U_1Q_0 - C_1U_1bt$, and $U_1b = b_1$ follows (III.3), thus $T_1(t)_P = (P_0 - C_1U_1)Q_0 - C_1b_1t$. But it is not the case in our model for two reasons: 1) based upon the anticipation, the monopolist prefers to purchase the competitors' capacity rather than to build his own, 2) the capacity expansion rate $1/(1 - R_2)$ impairs the model's symmetry (path 1 in Fig.4), thus it is impossible to simplify the model through substitution of variables and get an analytic equation as (III.9.1). A possible approach is to assume that the monopolist has already expanded capacity to $U_1Q_0/(1 - R_2)$ when he launches the active price-cutting, then the model preserves some symmetry and generates a similar equation. But its solution still contains item $1/(1 - R_2)$ that can not be combined, thus its images are not intuitive enough (see the proof in the next section).

Hence we take the second case that $T_1(t)_P = (P(t) - C_1)U_1Q_0$, where $P(t) = P_0Q_0/(Q_0 + b_2t)$. But the hyperbola function is not linear (path 2 in Fig.4), thus we take path AC as an approximation. Denote the slope of AC as m , and that of BE as M , $M = 2(C_2 - C_1)(1 - R_2)b_1$ follows (III.7), then we have to calculate m . First, the line segment $|BC| = t_P$, from Lemma 1 it follows that $C_2 = P_0Q_0/(Q_0 + b_2t_P)$. Then $BC = t_P = (Q_0/b_2)[(P_0 - C_2)/C_2] = Q_0r_2/b_2$. And the line segment $|AB| = (P_0 - C_1)U_1Q_0 - (C_2 - C_1)U_1Q_0 = (P_0 - C_2)U_1Q_0$. Thus, $m = -|AB|/|BC| = -(P_0 - C_2)U_1Q_0/(Q_0r_2/b_2) = -(P_0 - C_2)U_1b_2/r_2 = -C_2U_1b_2$. There are two reasons that we do not

take the sale or lease of competitors' capacity into account during the monopolization: 1) it is a more favorable condition of active strategy, 2) otherwise it will complicate the model.³⁸

The approximation's error is acceptable, e.g. in Rockefeller's case the difference of total profits from t_0 to t_p is about 5%. In addition, if the monopolist take path 1 with capacity expansion, it will be much more profitable than path AC. Thus, the latter is more favorable for the active strategy. Similarly, if the monopolist hikes the price after the monopolization, profits will increase (Corollary 5 in chapter V) and the passive strategy will have an additive profit of A_{EFIJ} (in general the monopolization time $t_A > t_p$), thus path FE is more favorable for the active strategy as well.

C. Comparison of two strategies

In Fig.4, the area A between axis t and a path represents the total profit of this path. We suppose that capacity building and purchasing cost same. Thus if $A_{ABH} + A_{EFG} < A_{CGH}$, or equivalently $A_{ABC} + A_{CDEF} < A_{BDE}$, the monopolist will take the active strategy; otherwise the passive one will be more profitable during the monopolization. We take the latter inequality because it will simplify the model.

Let line segment $|AB| = a'$, $|DE| = b'$, $|BC| = c'$, and $|BD| = d'$. Then for the active strategy

$$\frac{\frac{1}{2}a'c' + b'(d' - c')}{\frac{1}{2}b'd'} < 1 \Rightarrow \frac{a'c'}{b'd'} - 2\frac{c'}{d'} + 1 < 0. \quad (\text{III.8})$$

Let $y = M/|m|$, from (III.3) it follows that

$$y = \frac{2(C_2 - C_1)(1 - R_2)b_1}{C_2U_1b_2} = \frac{2(C_2 - C_1)}{C_2U_1} \cdot \frac{C_2}{P_0} \cdot \frac{U_1}{U_2} = \frac{2(R_1 - R_2)}{U_2}.$$

By the way, C_2 is cancelled because of the assumption related to $R_2 < 1/2$ in (III.7). Then $a' = (P_0 - C_2)U_1Q_0$, $b' = (C_2 - C_1)Q_0 - (C_2 - C_1)U_1Q_0 = (C_2 - C_1)U_2Q_0$, $c' = a'/|m| = (P_0 - C_2)U_1Q_0/|m|$, and $d' = b'/M = (C_2 - C_1)U_2Q_0/(y|m|)$. Substituting them into (III.8) gives us

$$y \left(\frac{P_0 - C_2}{C_2 - C_1} \cdot \frac{U_1}{U_2} \right)^2 - 2y \left(\frac{P_0 - C_2}{C_2 - C_1} \cdot \frac{U_1}{U_2} \right) + 1 < 0.$$

$(P_0 - C_2)/(C_2 - C_1) = [(P_0 - C_2)/P_0][(C_2 - C_1)/P_0] = R_2/(R_1 - R_2) = V_2/V_1$, is called *Profit Loss Ratio*, and U_1/U_2 is *Market Share Ratio*. Let $x = (V_2/V_1)(U_1/U_2)$, then for the domain $x \in (0, 1)$ and $y \in (0, +\infty)$, we get

$$yx^2 - 2yx + 1 < 0. \quad (\text{III.9.1})$$

³⁸ We suppose that in this case all competitors will simultaneously quit and sell their capacity when the average $R_2 = 0$, thus the line segment $|CF|$ is perpendicular, which is an approximation of Rockefeller's acquisitions in 1871.

Treat y as a coefficient, since $y > 0$, $yx^2 - 2yx + 1$ is a concave function. Thus the condition under which (III.9.1) holds is that “*Monopoly Equation*”

$$yx^2 - 2yx + 1 = 0 \quad (\text{III.9.2})$$

has two different real roots x_1 and x_2 , and $x_1 < x < x_2$: 1) the discriminant $\Delta > 0$, i.e. $4y^2 - 4y > 0$, then $y > 1$ or $2(R_1 - R_2)/U_2 > 1$, which implies that the monopolist's level of capacity expansion in the active strategy ought be higher than the competitors' one in the passive strategy. Let $V = R_1 - R_2$, $V \in (0, 1)$, and $2V$ is called *Profit Critical Difference* of the competitors ($1 - 2V$ is that of the monopolist), with Theorem 2 we get

$$V_2 < U_2 < 2V. \quad (\text{III.10})$$

2) the roots $x = [2y \pm \sqrt{(4y^2 - 4y)}]/2y = 1 \pm \sqrt{(1 - 1/y)}$, then

$$1 - \sqrt{1 - \frac{1}{y}} < x < 1 + \sqrt{1 - \frac{1}{y}},$$

since $x = (V_2/V_1)(U_1/U_2)$ and $y = 2V/U_2$, then

$$1 - \sqrt{1 - \frac{U_2}{2V}} < \frac{V_2}{V_1} \cdot \frac{U_1}{U_2} < 1 + \sqrt{1 - \frac{U_2}{2V}},$$

since $V_1 = 1 - V_2$ and $U_1 = 1 - U_2$, hence

$$\frac{V_2}{1 + (1 - V_2)\sqrt{1 - \frac{U_2}{2V}}} < U_2 < \frac{V_2}{1 - (1 - V_2)\sqrt{1 - \frac{U_2}{2V}}}. \quad (\text{III.11})^{39}$$

Comparing (III.11) with (III.10), we have 1) obviously,

$$\frac{V_2}{1 + (1 - V_2)\sqrt{1 - \frac{U_2}{2V}}} < V_2,$$

2) Let $U_2 = z$, then the equation

$$z = \frac{V_2}{1 - (1 - V_2)\sqrt{1 - \frac{z}{2V}}}$$

can be rewritten as a cubic one

³⁹ Proof. Let $a = \sqrt{1 - U_2/2V}$, then $1 - a < (V_2/V_1)[(1 - U_2)/U_2] < 1 + a$, $(1 - a)V_1/V_2 < (1 - U_2)/U_2 < (1 + a)V_1/V_2$, $(1 - a)V_1/V_2 < 1/U_2 - 1 < (1 + a)V_1/V_2$, $(V_1 - aV_1 + V_2)/V_2 < 1/U_2 < (V_1 + aV_1 + V_2)/V_2$, $(1 - aV_1)/V_2 < 1/U_2 < (1 + aV_1)/V_2$, $V_2/(1 + aV_1) < U_2 < V_2/(1 - aV_1)$, finally we get (III.11).

$$Z = \frac{(1 - V_2)^2}{2V} z^3 + (2V_2 - V_2^2) z^2 - 2V_2 z + V_2^2 = 0. \quad (\text{III.12})$$

Let V_2' be the largest nonnegative real root of (III.12) if it exists, and $V_1' = 1 - V_2'$, V' is called *Strategy Threshold Value*. For the monopoly equation (III.9.2), when $\Delta = 0$ plane $z = 2V$ and surface $z = V_2'$ are tangent (at OG in Fig.5), when $\Delta > 0$ the latter must be convex below the former, i.e. $V_2' < 2V$.⁴⁰ Hence, the larger lower bound is V_2 and the smaller upper bound is V_2' , the constraint becomes

$$V_2 < U_2 < V_2'. \quad (\text{III.13})$$

But (III.12) has three roots, we must show the only possible one for our model is V_2' .⁴¹

- 1) when $z = 1$, $Z = (1 - V_2)^2/2V > 0$,
- 2) when $z = V_2$, $Z = V_2^2(1 - V_2)^2(V_2/2V - 1) < 0$ since $V_2 < 2V$ if (III.10) holds,
- 3) when $z = 0$, $Z = V_2^2 > 0$.

Since Z is a continuous function, if $Z = 0$ has three real roots, they must be $V_2 < z_1 < 1$, $0 < z_2 < V_2$, and $z_3 < 0$, the third one follows that z^3 's coefficient $(1 - V_2)^2/2V > 0$. However, $U_2 < V_2$ and $U_2 < 0$ are impossible in our model. Thus, only the largest one z_1 , i.e. V_2' is possible. Moreover, if (III.10) holds, then z_1 and z_2 must exist. Since the imaginary roots of cubic equation must appear in pairs, we get

Lemma 2. For the cubic equation $Z = 0$, if $V_2 < 2V$, then it must have three real roots and the largest nonnegative real root V_2' must exist.

Theorem 3 (Monopoly Strategy Theorem). When the conditions of Theorem 2 and that the competitors' monopoly threshold value V_2 is lower than their profit critical difference $2V$, i.e. $V_2 < 2V$ ($V_1 > 1 - 2V$) are satisfied, the active price-cutting is possible iff the competitors' share U_2 is lower than their strategy threshold value V_2' , i.e. $U_2 < V_2'$; or equivalently the monopolist's share U_1 is higher than his strategy threshold value V_1' , i.e. $U_1 > V_1'$.

Since the strategy model is 3-dimension, let $x = V_2$, $y = V$, and $z = U_2$, where $V_2 = R_2/R_1$ and $V = R_1 - R_2$, $x, y, z \in (0, 1)$. We can use its intuitive images to check if and how a market set (R_1, R_2, U_2) satisfies the constraint (III.13). To draw the images, we have to show some corollaries of feasible domains, relationships of surfaces, boundary lines and points etc.

From Lemma 2 it follows that when a point $(V_2, 2V)$ is above line $y = x/2$, there is some probability that U_2 satisfy the constraint (III.13); otherwise, the monopolist must choose the passive strategy. Hence we get

⁴⁰ A simple proof. $z = V_2'$ has real roots iff $\Delta \geq 0$, when $\Delta = 0$, $z = 2V$ are boundary roots, thus $V_2' < 2V$.

⁴¹ Proof. 1) $z = 1$, $Z = (1 - V_2)^2/2V + 2V_2 - V_2^2 - 2V_2 + V_2^2 = (1 - V_2)^2/2V$.

