The Symmetry Assumption in Transaction Costs Approach
And
Symmetry Breaking in Evolutionary Thermodynamics of Division of Labor

Ping Chen

China Center for Economic Research at Peking University in Beijing, China
pchen@ccer.edu.cn
http://pchen.ccer.edu.cn/

And

Center for Political Economy at Fudan University in Shanghai, China

Draft: June 30, 2007

Abstract

Coase raised fundamental questions on the firm nature and market solution for social conflicts. However, confusion was around the symmetric intonation of transaction costs, the ill-formulated Coase Theorem, and the false analogy in physics. Fundamental issues in the transaction costs approach can be elaborated by the symmetry assumption in equilibrium economics and symmetry breaking in evolutionary dynamics. The Coasian belief of decreasing transaction costs by market competition is against historical experiences of the division of labor and basic law in thermodynamics. The creative nature of the firm and selective role of institution can be understood by Maxwell's demon of living boundaries and increasing complexity in industrial economy.

Key Words: transaction costs, Coase Theorem, symmetry principle, symmetry breaking, evolutionary thermodynamics

I. Introduction:

Inspiration and confusion surround the concept of transaction costs. Under the term "Coase theorem" in the Palgrave Dictionary of Economics and Law, the article began with a startling question (De Meza 1998):

> "Is this statement (Coase Theorem) profound, trivial, a tautology, false, revolutionary, wicked? Each of these has been claimed."

There are three sources of confusion concerning the Coase theory. First, Coase himself never gave a clear definition of transaction costs and a rigorous statement of the Coase theorem. Therefore, different interpretations generated conflicting implications. Second, Coase made a false analogy between the Coasian world of zero transaction costs and the physics world without friction. Third, Coase claimed that his approach was

1

nothing new, but a simple application of price theory. Cheung found a fundamental flaw in Stigler's formulation of the Coase theorem, and reformulated it in terms of the symmetry assumption between consumption and investment (Cheung 1998). Cheung's work helps us to rethink hidden symmetry assumptions in equilibrium economics (the narrow interpretation of neoclassical economics), which excludes non-convexity, instability, and diversity.

We will first examine different versions of the Coase Theorem; then discuss the symmetry principle and symmetry breaking in physics, biology and economics, and the fundamental differences between equilibrium and evolutionary perspectives. We will show that the Coasian belief of decreasing transaction costs by market