2) $z = V_2$, $Z = (1 - V_2)^2 V_2^3/2V + (2V_2 - V_2^2) V_2^2 - 2V_2^2 + V_2^2 = (1 - V_2)^2 V_2^3/2V + V_2^2 (-V_2^2 + 2V_2 - 1) = (1 - V_2)^2 V_2^3/2V - V_2^2 (1 - V_2)^2 = V_2^2 (1 - V_2)^2 (V_2/2V - 1)$.

Corollary 1. *The feasible domain of active price-cutting is $y > x/2$.*

Corollary 2. *The feasible domain of strategy model is $x + y < 1$ and $y < (1 - x)/2x$.*

Proof. 1) Assume $x + y > 1$. Then $R_2/R_1 + R_1 - R_2 > 1$, $[R_2 + R_1(R_1 - R_2)]/R_1 > 1$, $R_1(R_1 - R_2) > R_1 - R_2$, thus $R_1 > 1$ since $R_1 - R_2 > 0$, but it is impossible for our model. Hence, we must have $x + y < 1$, i.e. all points $(V_2, 2V)$ are below line $y = 1 - x$. 2) Assume $y > (1 - x)/2x$. Then $R_1 - R_2 > (1 - R_2/R_1)/2(R_2/R_1)$, $R_1 - R_2 > (R_1 - R_2)/2R_2$, $1 > 1/2R_2$, thus $R_2 > 1/2$, but it is in contradiction to our assumption $R_2 < 1/2$ in (III.7). Hence we must have $y < (1 - x)/2x$, i.e. all points $(V_2, 2V)$ are below line $y = (1 - x)/2x$.

Then we get some boundary points (Fig.5 and 6): the intersection point of $y = x/2$ and $x + y = 1$ is point D $(2/3, 1/3)$; those of $y = (1 - x)/2x$ and $x + y = 1$ are point E $(1/2, 1/2)$ and $(1, 0)$; that of $y = x/2$ and $y = (1 - x)/2x$ is point F

$$\left(\frac{\sqrt{5} - 1}{2}, \frac{\sqrt{5} - 1}{4} \right),$$

whose values are about the golden ratio. Thus the assumption related to $R_2 < 1/2$ in (III.7), equivalent to the condition $|(q_i - p_i)/p_i| < 50\%$ in (II.2), accounts in large part for the *simplicity* and *uniqueness* of the strategy model.

Corollary 3. *For planes and surface*

$$\begin{aligned} z &= x, & (1) \\ z &= 2y, & (2) \\ z &= \frac{x}{1 - (1 - x)\sqrt{1 - \frac{z}{2y}}}, & (3) \end{aligned}$$

they intersect at one space line $x = 2y = z$.

Proof. Obviously, the intersection line of (1) and (2) is $x = 2y = z$. Substituting (2) into (3) gives us: $z = x$, thus (3) must intersect (1) at the same line ((2) and (3) are tangent at this line).

The point of maximum V_2' is meant to be the tangent one of line $x + y = 1$ and (III.12)'s contour, i.e. $y = (1 - x)^2 z^3 / 2[(x^2 - 2x)z^2 + 2xz - x^2]$, that is about $(0.58, 0.42)$, and $\max(V_2') \approx 0.70$ (computation omitted). But this point is not in the feasible domain, which follows the above corollaries. Thus the contour has to move left until it reaches the corner point E , and the feasible $\max(V_2') \approx 0.69$. Finally, we get Fig.5 and 6. In fact, such 3D solution is the simplest and unique, while all others lead to more complicated substitutions⁴² or no 3D solution at all. With this solution, we rewind the monopoly film 150 years back to watch whether Lockefeller is a “predator” or a “redemptor” during the monopolization.

⁴² E.g. if $M = (C_2 - C_1)b_1$, i.e. without the purchase or rent of competitors' capacity, then the substitution is $(x = R_2/R_1, y = (R_1 - R_2)/(1 - R_2), z = U_2)$.

Fig.5

Fig.6

IV. Case analysis of model A

A. Historical data

Before the analysis, two assumptions have to be reviewed: 1) the cost C is fixed, and 2) the competitors shall quit at $R_2 = 0$. However, in reality both cases are unusual. The technology conditions of production may remain unchanged in the short term, but the cost of raw materials is often volatile, e.g. the price of crude oil. And the competitors may continue to operate in the red for a long time. The problems can be solved by the substitution of variables.

First, we observe that in general the cost of raw materials has the same impact on all competitors since the model is linear and symmetric (Lockefeller's case is not since $c = \mu g/h$, but it could be done by an approximation), which is equivalent to keeping the cost fixed, and adjusting the sale price to P_0^{adj} . If the monopolist predicts the mean price of raw materials in the next period will change from p to p' , let $\alpha = \Delta p = p - p'$, then

$$P_0^{adj} = P_0 + \alpha, \quad (IV.1)$$

and let $R_k^{adj} = (P_0^{adj} - C_k)/P_0^{adj}$. Thus C_k remains unchanged and the model still works by substituting P_0^{adj} for P_0 , and (U_k, R_k^{adj}, C_k) for (U_k, R_k, C_k) , $k = 1, 2$.

Second, suppose the competitors remain in the business until $R_2^{adj} = -\beta$ ($\beta > 0$), then it is quite possible that they will reenter the business when the price picks up to $R_2^{adj} = -\beta$ as well since they need to build capacity in advance, which did happen in Rockefeller's case. It means their *virtual* cost C_2^{vir} is lower (C_2 is called *actual* cost), then

$$C_2^{vir} = C_2/(1 + \beta), \quad (IV.2)$$

and let $R_2^{v\&a} = (P_0^{adj} - C_2^{vir})/P_0^{adj}$. Hence by substituting $(U_2, R_2^{v\&a}, C_2^{vir})$ for (U_2, R_2, C_2) we preserve the second assumption. In addition, government subsidy could be treated as virtual cost, but it would distort the market structure and lead to surplus supply – a kind of corss-subsidization should be rejected (corss-subsidization is investigated in chapter V).

Proof. Suppose R_2^{adj} reaches $-\beta$ when the price falls Δp from C_2 , thus $[(C_2 - \Delta p) - C_2]/(C_2 - \Delta p) = -\beta$, $\Delta p = [\beta/(1 + \beta)]C_2$, let $C_2^{vir} = C_2 - \Delta p = C_2/(1 + \beta)$. Thus when $P = C_2^{vir}$, $R_2^{v\&a} = 0$.

Then we have to face the problem of inaccurate and absent historical data – the prices of production are apt to be underrated while those of raw materials overrated, and it is hard to estimate other costs because of the lack of data. For the former, we adjust them a little, e.g. we raise the mean kerosene price of 1870 from 26 ¢/gl⁴³ to 27 ¢/gl, or $P_0 = 11.34$ \$/bl (1 barrel = 42 gallons), and let the mean price of crude oil $g = 3.65$ \$/bl (histotical data range from 3.5 to 4.0)⁴⁴. For the latter, we calculate them on available information:

- 1) Rate of refining yield h . We does not find any records of it. Thus we have to estimate it according to the refining technologies and the quality of Pennsylvanian crude then. Since Pennsylvanian crude was paraffin-based, we estimate its yield of light fractions (AGO) from atmospheric distillation is 40-50%, a kind “kerosene” mixed with naphtha, gasoline and diesel etc.,⁴⁵ its yield of heavy fractions (VGO) from vacuum distillation is 20-30%, including heavy diesel and light lubricating oil etc.; and vacuum residuum (heavy oil) about 20-30% that could be processed to heavy lubricating oil, pitch, paraffin and vaseline etc. or used as fuel oil. To simplify the calculation, we convert the return of the latter two into that of kerosene and take the overall yield as 60-70%. Since Standard Oil had greater productive efficiency and pioneered in some uses for byproducts,⁴⁶ we take h_1 relatively high, say 71.4%, then the multiplier $1/h_1 \approx 1.4$, while its rivals had an average rate, say $h_2 = 62.5\%$, and $1/h_2 = 1.6$.
- 2) Refining cost e . Only one record is found: “Standard’s average cost of refining a gallon of kerosene in 1870 was 3 cents.”⁴⁷ Thus, $e_1 = 0.03 \cdot 42 \approx 1.2$ \$/bal. It seems to be reasonable. Then we suppose the competitors’ mean cost was one dollar higher, i.e. $e_2 = 2.2$ \$/bl, since Rockefeller was better at saving costs.⁴⁸
- 3) Transportation fee f . It is the crucial factor of the conflict between Rockefeller and his rivals. There are a few sources of such information, we take $f_1 = 1.65$ and $f_2 = 2.40$.⁴⁹
- 4) Share of Standard Oil U_1 and related price discount μ of crude oil. There are many sources of Rockefeller’s share to the whole market in 1870, from 4%-10%, but few about Cleveland’s share – our estimation is about 30%, thus Lemma 1 holds. If Rockefeller’s

⁴³ Donald J. Boudreaux & Burton W. Folsom, *Microsoft and Standard Oil: radical lessons for antitrust reform*, The Antitrust Bulletin, Fall 1999, P.558.

⁴⁴ www.chartsbin.com

⁴⁵ Such “kerosene” was easy to explode at that time, that is why Rockefeller named his company “Standard Oil” to indicate the quality of his production.

⁴⁶ Id. as 43.

⁴⁷ Id., P.559.

⁴⁸ Id., P.558.

⁴⁹ Ron Chernow, *Titan, The Life of John D. Rockefeller*, Vintage eBooks, Chapter 6: “In 1868 ... that allowed them to ship crude oil to Cleveland and the refined oil to New York for only \$ 1.65 per barrel compared to an officially listed rate of \$ 2.40.”(see the railroad map in Fig.10)

share to the whole market was 10%, he would have $0.1/0.3 = 1/3$ share of Cleveland⁵⁰ in 1870, i.e. $U_1 = 1/3$ and $U_2 = 2/3$. Because Standard's size was much larger than anyone else in Cleveland, it might have discount, say $\mu_1 = 0.8$, and suppose others did not, $\mu_2 = 1$.

Therefore, we can compute the market sets of Rockefeller and his rivals in 1870, just before 1871's depression and 1872's acquisitions – "Cleveland Massacre". For Rockefeller, $C_1 = \mu_1 g/h_1 + e_1 + f_1 = 0.8 \cdot 3.65 \cdot 1.4 + 1.2 + 1.65 \approx 6.94$, $R_1 = (P_0 - C_1)/P_0 = (11.34 - 6.94)/11.34 \approx 38.8\%$, and $r_1 = (P_0 - C_1)/C_1 = (11.34 - 6.94)/6.94 \approx 63.4\%$, while $U_1 = 1/3$. On the other side, $C_2 = 3.65 \cdot 1.6 + 2.2 + 2.4 \approx 10.44$, $R_2 \approx 7.9\%$, and $U_2 = 2/3$. But before putting them into the strategy model, we must verify their realism.

B. Verification of estimations

In Jan.10, 1870, Rockefeller found Standard Oil with book capital 1,000,000 \$ and at the same year he paid dividends of 105 percent (1,050,000 \$); in 1871, he declared a 40 percent dividend (40,000 \$), with a small surplus to spare.⁵¹ Rockefeller might lie, but money never – the dividends were credible. Another problem is to determine Standard's sales or productions. The crude oil productions in 1870 and 1871 were almost the same, about 5,200,000 bls⁵². We estimate that 4,300,000 bls were refined to kerosene and byproducts, 700,000 bls were stored (see the reason later on) and 200,000 bls were used for other purposes (special byproducts) in 1870. It would produce about 2,709,000 bls refined oil with 63% refining yield. According to historical data, Standard Oil's share to the whole market in 1870 was close to 10%,⁵³ thus Standard might produced 267,500 bls refined oil in 1870 and the gross annual profit $G_1 = (11.34 - 6.94) \cdot 267500 = \$1,177,000$, in accordance with the dividends of \$1,050,000 in 1870.

In 1871 the (average) kerosene price slumped 25%⁵⁴, i.e. $P_0' = 11.34 \cdot (1 - 25\%) = 8.505$ \$, but how did it happen? If both in 1870 and 1871 the same 5,000,000 bls crude were refined, the price would not drop because the supply did not change, according to Lemma 1. The only possible explanation is that most new refining capacity was on building yet in 1870, thus the crude production of the same year did not work out, and the surplus was stored for the next year's expansion. When these refineries were finished in 1871, all 5,000,000 bls crude of the same year and 700,000 bls of the previous year were refined, which produced 3,591,000 bls refined oil. Hence, $1 - 2709000/3591000 \approx 24.6\%$, i.e. the price fell about 25% in 1871 by Lemma 1.

⁵⁰ Id., chapter 6: "(in 1868) he was the world's largest refiner, equal in size to the next three largest Cleveland refineries combined." that implies his share must be less than 1/2. Thus 1/3 is a reasonable estimation.

⁵¹ Id., chapter 8.

⁵² Harold, Williamson & Arnold R. Daum, *The American Petroleum Industry: The Age of Illumination 1859-1899*, Evanston, 1959.

⁵³ John McGee, *Predatory Price Cutting: The Standard Oil (N.J.) Case*, Journal of Law and Economics, Vol.1. (Oct., 1958), P.143, Mr. Archbold's testimony;

Ron Chernow, *Titan, The Life of John D. Rockefeller*, Vintage eBooks, chapter 8;
https://en.wikipedia.org/wiki/Standard_Oil_Co._v._United_States: "By 1870, Standard Oil was producing about 10% of the United States output of refined oil. This quickly increased to 20% through the elimination of then competitors in the Cleveland area."

Donald J. Boudreaux & Burton W. Folsom, *Microsoft and Standard Oil: radical lessons for antitrust reform*, The Antitrust Bulletin, Fall 1999, P.558: "In 1870... Rockefeller had a 4% market share." But it is too low to fit Rockefeller's dividends in the same year.

⁵⁴ Ron Chernow, *Titan, The Life of John D. Rockefeller*, Vintage eBooks, chapter 8.

For the same reason the crude supply did not meet the refining demand and its mean price went up to 4.14 \$/bl in 1871. We suppose Rockefeller's production of this year increased a little to 272,500 bls. Thus $C_1' = \mu_1 g'/h_1 + e_1 + f_1 = 0.8 \cdot 4.14 \cdot 1.4 + 1.2 + 1.65 \approx 7.49$, $R_1 = (P_0' - C_1)/P_0' = (8.505 - 7.49)/8.505 \approx 11.9\%$, and $r_1 = (8.505 - 7.49)/7.49 \approx 13.6\%$. The annual profit was $G_1' = (8.505 - 7.49) \cdot 272500 \approx 276,600$ \$. The overall profit of two years was $1177000 + 276600 = 1,453,600$ \$, the overall dividend was $1050000 + 40000 = 1,450,000$ \$, and the surplus was only 3,600 \$, which fits Rockefeller's declaration in 1871.

In addition, in 1870 refiners "saw the profit margin between crude- and refined-oil prices shrink to a vanishing point... Rockefeller estimated, 90 percent of all refineries were operating in the red."⁵⁵ Then we add a small-sized refiner to compare, with its $1/h_3 = 1.75$ and $e_3 = 2.4$, other parameters are the same as those of the mid-sized one. Thus $C_3 = 3.65 \cdot 1.75 + 2.4 + 2.4 \approx 11.19$, $R_3 \approx 1.3\%$. Suppose their book capitals ρ respectively be $\rho_1 = \$1,000,000$, $\rho_2 = \$200,000$, $\rho_3 = \$50,000$, 50% debt ratio with annual debt services $i_1 = 11\%$, $i_2 = 13\%$, $i_3 = 15\%$, annual productions $q_1 = 267,500$ bls, $q_2 = 54,000$ bls, $q_3 = 13,500$ bls, and annual depreciations⁵⁶ $d_1 = 10\%$, $d_2 = 12.5\%$, $d_3 = 15\%$. Their net returns on sales N are respectively

$$N_1 = (G_1 - 0.5\rho_1 i_1 - \rho_1 d_1)/(P_0 q_1) = (1177 - 0.5 \cdot 1000 \cdot 0.11 - 1000 \cdot 0.1)/(11.34 \cdot 267.5) \approx 33.69\%,$$

$$N_2 = (G_2 - 0.5\rho_2 i_2 - \rho_2 d_2)/(P_0 q_2) = (54.81 - 0.5 \cdot 200 \cdot 0.13 - 200 \cdot 0.125)/(11.34 \cdot 54) \approx 2.75\%,$$

$$N_3 = (G_3 - 0.5\rho_3 i_3 - \rho_3 d_3)/(P_0 q_3) = (2.025 - 0.5 \cdot 50 \cdot 0.15 - 50 \cdot 0.15)/(11.34 \cdot 13.5) \approx -0.06\%.$$

Since the calculations were based on annual averages, it was quite possible that small- and mid-sized refiners were operating in the red in late 1870, which is in line with the historical record. Hence, the realism of our estimations is well verified.

C. Analysis of market sets

The average price of kerosene went up from 3.65 \$/bl in 1870 to 4.14 \$/bl in 1871. But its impacts on Standard and its rivals had some discrepancy since $1/h_1 = 1.4$ and $\mu_1 = 0.8$ while $1/h_2 = 1.6$, $\mu_2 = 1.0$. We take the middle ones, then $\alpha = (3.65 - 4.14) \cdot 1.5 \cdot 0.9 \approx -0.66$, $P_0^{adj} = 11.34 - 0.66 = 10.68$, and $R_1^{adj} = (10.68 - 6.94)/10.68 \approx 35\%$, while $R_2^{adj} = (10.68 - 10.44)/10.68 \approx 2.25\%$. We observe that $2V^{adj} = 2(R_1^{adj} - R_2^{adj}) = 0.655 > 2V \approx 0.617$, and $V_2^{adj} = R_2^{adj}/R_1^{adj} \approx 0.064 < V_2 \approx 0.204$. Thus, the adjusted market set is more favorable for monopolization and active strategy than the previous one.

Corollary 4. If the costs of monopolist and competitors increase simultaneously, then the adjusted market set is more favorable for monopolization and active strategy, and vice versa.

Proof. $V_2^{adj} = R_2^{adj}/R_1^{adj} = (P_0 + \alpha - C_2)/(P_0 + \alpha - C_1) = 1 - \Delta C/(P_0 + \alpha - C_1)$, $\Delta C = C_2 - C_1 > 0$, $2V^{adj} = 2(R_1^{adj} - R_2^{adj}) = 2(C_2 - C_1)/(P_0 + \alpha)$, which follows from (IV.1). And $V_2 = R_2/R_1 = 1 -$

⁵⁵ Id.

⁵⁶ John McGee, *Predatory Price Cutting: The Standard Oil (N.J.) Case*, Journal of Law and Economics, Vol.1. Oct., 1958, P.146, Mr. Emery's testimony about depreciation.

$\Delta C/(P_0 - C_1)$, $2V = 2(R_1 - R_2) = 2(C_2 - C_1)/P_0$. The cost increases means $\alpha < 0$, thus $V_2^{adj} < V_2$ and $2V^{adj} > 2V$; when $\alpha < 0$, $V_2^{adj} > V_2$ and $2V^{adj} < 2V$.

We assume that Rockefeller would take the cost adjustment into account and suppose his rivals quit at a mean value of $R_2 = -15\%$.⁵⁷ Then $C_2^{vir} = 10.44/(1 + 15\%) = 9.078$, and $R_2^{v\&a} = (10.68 - 9.078)/10.68 = 15\%$. Hence, $R_1^{adj} = 35\%$, $R_2^{v\&a} = 15\%$ (point A in Fig.3, 4, 5 and 6), $U_1 = 1/3 \approx 0.333$, and $U_2 = 2/3 \approx 0.667$. Then we get $V_1 \approx 0.571$, $V_2 \approx 0.429$, and $2V = 0.4$. Thus, $U_2 > V_2$ ($0.667 > 0.4$), $W = 0.571/0.333 \approx 1.72$, and $V_2 > 2V$ ($0.429 > 0.4$), thus Rockefeller would like to monopolize but must take the passive strategy, and he did⁵⁸.

Was it possible for Rockefeller to take the active strategy in 1870? Almost impossible, since $\max(V_2') = 0.69$ is very close to 0.667 , there is little probability of $U_2 < V_2'$. If we take an extreme set as $R_1^{(adj)} = 80\%$, $R_2^{(v\&a)} = 40\%$ (point B in Fig.5 and 6), then $U_1 > 35.8\%$ follows from (III.12). But such case only occurs in the initial phase of market as an even game – few competitors can reach up to such high share even though in a local market, let alone initial phase is not the case of our model.

After Rockefeller eliminated his rivals in Cleveland, the remaining competitors would be stronger – it makes sense to suppose that his advantage, i.e. $V = R_1 - R_2$ would decrease with the growth of Standard's market share during the monopolization. As Corollary 4 shows, another factor affecting V in Rockefeller's case was the fluctuation of g , the crude oil price. However, it could be omitted since it had much more impact on V_2 in Theorem 2 than on $2V$ in Theorem 3. Hence, even the market set $(V_2^{(v\&a)}, V^{(v\&a)})$ located in area I, it should be lower than point A and close to the boundary line OD , e.g. point C (0.286, 0.15), say $R_1^{adj} = 21\%$, $R_2^{v\&a} = 6\%$.⁵⁹ It followed that $70.1\% < U_1 < 71.4\%$ – the range was so small⁶⁰ that it was almost impossible to take the active strategy. And in case $U_1 > 71.4\%$, the price-cutting (whether active or passive) itself would be undesirable, and only M&A were feasible. For instances, in 1874 Rockefeller acquired the refinery of Lockhart and Warden in Pittsburgh just by inviting Warden to inspect the Standard Oil books, and Warden surrendered because Standard's cost was much lower than his.⁶¹ Thus, when Rockefeller took high shares he still had little chance to employ “predatory price cutting”, and he did not as John McGee showed.

In the developing phase of market, there are numerous chances of slump for the passive strategy. On the other hand, it takes much longer time, has much more uncertainties, and is

⁵⁷ In this case most refiners actually quit at annual average $R_2 = -30\%$, a large loss. Ron Chernow, *Titan, The Life of John D. Rockefeller*, Vintage eBooks, chapter 8: “refiners carried heavy bank debt and other fixed costs, and they discovered that, by operating at a loss, they could still service some debt. Obviously, they couldn't lose money indefinitely, but as they soldiered on to postpone bankruptcy, their output dragged oil prices down to unprofitable levels for everybody... In a day of primitive accounting systems, many refiners had only haziest notion of their profitability or lack thereof. As Rockefeller noted, ‘often-times the most difficult competition comes, not from the strong, the intelligent, the conservative competitor, but from the man who is holding on by the eyelids and is ignorant of his costs, and anyway he's got to keep running or bust!’”

⁵⁸ John McGee, *Predatory Price Cutting: The Standard Oil (N.J.) Case*, Journal of Law and Economics, Vol.1. (Oct., 1958), P.144: “I can find no real evidence that predatory price cutting or any other type of coercion figured in the acquisitions.” Similarly, Ron Chernow did not note any predatory price cutting in the Cleveland acquisition.

⁵⁹ The case with so low $R_2^{v\&a}$ might happen when the crude oil price soared from \$1.35 in 1875 to \$2.56 in 1876.

⁶⁰ Even if point C is higher than point A and somewhat away from line OD , the range will be only about 10%, and the gain is quite small. However, such cases are almost impossible in reality.

⁶¹ Ron Chernow, *Titan, The Life of John D. Rockefeller*, Vintage eBooks, chapter 9.

much less profitable to employ the active one. No sane entrepreneur would take such risks to acquire the monopoly power. Since the chance of active strategy was so scarce, to recognize it Rockefeller did not need an intelligent mind as economists but the canny accounting – it was his advantage. Let us check the following table of Rockefeller's books and corresponding market data from 1869 to 1873 to see the details of his monopolization process.

year	o.price \$/bl ⁶²	k.price		R.k.p. 1000bl	R.profit (annual)			m.k.p. 1000bl	R.m. share	m.o.p. ⁶³ 1000bl	m.r.o.p 1000bl
		\$/bl	€/gl		\$/bl	ratio	(\$1000)				
1869	3.50	12.19	29	210	5.42	44.5%	11,382	2,520	8.3%	4,200	4,000
1870	3.65	11.34	27	267.5	4.40	38.8%	11,770	2,709	9.9%	5,200	4,300
1871	4.14	8.51	20 1/4	272.5	1.02	11.9%	2,766	3,591	7.6%	5,200	5,700
1872	3.50	8.82	21	630	2.05	23.2%	12,915	3,463	18.2%	6,290	5,500
1873	1.73	6.41	15 1/4	1,000 ⁶⁴	1.14	17.8%	11,400	4,750	21.1%	9,900	7,500

Table.1. Legends: o.= (crude) oil, k.= kerosene & byproducts, R.= Rockefeller's, p.= production, m.= market, r.= refined; red = data from sources (may adjusted), green = calculated on sources, black = estimated. Remark: 1) For simplification, all calculations are based on fixed costs except for the price of crude oil. 2) We assume there was no price discount of crude oil in 1873 because of the slump.

There are three comments on the table: 1) The difference between m.o.p. and m.r.o.p. was used for storage and special byproducts. 2) In 1871 Rockefeller's output was about 270,000 bls. In the Cleveland acquisition, he might purchase two times volume of his own according to our model, i.e. capacity of 540,000 bls. But we estimate he dismantled at least 1/3 of them with outdated technologies,⁶⁵ i.e. 180,000 bls. Thus his production in 1872 would be 270000 + 540000 – 180000 = 630000 bls. 3) The slump of crude oil price in 1873 was due to two factors: first, after Treaty of Titusville fell apart, crude oil production soared from 6,290,000 lbs in 1872 to 9,900,000 lbs in 1873; second, after the Black Thursday (Sep.18, 1873), the price of crude oil touched 80 €/bl, and tumbled to 45 €/bl in the next year.⁶⁶ Just in the succedent six-year recession, Rockefeller achieved his monopolization.

John McGee was wondering why Rockefeller signed agreements (e.g. Treaty of Titusville) with crude oil producers to curb production – since the larger the production, the lower the price, which should be favorable for a big purchaser as Rockefeller.⁶⁷ However, lower cost implied more competitors would enter the business and their new production of kerosene surely pulled down its price. Since the kerosene price dropped more than 27% in 1873 (from 8.82 \$/bl to 6.41 \$/bl), Rockefeller's annual profit was lower than that of 1872 even though his production soared to 1,000,000 lbs through acquisitions. The scenario could be seen in Fig.7. Thus, Ron Chernow answered John McGee's question: "So long as he could maintain

⁶² Id. as 44.

⁶³ Id. as 52.

⁶⁴ Ron Chernow, *Titan, The Life of John D. Rockefeller*, Vintage eBooks, chapter 9: "By 1873, Standard Oil was shipping about a million barrels of refined oil per year and earning about a dollar a barrel..."

⁶⁵ Id., chapter 8: "Rockefeller... taking over many plants not to operate them but to shut them down and eliminate excess capacity. He ridiculed many of the refineries he bought as 'old junk, fit only for the scrap heap.'"

⁶⁶ Id., chapter 9.

⁶⁷ John McGee, *Predatory Price Cutting: The Standard Oil (N.J.) Case*, Journal of Law and Economics, Vol.1. Oct., 1958, P.146, footnote 29.

ample spreads between crude and refined prices, Rockefeller blessed the producers' efforts to impose higher prices and control output."⁶⁸ It was the same reason that Rockefeller decided to monopolize – stable growth under monopoly was a better strategy for him.⁶⁹

Then we give the comparisons of profit and cost between Rockefeller and his rivals (if they intended to reenter the business in 1872 and 1873) and some comments:

R (%) / Profit (\$/bl)	1869		1870		1871		1872		1873	
1. Rockefeller (large)	44.5	5.42	38.8	4.40	11.9	1.02	23.2	2.05	17.8	1.14
2. Competitor (mid)	16.3	1.99	7.9	0.90	-31.9	-2.72	-15.6	-1.38	-15.0	-0.96

Costs in 1870 (\$/bl)	$C = c + e + f$	e	f	$c = c_\mu + c_h$	$c_\mu = \mu g$	$c_h = \mu g(1 - h)/h$
1. Rockefeller (large)	6.94	1.20	1.65	4.09	2.92	1.17
2. Competitor (mid)	10.44	2.20	2.40	5.84	3.65	2.19
Difference	3.50	1.00	0.75	1.75	0.73	1.02

Table.2. Legends: C = total cost, c = raw material, e = refining, f = transportation, c_μ = part of price discount, c_h = part of refining yield, μ = price discount, g = crude oil price, h = refining yield.

- 1) The Cleveland acquisition really worked – the average kerosene price stopped falling and pick up a little in 1872. Rockefeller cut about 300,000 - 400,000 bls capacity in Cleveland that accounted for 8.5 - 11.5% of the market production in the same year, which stabilized the kerosene price (also with cooperations of other refiners outside Cleveland). In the next two years, the average price stayed at levels that the previous competitors would have returns of about -15% if they tried to reenter, which fits our assumption.
- 2) Rockefeller had the advantages of size, management, and technology, which was reflected respectively in f & c_μ ($0.75 + 0.73 = 1.48$ \$/bl), e (1.00 \$/bl), and c_h (1.02 \$/bl), and totally 3.50 \$/bl. The productivity was his secret of profit and key of monopoly.
- 3) In 1870, the transportation fee accounted for about half of Rockefeller's profit (before discount), and more than two times of competitors' profit. In addition, it was relatively easy to adjust by negotiation. That is why the incident of South Improvement Company aroused great repercussions – it would raise the transportation cost of small- and mid-sized refineries and subsidize large ones. Was it a rascal collusion? If it was, the government then should be prosecuted especially – the special charters of such shell organizations that Pennsylvania Railroad bought were created by Pennsylvania legislature for authorizing the right to hold stock in companies outside Pennsylvania, which was against its own state law at that time.⁷⁰ On the other hand, such “collusion” was hard to be conformed as we have seen in the case of Treaty of Titusville and many other federations of firms. It is just a competition measure and has nothing to do with “morality”, a common excuse for politicians to fabricate “enemies”.

⁶⁸ Ron Chernow, *Titan, The Life of John D. Rockefeller*, Vintage eBooks, chapter 9.

⁶⁹ Id., chapter 8, Rockefeller noted: “Neither the depressions nor the advances were profitable. The depressions gave occasion to the advances; so that the conditions of the depressions had to be offset by the advances. I concede that so far as the oil industry was concerned we were successful in preventing to an extent these extremes so trying and unprofitable.”

⁷⁰ Id.

In addition, in Fig.7 we observe a deep “V” of Rockefeller’s annual profit in 1871. This year was a tough one not only for his rivals but also for himself: Standard’s profit dropped 76.5% because the cost increased 7.9% and the sale price fell 25% – profit was remarkably sensitive to cost and sale price. But that would not be the only thing if we looked at the monthly breakdown in theory. Since $T_1(t)_P = (P_0 S_0 / (S_0 + b_2 t) - C_1) U_1 S_0$, its discrete form should be

$$T_n = \left(\frac{P_0}{1 + \frac{r \cdot n}{12}} - C_1 \right) U_1 S_0, \quad (\text{IV.3.1})$$

where $n \in [1, 2, \dots, 12]$, $P_0 = 9.925$ \$/lb is the initial price (in theory on Dec.1870), $r = [1/(1 - 25\%)] - 1 = 1/3$ is the percentage of new production, $C_1 = 7.49$ \$/lb (average cost of 1871), $U_1 = 1/3$, $S_0 = 67,500$ lbs is the initial monthly production of Cleveland (corresponding to P_0). By the way, we can calculate the expansion rate $b_2 = r S_0 / 12 = 67500 / (3 \cdot 12) = 1875$ bls/m, which was equivalent to building a new refinery of annual output 22,500 bls every month. And the discrete price is

$$P_n = \frac{P_0}{1 + \frac{r \cdot n}{12}}. \quad (\text{IV.3.2})$$

Fig.7

Fig.8.

Hence we get Fig.8, it could be seen that Standard’s monthly profit in theory slumped from about \$50,000 in the beginning to a red one in the end of 1871 though the loss was only about \$1000: $T_{12} \approx \$-1040$ that follows from (IV.3.1). At the same time, the kerosene price touched a low of $P_{12} \approx \$7.44$ by (IV.3.2) – Standard must have been on the brink of loss in late 1871 while its rivals already stuck deeply in the mud. Rockefeller should be so shocked that he lost somewhat confidence and sold off a few shares, the only time in his life.⁷¹ Similarly, in 1872 the kerosene price fluctuated roughly between \$7.4 and \$10.2, which generated a mean price of \$8.82 and gave chances for rivals to reenter the business – so that Rockefeller

⁷¹ Id., chapter 8: “John D. Rockefeller sold off a small block of Standard Oil shares – the only time he ever lost heart momentarily – prompting brother William to lament, ‘Your anxiety to sell makes me feel uneasy.’ This discouragement was short-lived.”

dissolved the Pittsburgh Plan on Jun. 24, 1873: “He was momentarily disheartened by this failure, which again confirmed his preference for outright fusion rather than an unwieldy federation of firms.”⁷²

Did Rockefeller manipulate all of these through slashing the price and then pulling it back? Of course not – the *market* price could not be accomplished unilaterally as our model shows in section B. In fact, the fluctuation of oil market in 1871 and 1872 were pushed by all competitors rather than Standard alone. To some extent, Rockefeller’s monopolization was to save both his and rivals’ businesses at stake as he noted.⁷³ Without such insight, no one could reveal a true story, nor did the antitrust court.

V. Model B of maintaining monopoly

A. Model B of cross-subsidization

In a *local retail* market, suppose one company is maintaining its monopoly position (assume it has 100% shares for simplification) but its dominance is checked by rivals. In such cases, model A does not work because the company can only employ the active price-cutting with capacity expansion and its profit will be less than before since it already takes all shares.

Corollary 5. When Lemma 1 holds with fixed price and cost, price-cutting with capacity expansion reduces profit. For an monopoly market set (P, R, C, Q) with $P = a/Q$ and the percentage of price-cutting v , the previous profit $G = aR$, the following $G' = a(R - v)/(1 - v)$, and $G' < G$. On the other side, markup with capacity contraction enhances profit. For the same market with the percentage of markup u , $u = -v$, $G' = a(R + u)/(1 + u)$, and $G' > G$.

Proof. The previous profit is $G = PQ \cdot R = aR$. Then the following return $R' = [P(1 - v) - C]/P(1 - v) = 1 - (C/P)/(1 - v) = 1 - (1 - R)/(1 - v) = (R - v)/(1 - v)$, and the following profit $G' = aR' = a(R - v)/(1 - v)$. Assume $(R - v)/(1 - v) > R$, then $R - v > (1 - v)R$, $R - v > R - vR$, $-v > -vR$, thus $R > 1$, but it is impossible in our model. Hence we must have $(R - v)/(1 - v) < R$, i.e. $G' < G$. Moreover, since $R' = 1 - (1 - R)/(1 - v)$, thus if v increases then R' decreases, i.e. the more the price-cutting, the less the profit, which makes it an unappealing strategy unless there is recoupment.

Thus the cross-subsidization is inevitable: in terms of antitrust laws, the company charges *monopoly prices* in other markets where it faces no competitors and use *predatory price-cutting* in this market to push rivals out. But an important factor is ignored – the monopolist must shift some supplies from the former to the latter to meet the new demands (assume Lemma 1 holds in both markets), otherwise rivals still can sell out their productions

⁷² Id., chapter 9.

⁷³ Id., chapter 8: “I repeat again... in our efforts most heroic, well meant—and I would almost say, reverently, Godlike—to pull this broken-down industry out of the Slough of Despond [for which] we are charged with criminal proceedings.”

at the previous price as we have showed in chapter III.B. Then we show how it affects the monopolist's overall profit of both markets.

Suppose the company has two independent monopoly markets M and M' , the dominance of M is checked by a rival. The market sets of M and M' are respectively: (P, R, C, Q) , $P = a/Q$; and (P', R', C', Q') , $P' = a'/Q'$. Let the shifted supply be ΔQ , u and v is defined as before. The rival's return is supposed to be lower than R and v . Obviously, the larger the v , the greater the probability that the rival will quit. The discrepancy between C and C' may be due to the transportation and retail costs if they have the same product location. Then the new market price of M' is

$$p' = a'/(Q' - \Delta Q), \quad (\text{V.1})$$

from $C' = P'(1 - R')$ and $P' = a'/Q'$ it follows

$$C' = a'/[Q'(1 - R')], \quad (\text{V.2})$$

the shifted supply $\Delta Q = a/[P(1 - v)] - Q = Q/(1 - v) - Q$, i.e.

$$\Delta Q = [v/(1 - v)]Q. \quad (\text{V.3})$$

Let $w = v/(1 - v)$ and $K = Q'/Q$, K is called *Market Size Ratio*. Then $u = (p' - P')/P' = Q'/(Q' - \Delta Q) - 1 = 1/(Q'/\Delta Q - 1)$, i.e.

$$u = 1/(K/w - 1). \quad (\text{V.4})$$

The overall profit of two markets before price-cutting is

$$A = aR + a'R', \quad (\text{V.5})$$

and from Corollary 5 it follows the overall profit after price-cutting

$$B = a(R - v)/(1 - v) + (p' - C')(Q' - \Delta Q). \quad (\text{V.6.1})$$

And then substituting (V.1), (V.2) and (V.3) into (V.6.1) gives us

$$B = a \cdot \frac{R - v}{1 - v} + a'R' + a'v \cdot \frac{Q}{Q'} \cdot \frac{1 - R'}{1 - v}. \quad (\text{V.6.2})$$

Since $Q = a/P$ and $Q' = a'/P'$, from (V.5) and (V.6.2) we get the difference of two profits

$$D = B - A = av \left(\frac{P'(1 - R')}{P(1 - v)} - \frac{1 - R'}{1 - v} \right). \quad (\text{V.7})$$

From Hypothesis one, it follows that

$$\frac{P'(1-R')}{P(1-v)} - \frac{1-R}{1-v} > 0,$$

which gives $P'(1-R') > P(1-R)$. But the cost $C = P(1-R)$ and $C' = P'(1-R')$, thus we get

$$C' > C. \quad (\text{V.8})$$

Theorem 4 (Cross-Subsidization Theorem). *For two independent monopoly markets M and M' , if the dominance of M is checked by rivals, then the cross-subsidization is possible iff the cost of M' is greater than that of M , i.e. $C' > C$.*

Since $w = v/(1-v) = 1/(1/v - 1)$, equation (V.7) can be rewritten as

$$D = \frac{a}{\left(\frac{1}{v} - 1\right)} \left(\frac{P'}{P} \cdot (1-R') - (1-R) \right),$$

which indicates that the larger the v , the greater the D . Monopolists usually cuts the price to C , i.e. $v = R$, then $w = R/(1-R) = r$ (profit-cost ratio), and let $S = [P'(1-R')]/[P(1-R)] - 1 = C'/C - 1 = (C' - C)/C$ be called *Cost Overflow Rate*, therefore (V.7) becomes

$$D = aRS. \quad (\text{V.9})$$

Now let us check how great gain D would be with case A as $P'/P = 1.1$, $R' = 20\%$, and $R = 25\%$. Then $C'/C = [P'/P] \cdot [(1-R')/(1-R)] \approx 1.173 > 1$, $D = a \cdot 0.25 \cdot (1.173 - 1) \approx a \cdot 4.3\%$, i.e. the return increases 4.3% with respect to market M – not much, since market discrepancy of one company would not be much large. Thus, though D is monotone ascending with respect to v , the monopolist could not cut the price too much in market M because the slash also hike the markup in market M' so that the gain might not compensate the risk that the dominance of market M' would be checked. Thus after the rival was driven out of market M , the monopolist would stop the cross-subsidization immediately to eliminate such risk in market M' .

In (V.4), we observe that markup u is related to market size ratio K . As we have showed, monopolists must try to suppress the markup for reducing the risk in market M' – they usually expect u to be below v , i.e.

$$v > \frac{1}{K \left(\frac{1-v}{v} \right) - 1}.$$

Thus $K > (1+v)/(1-v)$, obviously $K > 1$ since $v > 0$. Let $\kappa = (1+v)/(1-v)$ be called *Critical Size Ratio* (of cost price, if $v = R$), then we have

Size Ratio Rule. *If the monopolist expects markup u of market M' to be below reduction v of market M , i.e. $u < v$, then he must have the size (supply) of M' is larger than that of M and their ratio $K > \kappa$, $\kappa = (1+v)/(1-v)$. When $v = R$, $\kappa_c = (1+R)/(1-R)$.*

For case A, if two markets have the same size, i.e. $K = 1$, then $u|_{K=1} = 50\% > R = 25\%$, which is not reasonable. In fact, according to size ratio rule, $\kappa = (1 + 0.25)/(1 - 0.25) = 5/3$, i.e. $\min(K) \approx 1.67$ in this case. Thus if M' is two times size of M , i.e. $K = 2$, then $u|_{K=2} = 20\% < R$. In addition, for (V.9), let $x = R$, $y = S$, and $z = D/a$ be the percentage of gain, then it is the same hyperbolic paraboloid as W in Theorem 2 (Fig.9). Then the above case is point A (0.250, 0.173, 0.043), and most possible points of market set are nearby, thus gain D is quite small.

Fig.9

Fig.10

B. Case analysis of model B

It is controversial that to what extent Rockefeller got involved in underselling of retail market with the tank-wagon system after 1870s.⁷⁴ But we can investigate a substantial example in an 1886 letter written by colonel Thompson to Rockefeller: “We find the outsiders mainly from Pittsburgh and the Oil Region had 2,000 barrels of oil in Cincinnati...”⁷⁵ Then colonel Thompson told Rockefeller that he “lowered the Cincinnati market an *additional* half cent temporarily... jacked that price up a quarter (in Chicago)”. There are a few remarks:

- 1) In 1876 only one independent refinery remained in Cincinnati.⁷⁶ Ten years later the new competitors were still from Pittsburgh when Standard’s market share was close to 90% at that time – obviously Rockefeller’s dominance was not so firm.
- 2) Italic “*additional*” indicates there were at least two cuts of half cent, we assume 3~4 times, i.e. totally 1.5~2.0 ¢/gl, since colonel Thompson might not learn much about the new competitors and had to test their bottom lines of cost. The average kerosene price in 1885 was 8 ¢/gl,⁷⁷ and we estimate it would be 7¾ ¢ in 1886. Because Chicago ranked the 2nd biggest city in 1890,⁷⁸ we suppose its market price in 1886 was higher than Cincinnati

⁷⁴ Id., chapter 14: “Allan Nevins cited a federal study of predatory pricing that found that Standard Oil practiced it in only 37 of 37,000 towns serviced by its tank wagons and then only in response to cuts by competitors. Yet Rockefeller’s files are so rife with references to this practice as to refute Nevins’s verdict.”

⁷⁵ Id.

⁷⁶ Id., chapter 9: “Of twenty-two Pittsburgh refiners in existence when Rockefeller struck his Saratoga Springs deal (in 1874), only one was still in existence independently two years later.”

⁷⁷ Donald J. Boudreaux & Burton W. Folsom, *Microsoft and Standard Oil: radical lessons for antitrust reform*, The Antitrust Bulletin, Fall 1999, P.559.

⁷⁸ physics.bu.edu/~redner/projects/population/cities

(9th in 1890), say respectively 8 $\frac{1}{8}$ ¢ and 7 $\frac{1}{2}$ ¢. Thus, $P'/P \approx 1.083$, and the reduction $v \approx 20\sim 27\%$, we take the middle $v = 23.5\%$, thus it is similar to case A.

- 3) In Fig.10, we observe that the line distance between Oil Region and Chicago is about 1.5 times of that between Oil Region and Cincinnati in 1886. Thus the transportation fee of Chicago market must be higher than Cincinnati. And as a big city of manufacturing and financial center, the retail cost of Chicago market must be greater than Cincinnati. Hence, the total cost of Chicago market should be greater than Cincinnati, which satisfied the condition of Theorem 4.
- 4) The size of Chicago market was larger than that of Cincinnati because the former population was much larger than the latter in 1886, which meets Size Ratio Rule. According to historical data,⁷⁹ Chicago's population was 503,185 in 1880 and 1,099,850 in 1890, while Cincinnati's one was 255,139 in 1880 and 296,908 in 1890. For 1886, we took the middle ones, respectively 800,000 and 276,000, i.e. $K \approx 2.9$.
- 5) Italic "*temporarily*" implied it was a makeshift as we have argued in section A.

Substituting $v = 23.5\%$ and $K = 2.9$ into (V.4) gives us $u = 1/[2.9(1 - 0.235)/0.235 - 1] \approx 11.8\%$, i.e. $v:u \approx 2:1$, which fits the ratio (half cent/a quarter) in colonel Thompson's letter. Entrepreneurs certainly did not know the model, but they might develop the similar accounting in practice. In general, cross-subsidization is to maintain the monopoly position, i.e. a defending strategy. But during 1880s-1900s Standard had been competing with Nobel Brothers and Rothschilds in European markets and with Royal Dutch and Shell in Asian markets by the mean of subsidizing foreign markets with domestic ones (mainly during Archbold's tenure⁸⁰). Not surprisingly, the rivals were not defeated or acquired eventually, which was due to two factors: 1) they had lower exploitation and transportation costs, and pioneered new technologies.⁸¹ 2) the active strategy put Standard at a distinct disadvantage. Thus Rockefeller found price-cutting an unattractive policy.⁸² But Standard had no choice then – though it tried to purchase rivals' interests, all efforts failed for political reasons⁸³, which was the prelude of today's M&A regulation of antitrust laws. Anyway as Rockefeller defended: "If in doing so they were losing money, which they made up on some of the specialties – they made up the difference – would it be a crime?"⁸⁴, we should ask: why are predatory price-cutting and cross-subsidization illegal?

⁷⁹ Id.

⁸⁰ Ron Chernow, *Titan, The Life of John D. Rockefeller*, Vintage eBooks, chapter 27: "During his Standard Oil tenure, Rockefeller had mollified the public by generally keeping kerosene prices low. But when Archbold took control in the mid-1890s, he kept domestic prices high while depressing foreign prices to diminish overseas competition."

⁸¹ Id., chapter 14: "They pioneered a continuous refining method that was superior to Standard's batch system for sorting out distillates."

"The potent Russian wells flowed with such fierce abundance that it was cheaper to produce oil in Russia than at Titusville, and cut-rate kerosene soon flooded European markets, undercutting Standard's prices."

"Samuel used the Suez Canal to speed the export of Russian kerosene to Asian markets. Oil had taken four months to travel from New York to the Far East but now reached it from Batumi in a month."

⁸² John McGee, *Predatory Price Cutting: The Standard Oil (N.J.) Case*, Journal of Law and Economics, Vol.1. Oct., 1958, P.154, C. T. Collings' testimony.

⁸³ Ron Chernow, *Titan, The Life of John D. Rockefeller*, Vintage eBooks, chapter 14: "We reached a tentative agreement with them... In the end, Count Sergei Witte, the Russian finance minister, spiked the scheme for a grand alliance of Standard Oil with the Nobels and Rothschilds."

⁸⁴ Id.

VI. Conclusion

A. Luo's Law

The antitrust court argues that predatory price-cutting is both the effective weapon to obtain the dominance and maintain it. However, in theory we prove that active price-cutting plays quite different roles in two cases: it is almost impossible for the former, while it applies to the latter but subject to some conditions, i.e. even in cross-subsidization it can not be employed recklessly. And in practice John McGee showed that Rockefeller rarely adopted “predatory” tactics, and if there were any, it had apparently neither discouraged nor ruined the business of rivals⁸⁵ because it was also employed by rivals. However, for the same actions, only Standard was punished, though Theodore Roosevelt often emphasized that antitrust laws aimed not at monopoly itself but the abuse of it – but the legal reasoning implied that bigness was the only target. In fact, Rockefeller preferred to acquire interests or capacity of rivals rather than ruin them – there was a host of such examples, e.g. the case of Red C – in thirty years of competing Standard twice tried to purchase it but failed.⁸⁶

John Archbold ever complained: “It is usually alleged that whenever the Standard, for whatever reason, advances its prices, it is oppressing the consumer, and when if, on the other hand, it lowers its prices, it is then oppressing its competitors.”⁸⁷ It is a paradox since we can say in the opposite way: price-raising is good for competitors and price-cutting is good for consumers, which still works. In addition, when the court claims that monopolists charge the *monopoly price* in one market to recoup another one of *predatory price-cutting*, it implies the previous prices in both markets are normally *competitive* or *market* ones, which is in contradiction to another argument: monopolists always employ monopoly prices to exploit consumers. Antitrust laws were full of such conflicts, e.g., it alleged the rights of free pricing but also granted power to the Interstate Commerce Commission to set railroad rates.⁸⁸

Actually it is in vain to distinguish the monopoly/predator price from the competitive one because in theory all (mean) market prices eventually satisfy the Demand Theorem, and in practice officials possess no first-hand market information as entrepreneurs and consumers, let alone the illusion of justice in their minds – they act as blind guides of economy. Thus there are only competitive prices in the free market, and even in a realistic quasi-monopoly market it still exists potential competition, inside or outside.

Monopoly Law (Luo's Law). *Predatory price-cutting and monopoly price do not exist in the free market since they can not be defined and distinguished.*

The “monopoly” or “predatory” price only exists in *price control* – it should be defined as the price *forced* by a government rather than the price *higher or lower* than the competitive one.

⁸⁵ John McGee, *Predatory Price Cutting: The Standard Oil (N.J.) Case*, Journal of Law and Economics, Vol.1. Oct., 1958, P.146.

⁸⁶ Id., P.154.

⁸⁷ Ron Chernow, *Titan, The Life of John D. Rockefeller*, Vintage eBooks, chapter 14.

⁸⁸ Id., chapter 26: “Identifying railroad discrimination as a major issue, he (Theodore Roosevelt) supported the Hepburn bill, which granted broader power to the Interstate Commerce Commission to set railroad rates and placed interstate pipelines under its domain.”

Judgement of price violation is essentially price control, for example, the Interstate Commerce Act in 1887. Its prohibition of “price discrimination”, e.g. the railroad rate of short-distance should not be higher than that of long-distance, undressed the ignorance and insolence of legislators. Of course, something that does not exist has nothing to do with legitimacy. Thus all monopoly accusations are built on the sand, including such considerations of market structure as “collusion” and “restraint of trade” since price is the essence of market. The antitrust policy is a dragonslayer, but it virtually kills competition and innovation. The innovation refers to the process that entrepreneurs combine technology with business model in a creative way to meet the public consumption, and the prospect of monopoly profit gives major impetus to competition even just for local monopoly – after all no one expects the zero profit in perfect competition. For instance, the trust was an innovation of business model created by Rockefeller. Another example is the private lab – the monopoly supports creative researches, and in turn their achievements serve the dominance.

In 1885 a big oil field was found near a small town Lima in northwst Ohio (Fig.10). Though its oil smells badly because of high sulfur content, Rockefeller believed it would make him a business legend. He hired chemist Herman Frasch to remove sulfur from Lima crude, and at the same time Standard spent millions of dollars to buy Lima facilities and almost every produced barrel (the price fell to as low as 15¢/bl because only Rockefeller bought) – it was impossible for small competitors in perfect competition to take such risks. At Whiting (Fig.10), Rockefeller had the first lab of oil technology in the world built for Frasch. After two years of anxious waiting, Frasch completely solved the problem. The patent brought huge profits to Standard and boosted the status of scientists in the primitive industry. Rockefeller later set up labs in every refinery – just at the lab of Whiting refinery⁸⁹, William M. Burton invented the revolutionary thermal cracking process⁹⁰ and heralded the auto age. Another more well-known private lab is AT&T’s Bell Lab. As the greatest lab in the world and the symbol of American technologies, where is it now? Whether Bell Lab was the victim of AT&T’s divestiture in 1984 is a controversial issue, but AT&T had been a target of the antitrust court for decades long before. We will reveal the story in the next paper. In addition, big companies are major sponsors of universities and public research projects while small enterprises in perfect competition can not afford it as the example of Lima crude shows.

To clarify the role of government in business, we should highlight a fact: the first patent law in the world is the *Statute of Monopolies* enacted by the Parliament of England in 1624. Obviously, patent is one of *monopoly rights* granted by a government. In terms of business, monopoly rights are property rights of real estate, currency, goods, security, patent, copyright, brand etc. Broadly speaking, marriage, name and life safety are monopoly rights as well.

⁸⁹ Id., chapter 16: “...seventeen miles from downtown Chicago... process 36,000 barrels of crude oil daily... The refinery remained a wonder of world oil for many years.”

⁹⁰ Id., chapter 27: “Dr. William M. Burton of Standard Oil of Indiana, thought that Roosevelt and Taft had performed an inestimable service. After the 1911 dismemberment, he said, ‘It was felt all along the line—younger men were given a chance.’ Free of top-heavy bureacracy, Burton patented an exceptionally valuable process in 1913 for “cracking” crude oil...” But in fact, Burton and Robert E. Humphreys, chief chemist of Whiting lab, began to work on this project before 1908. By the end of 1910, they developed a primary process and applied to Indiana Standard for 100 sets of thermal cracking still of 8000 gllons capacity. However, the parent Standard Oil was in a mess of the antitrust case at that time, and rejected them – it was not the old guards at 26 Broadway but the very Roosevelt and Taft stifled their invention.

Except for production, all other economic actions may be defined as the exchange of property rights, in particular that between currency and other properties. For instance, the trading of securities forms the financial market. The government's economic duty should be restricted to determine the *initial* boundary of monopoly rights⁹¹ and maintain the principle of voluntary exchange, or *free trade*, that is, the refrain from *force* and *deception*. But the power is not exclusive to the government, e.g., in old days marriage did not require government approval – weddings were public certifications, similar to today's blockchain. Another example: why is the United States the greatest country? Because Americans can protect their freedom by *private* force, which is a necessary balance of *official* force of government. In fact, monopoly rights come from force, whether it is private or official.

Generally speaking, the word “monopoly” refers to a concentration status of competition. It could be the outcome of right exchanges (including M&A) in the free market, i.e., *natural monopoly* that is in line with “natural laws” of economy; and it also could be acquired by the authorization of government, i.e., *power monopoly* or *privilege*. Almost all early business monopolies were franchised by governments, e.g. the monopoly of salt or a company as Dutch East India Company. Today it has evolved into licensing laws in industries of medicine, food, law, banking etc. But as we have argued, the government could assign an exclusive *right* to some entity, but should not endow with an exclusive *outcome* of competition process. The blocks to entry into these fields act against the principle of free trade, thus it drastically cut supply and drive up the price (American medical business is the best example). That is exactly the consequence of monopoly alleged by the antitrust court, but comes from its own power. The solution is simple: a free market with competitive private certification. Of course it comes into conflict with the interest of privileges, e.g., FDA.

On the other hand, the antitrust court claims it is to protect consumer welfare or overall interest of society. Even without regard to the consumers in monopoly enterprises, this kind of justice is too arbitrary to define in any *economic* sense, except for Pareto improvement. If it relies on Arthur C. Pigou's Welfare economics, it must be against the principle we have showed in chapter II: utility comparison is invalid. In fact, interests of people are always in conflict, e.g., if in 1900s the American government subsidized manufacturers of gasoline vehicles, it would harm the interest of carriage makers – whose interest was more “righteous”? It implied the government should not have any *macro-economic* goals⁹² at all – no one could predict that gasoline vehicles would overwhelm carriage or allege that consumers and small refiners were more important than Rockefeller. Aside from feeding a bunch of lawyers and officials who live on antitrust laws with high taxes, the policy only constantly harass successful entrepreneurs and undermine the free development of society. The legislation of business is not to guard the illusory “justice” or “equality” that may apply to other social goals (e.g., voting rights), but to save the *freedom*.⁹³

⁹¹ “*Initial*” means the government can only determine the right at the starting point, otherwise it will violate the principle of free trade. And it shall not intervene in the results except for maintaining the free process of trade.

⁹² E.g. unemployment rate, benchmark interest rate etc. But public relief to some extent for individuals may be a must as compensation for odd results of the free market, though it is not necessarily exclusive to the government.

⁹³ Milton Friedman, *Poverty and Equality*, a speech (www.TheDailyHatch.com): “A society that puts equality – in the sense of *equality of outcome* – ahead of freedom will end up with neither equality nor freedom.”

Now the fact is clear: the crackdown on natural monopoly is actually suppressing competition, while the promotion of power monopoly plays the same role – the society has been hit twice. Then why are some politicians so interested in antitrust and licensing laws? Are these bad acts with good intentions? Maybe. But two things of vanity fair are also their goals:

- 1) These laws can cash their power even after they leave office, i.e. rent-seeking, that is about *fortune*. For instance, EU's huge fines on Google in the name of protecting the alleged "public privacy" – another example of dragonslayer.
- 2) Whether in democratic or dictatorial governments, there are some public power holders, of course, much more in the latter, who fear private powers.⁹⁴ Shifting people's disaffection of political corruption onto business oligarches kills two birds with one stone: it strikes potential rivals and establishes their own images of "justice", that is about *fame*.

B. Context of the Standard Oil case

To understand the case in 1911, we must trace back to how the Civil War arised, to what extent the government and businessmen "colluded" in the Gilded Age, and why Theodore Roosevelt aimed at business giants. All of these lay in the same economic factor: *tariff*.

In 1793, Eli Whitney invented a model gin for short-staple cotton growing inland.⁹⁵ The machine changed the South forever – both the southern economy and slavery revived. By the middle of the 19th century, cotton become the only bulk export of the United States and made the South richer than the North, while the population of black slaves in plantation increased to about 4,000,000. But at that time, most American whites did not have actual concern about Blacks' rights, nor did most politicians.⁹⁶ The abolition of slavery was a stopgap to win the war,⁹⁷ and played a role of camouflage with the slogan of unity to cover up the real cause of the war: southern plantation owners was demanding low tariffs for boosting the export of cotton and the import of European industrial products with lower price and higher quality than the North, while northern businessmen and officals was expecting to protect their young industries by high tariffs – the interest conflict became irreconcilable after Abraham Lincoln came to power in 1861. In 1860, the average tariff rate and the dutiable rate were respectively about 15% and 19%; on May 1860, Morrill Tariff Act was passed by the house of Representatives, which enhanced the dutiable rate to 37.5% and enlarged the scope of dutiable imports; on Mar. 1861, two days before Lincoln's presidential inauguration, the act was passed by the Senate; in the middle of Lincoln's tenure, the dutiable rate soared to 48.3%, and such high tariffs roughly remained untill the federal income tax started to be imposed in 1913.⁹⁸ (Fig.11) Before the Civil War, the South paid about 80% tariffs and got much less

⁹⁴ Eleanor E. Fox, *The Symbiosis of Democracy and Markets*, DAF/COMP/GF(2017)5, P.4: "On April 29, 1938, President Franklin D. Roosevelt gave a 'message to Congress on curbing monopolies,' saying: 'The first truth is that the liberty of a democracy is not safe if the people tolerate the growth of private power to a point where it becomes stronger than their democratic state itself.'"

⁹⁵ The variety is called Upland cotton. In contrast, Sea Island cottone has long-staple lint that could be easily separated from seed by roller gin, but it can only grow on the coast.

⁹⁶ Many (would-be) politicians were slave holders, e.g. General Ulysses S. Grant, Justice John M. Harlan etc.

⁹⁷ A striking evidence was the status of black people has almost not improved in any way after the war.

⁹⁸ Frank W. Taussig, *The Tariff History of the United States*, Fifth Edition, G.P. Putnam's Sons New York and London and Knickerbocker Press, 1910.

financial expenditures in return while tariff was the major income of the government: high tariffs tightly bundled northern industrialists and politicians together – economy is the essence of politics and war is the continuation of politics.

Fig.11

By the way, Whitney did not earn one penny from his invention because southern state governments favored those patent infringers. He then turned to the arms industry and became the godfather of the machine age – his idea of manufacturing nearly identical parts put hundreds of thousands of rifles in the hands of Civil War soldiers.⁹⁹

Rockefeller did make his first fortune from the war. First, the Union employed blockade policy to strangle the Confederacy's food and material supplies, which made prices of agricultural products soar during the war while Rockefeller's first company did the very business at that time.¹⁰⁰ Second, in 1863 Rockefeller began to invest in the rising oil industry, and when Rockefeller, Andrews and Flagler company was established in 1867, its one third of capitals (\$100,000) came from a Flagler's relative Stephen V. Harkness whose history of success was worth mentioning: "Harkness had capitalized on inside political information to make a fortune during the war. As an ally of U.S. senator *John Sherman* of Ohio, he had received timely word in 1862 of an upcoming government move to levy a two-dollar tax on every gallon of malt and distilled liquor. Before the tax took effect, he busily stockpiled wine and whiskey and even raided the deposits of a local bank he owned to pour more money into

⁹⁹ Harold Evans, *They Made America: from the steam engine to the search engine, Two Centuries of Innovators*, First eBook Edition, February 2009, Part I: Eli Whitney.

¹⁰⁰ Ron Chernow, *Titan, The Life of John D. Rockefeller*, Vintage eBooks, chapter 4: "Rockefeller's need for money only grew during the Civil War, which was a bonanza for the commodity business. As a partner in a Cleveland produce house, John D. Rockefeller was strategically positioned to profit from the war...The war enhanced Cleveland's strategic importance for a simple logistical reason: As North-South fighting severed freight routes on the Mississippi River, the east-west routes through the rivers and Great Lakes gained a corresponding amount of traffic. Though Rockefeller and his associates secured no lucrative government contracts, they profited from the enormous inflation in commodity prices and the general business surge. Selling mostly on commission, they dealt in numerous foodstuffs and farm implements. By 1862, their annual profits had soared to \$17,000, or almost four times what they had earned during their only prewar year."

this operation. When the tax was enacted in July 1862, he sold his enormous cache of spirits for a fast \$300,000 profit.”¹⁰¹ Ironically, John Sherman was the very proposer of Sherman Antitrust Act, and also the brother of “butcher” general William T. Sherman in the Civil War. He even received Standard’s campaign contribution in 1885.¹⁰² Actually, those politicians who benefited from power monopoly were the most active ones who promoted antitrust laws.

After nepotistical General Grant became president in 1869, the government began to get heavily involved in the economy: land grants, railway franchises, bank charters, everything had its price – hotels in Washington were crammed with businessmen toting cash suitcases. Grant himself was not completely free from corruption as popular perception – contrarily, he and his extravagant wife enjoyed “expensive gifts” from businessmen. Grant died in abject poverty only because he was not good at finances and had a fatbrained son. During his “darkest” eight-year tenure, a host of officials and businessmen was involved in corruption and scandal. One of them was Wall Street tycoon Jay Cooke, an old friend of Grant – on Sep.18, 1873, the bond problem of the Northern Pacific Railway led to the insolvency of Jay Cooke & Associate, which triggered a run on banks. Since many banks were lack of cashes because they financed the Republic heavily, it ended in Black Thursday and more than 5,000 banks went broke in one month, which followed a six-year recession (also see chapter IV.C). As Mark Twain commented: “There is a Congressman – I mean a son of a bitch – But why do I repeat myself?”,¹⁰³ politicians then were eager to cash their power obtained in the war.

In the late 1870s, Standard started to shift its railroad transportation onto pipeline, then independent crude producers replied. At first, they tried to run a line from Oil Creek to Baltimore. But J. N. Camden quickly “bought an exclusive pipeline charter in the Maryland legislature that carried an ironclad guarantee that no other company would receive a charter that session.”, the cost was about \$40,000.¹⁰⁴ Then Tidewater Pipe Line Company opted for another line passing New York state, and Flagler coordinated with the Erie Railroad to stifle a free-pipe bill in the New York state parliament, because payoffs were so expensive that even Standard Oil needed rich partners to ease the burden. At the same time, A. N. Cole, a New York state senator, wrote to Rockefeller and “presented himself as an ‘attorney’ to be hired by Standard Oil to manage the campaign against the free-pipe bill: ...Government bonds are better to deal in than money, since, were ‘attorneys’ to be paid in cash, it might be construed into corruption...”¹⁰⁵ Standard also brought strips of land (“dead lines”) to prevent the pipeline, but eventually it failed. However, within a year of its completion it was merged into a railroad pool supervised by John D. Rockefeller.

Another case was street gaslight. From 1880s, Standard began to explore the market of natural gas. Because major customers were municipalities, corruptions were rampant in the business. In Detroit, Standard Oil sent an emissary with cashes and gas stocks to try for

¹⁰¹ Id., chapter 6.

¹⁰² Id., chapter 16: “In August 1885, soliciting a campaign contribution for Sherman, Mark Hanna had told Rockefeller that ‘John Sherman is today our main dependence in the Senate for the protection of our business interests.’ Dubious at first, Rockefeller finally sent a check for six hundred dollars.”

¹⁰³ Id., chapter 12.

¹⁰⁴ Id.

¹⁰⁵ Id.

franchise.¹⁰⁶ In 1886, Daniel O'Day told Rockefeller that he found all Republican local politicians of Philadelphia are stockholders of the rival Columbia Natural Gas Company.¹⁰⁷ A more astonished story occurred in Toledo, Ohio, where Standard manipulated the bid for a gas franchise since its former governor, Charles Foster, was an old childhood friend of Flagler and a recipient of Standard's campaign contribution. In 1888, Foster wrote to Rockefeller to demand his payoff: "is that you send me a cheque for this amount... I have refused to ask you or your people for contributions for several years past. In this case I did it because I know that you feel an interest with us, and for the further reason that I thought it would be helpful in warding off the blows made at you, and at our Gas Co."¹⁰⁸ In 1890, a bill of Maryland legislature (Baltimore) called for an annual payment to the city from the Consolidated [Gas Company] of \$10,000 a year and 3 percent of all dividends declared in return for the privilege of enjoying a 25-year monopoly.¹⁰⁹ (Fig.10) Obviously, bidding with unfixed management rights is a better solution to public projects though it can not eliminate corruption completely.

In these cases, businessmen had to solicit the authorization of government if it employed power monopoly, otherwise they would not be able to compete with those who had franchises. It was not collusion of two sides because *one without force was forced*. Rockefeller might not be a redeemer of consumers as he claimed to be, nor did the government – it is monopoly and can not eliminate monopoly. The monopolization of power must lead to the monopolization of economy, but not vice versa.

The industrialization in the Gilded Age led to many economic and social problems such as poverty, pollution, violence, racism, class warfare etc. Though these problems were mainly due to political corruption¹¹⁰, it was easier to condemn the evils of corporate "greed", as the *World* attacked against the trust in 1887: "When the 19th century shall have passed into history, the impartial eyes of the reviewers will be amazed to find that the U.S., supposed to be conservative of human liberty and human right, tolerated the presence of the most gigantic, the most cruel, impudent, pitiless and grasping monopoly that ever fastened itself upon a country."¹¹¹ Only when the Progressive movement had withered away, some journalists dug up the root of dark sides, one of them was Lincoln Steffens. After he became disillusioned with communism, Steffens pointed out in his *Autobiography* (1931): "It is privilege that causes evil in the world, not wickedness, and not men... Power is what men seek, and any group that gets it will abuse it. It is the same story." But in the early 1900s he did charge the

¹⁰⁶ Id., chapter 14: "In securing the Detroit franchise, Standard Oil furnished an emissary, G. A. Shelby, with \$15,000 in cash and \$10,000 in gas stock to sway politicians. When payment came tardily, Shelby groused to Rockefeller: 'Will you guarantee the amount stated if Ordinance passes and is approved by the Mayor. . . . I have been to considerable expense and want to be sure of prompt settlement when work is completed.'"

¹⁰⁷ Id.

¹⁰⁸ Id., "In July 1886, O'Day reported to Flagler that the ex-governor had agreed to merge his Fostoria Illuminating Gas Company with the Standard's Toledo gas start-up to form the Northwestern Ohio Natural Gas Company. O'Day relayed the secret terms of this arrangement: 'That Gov. Foster be President of the Co. But that we would have full control of management.' Toledo citizens were delighted when the Eastern Ohio Natural Gas Company decided to vie with Northwestern for a gas franchise; in a compromise settlement, both companies received franchises. Then it surfaced that both rival companies were controlled by Standard Oil..."

¹⁰⁹ George T. Brown, *The Gas Light Company of Baltimore: A Study of Natural Monopoly*, Johns Hopkins University Press, 1936, p.75.

¹¹⁰ E.g., in the case of CFI in 1913 (chapter II), Bowers would dare not use force against striking workers without the authorization of county sheriffs. It is the same reason that capitalists dare oppress workers.

¹¹¹ Ron Chernow, *Titan, The Life of John D. Rockefeller*, Vintage eBooks, chapter 16.

problems upon businessmen: “In all cities, the better classes – the business men – are the sources of corruption, but they are so rarely pursued and caught that we do not fully realize whence the trouble comes.”¹¹² And he appealed to moralism and a “good” government to solve problems.

Though he continued to be involved in leftist activism, Steffens later touched the point as Ronald Reagan noted: “government is not the solution to our problem, government is the problem.”¹¹³ But power holders as Theodore Roosevelt knew the problem from the very beginning. Thus after Steffens debated with Roosevelt at the White House and then exposed the corruptions of government officials,¹¹⁴ Roosevelt was enraged and soon after denounced investigative reporters as *muckrakers* in a speech on Apr. 14, 1906¹¹⁵ – he must have realized the urgency of suppressing and diverting the fire despite he supported the movement in its incipency. On May 2, Roosevelt made Bureau of Corporations’ report on the oil trust public, to push through the Hepburn bill. It highlighted Standard’s collusion in secret rates and price discrimination with the railroads.¹¹⁶

In fact, Roosevelt started attacking businessmen long before that. As a New York state congressman in 1883, he rebuked Jay Gould as “the wealthy criminal class”¹¹⁷ – the first rhetorical blast bundling richness and crime together. Though Standard and other businessmen contributed to his New York mayor and governor campaigns, Roosevelt soon turned against them by enacting a tax on corporate franchises and supporting factory regulation, whereupon New York businessmen eased him out of the governorship and into the vice presidential slot on the McKinley ticket in 1900.¹¹⁸ Roosevelt always believed that Standard got involved in the conspiracy, but as a blessing in disguise he became the president after McKinley was assassinated in 1901. Another matter of resentment was the Bureau of Corporations that Roosevelt promoted in 1903, because he revealed to the press the telegrams that six senators received from Rockefeller (actually junior Rockefeller) urging defeat of the plan. In addition, Roosevelt repeatedly abused business tycoons as “malefactors of great wealth”, “the speculative folly and flagrant dishonesty of a few great men of wealth” – in his eyes, rich men were equivalent to criminals. Roosevelt’s hostility to Rockefeller and other industry giants was largely personal and he did use the presidency to interfere in the judicial. An evident instance was the Indiana Standard case in 1907: “When Teddy Roosevelt and his attorney general heard that Landis (Kenesaw M. Landis) wanted to haul Rockefeller into court, they were greatly dismayed, for if Rockefeller testified in the Chicago case, he might

¹¹² Lincoln Steffens, *The Shame of the Cities*, McClure, Phillips & Co., 1904, P.40.

¹¹³ We do not completely agree with the argument literally, because government is the necessity of social development as we argue in the next section.

¹¹⁴ Steffens had been working on police corruption in New York during 1892-1901. He later set up a board of police commissioners headed by Theodore Roosevelt, the New York police chief then, they became friends.

¹¹⁵ Ron Chernow, *Titan, The Life of John D. Rockefeller*, Vintage eBooks, chapter 26: “In March 1906, Teddy Roosevelt delivered his famous speech at Washington’s Gridiron Club in which he borrowed a term from Pilgrim’s Progress and denounced the new investigative reporters as muckrakers who kept their eyes fixed on lowly matters instead of occasionally lifting them up to heaven. The muckrakers were now on the wane, but the trustbusters were not.” The speech date of another source is Apr. 14, 1906.

¹¹⁶ Id.

¹¹⁷ Id., chapter 22.

¹¹⁸ Id.

win an ‘immunity bath’ from possible criminal prosecution in the more important federal antitrust suit. They sent an emissary to Chicago to plead with Landis.”¹¹⁹

In 1908, a federal appeals court revoked the Landis fine, and in a retrial Standard was found not guilty. Roosevelt replied that the decision had “hurt the cause of civilization” – Teddy did believe he was the representative of civilization. However, he forgot Roma was not built in a day, and not by a person, just as Rockefeller’s statement on the Landis fine noted: “A great injustice has been done the company. It was from ignorance on how the great business was founded. For all these years no one has known and no one seems to have cared how it came into existence.”¹²⁰ The civilization was formed not only by rulers (if they did not hurt), but also through more hands of civilians, including businessmen. At the end of 1909, a federal circuit court ruled that Standard and thirty-seven affiliates had violated the Sherman Antitrust Act. Roosevelt claimed the verdict was “one of the most signal triumphs for decency which has been won in our country.”¹²¹ But his elation did not last too long. After Standard was finally dismantled by the Supreme Court in 1911, the new companies were listed on NYSE and their prices soared, Rockefeller became the richest man in the world – the market was not yet the vassal of Teddy Roosevelt. When J. P. Morgan heard of the 1911 verdict, he asked: “How the hell is any court going to compel a man to compete with himself?”¹²² Of course not. The market has its own “natural laws” that often goes against intuition, and politicians are good at manipulating people’s intuition in the name of justice or equality. Thus as the conclusion, it is necessary to give the legislation principle of restricting political power.

C. Luo’s Principle

Legislation Principle (Luo’s Principle). *Lawmaking is subject to the criteria of equity and efficiency: first, for any act and clause, it must exist its explicit definition of value, right, or boundary etc.; second, its enforcement of government must be more efficient than that of individual or civil organization. The equity criterion is a prerequisite to the efficiency one.*¹²³

For examples, 1) Because of Luo’s Law, the antitrust policy shall be rejected since it does not meet the equity criterion. 2) Gambling probably impairs oneself and others, but it is also an entertainment – the boundary between them is hard to define. Therefore it is not necessary to legislate against gambling, so does alcohol – think about the Volstead Act, at first in order to realize the Puritans’ abstinence ideal, but ended up with the rise of gangs, corruption and deterioration of public order. In contrast, drug seriously poisons oneself and society, its harm can be clearly determined and the government does employ more powerful punishments, hence drug control is a must.¹²⁴ 3) In general, the government act more effectively on

¹¹⁹ Id., chapter 27.

¹²⁰ Id.

¹²¹ Id.

¹²² Id.

¹²³ It applies not only to economic laws – it is *the law of laws*. For example, Donald Trump abused the press as rumormonger, but it is impossible to define what is rumor since an incident or a figure could be described by numerous facets and means. No one can monopolize the truth: when only the official sound is heard, it must be a lie; and people has the rights to “rumor”, i.e., freedom of speech, only above it the truth rises.

¹²⁴ By the way, the drug problem was an indirect consequence of Prohibition – gangs found it as a more profitable substitution for alcohol since they predicted the act of Prohibition would be repealed.

notarizing and protecting patents that are easy to copy, which applies to most important inventions, e.g., Whitney's cotton gin. Contrary to Austrian School's perspective, patent laws do promote inventions when they are implemented rigorously.

Government is the necessity of social development to a certain extent, just as monopoly must appear with economies of scale. It is a social contract that people give up some private force to get more effective protection of rights in return – government *may* promote the efficiency of market economy, though market can exist without it. Government is an organic part of market rather than an opposite of market as some Austrian economists argue. However, with official force, the government may impose policies by manipulating the public opinion, congress and court as we have showed in the case of Standard, and seriously violates human rights even in a democratic form, i.e. tyranny of the majority – it is a double-edged sword, so does private force, but the former is much sharper than the latter on both edges. What makes the matter worse is that individuals are hard to retreat from it, although among kinds of freedoms, the right to withdraw from social contracts is the first of all. For the example of the Civil War, the industrialization would boost the overall development of society,¹²⁵ i.e., Pareto improvement, as Alexander Hamilton argued in his prescient report in 1791 that America's destiny lay in encouraging domestic manufacturers with high tariffs.¹²⁶ But the assumption of "high tariffs" was arbitrary – there were many counter examples in modern history,¹²⁷ thus it did not meet the efficiency criterion. In fact, the American industrialization in the 19th century benefited greatly from the free market system¹²⁸ and American creative spirit (immigrants and their descendants are innovative) rather than tariffs, especially in the rising businesses, such as oil and steel¹²⁹ – again, the truth went against our intuition. Washington and Jefferson's objections to Hamilton's project was not out of their short sight as southerners, but what they were worried about was government's arbitrary intervention, that would come into conflict with the founding principle of the United States: sufficient freedom with a small government. Their fears came true, and Abraham Lincoln even went much far – declared a bloody war to prevent the South's independence, which was in breach of the constitution:

Amendment 10. *The powers not delegated to the United States by the Consitution, nor prohibited by it to the States, are reserved to the States respectively, or to the people.*

¹²⁵ E.g., after the Homestead Act was enacted in 1862, mechanization and fertilizer of the northern industries were employed widely in western land, and its grain yield was the key factor for the North to win.

¹²⁶ Harold Evans, *They Made America: from the steam engine to the search engine, Two Centuries of Innovators*, First eBook Edition, February 2009, prelude: America's Genius for Innovation.

¹²⁷ E.g. in the late 19th century, Germany made the industrialization almost without trade protection (only imposed protective tariffs on British textiles); in the early 20th centur, Argentina failed with the protection of high tariffs.

¹²⁸ Id. as 125: "Three legal innovations provided a sympathetic framework: the Supreme Court ruling liberating interstate commerce, the federal patent law and the invention of the corporation to limit liability and facilitate the raising of capital for projects."

¹²⁹ E.g., unlike those conservative competitors under the protection of high tariffs, Andrew Carnegie tried his best to cut costs by employing the revolutionary Bessemer process, enhancing the level of mechanization, and investing most profits into reproduction for the economy of scale. It was not trade protection but Carnegie and his engineers who contributed to the rise of American steel industry, and he also released consumers from high prices as the consequence of high tariffs. But since 1960s, American steel industry has declined because the protections of high tariffs and labour rights led to the lacks of impetus and profit to invest in new technologies and reproduction. In fact, only the free development of production can secure labour rights, while governmental protection is just the opposite to what it wishes – since the factory goes bankrupt with all workers unemployed, *nothing could be protected*. In contrast, American special steel companies work well because of high-technology shresholds. Without the awareness of the key problem, Donald Trump's tariff policy must fail again.

Of course states would have the rights to separate from the Union if they could be united – war in the name of unity is true treason – politicians are good at playing with words. Even without regard to the largest casualties and property losses in the American history, the Civil War remained various social problems and still tore America apart today. Or worse, it opened the door for Theodore Roosevelt’s jeopardous nationalism of massive government, e.g., the powerful IRS in 1862 and National Bank Act in 1863 to raise money for huge military outlays. It is inappropriate to attribute the future prosperity of America to the war – a time correlation did not necessarily mean a causal correlation. The Civil War might accelerate the industrialization, but at a high cost. In fact, only government can wage destructive wars, e.g., the two World Wars. As a necessary evil, government can not be fully trusted, even as a democratic form – think about Hitler’s Third Reich. Only the public power, rather than the private capital, may “enslave” people in the name of liberating them from alleged “enemies”,¹³⁰ even if it wears no crown of king.¹³¹

And we should always be alert to such left-wing arguments: “The man who wrongly holds that every human right is secondary to his profit must now give way to the advance of human welfare, who rightly maintains that every man holds his property subject to the general right of the community to regulate its use to whatever degree the public welfare may require it.”¹³² – there is no “*general*” right, only *individual* right. Not the forced “equality” but the spirit of *freedom* made America, and made it great.

As the example of Sherman Antitrust Act, almost all business acts were proposed by lawyer politicians. Despite their initial intentions, the lack of ideas of economics in these laws are still threats against the society today. We do need a brand new economics to determine the boundary of government’s function as clearly as possible according to Luo’s Principle. In theory, it shall develop non-equilibrium models to test the equity criterion; in practice, a free market is a must to try any private solutions while public ones, e.g. lawmaking, are the last choices. As a complicated process, democracy lies in a combination of religion, history, culture, technology, economy... and ideas of economics, the essence of human action that shall play a pivotal role. To approach the sympathy between democracy and markets, i.e. *autonomy*, economics is supposed to be a light of tower, rather than a stick of power.

¹³⁰ John M. Harlan, *Standard Oil Co. v. United States*, 221 US 1, 83-84(1911): “All who recall the condition of the country in 1890 will remember that there was everywhere, among the people generally, a deep feeling of unrest. The nation had been rid of human slavery, but the conviction was universal that the country was in real danger from another kind of slavery sought to be fastened on the American people, namely, the slavery that would result from aggregations of capital in the hands of a few individuals and corporations controlling, for their own profit and advantage exclusively, the entire business of the country, including the production and sale of the necessities of life. Such a danger was thought to be then imminent, and all felt that it must be met firmly and by such statutory regulations as would adequately protect the people against oppression and wrong.” Harlan was a justice of the Supreme Court (1877-1911).

¹³¹ Eleanor E. Fox, *The Symbiosis of Democracy and Markets*, DAF/COMP/GF(2017)5, P.3: “John Sherman said to the US Congress in 1890: ‘If we will not endure a king as a political power, we should not endure a king over the production, transportation, and sale of any of the necessities of life. If we would not submit to an emperor, we should not submit to an autocrat of trade.’”

¹³² Theodore Roosevelt, *The New Nationalism*, Aug.31, 1910 (www.presidentialrhetoric.com). In this speech, Roosevelt called for a generous minimum wage, a progressive income tax, and an estate tax in the name of equality. Not surprisingly, he also supported limit immigration, and eugenism – subsidies for white Americans to have more children and sterilizing the poor and mentally handicapped. However, equality is a framework rather than that of outcome – the efforts to remove inequalities (of outcome) must create new inequalities, actually, more evils.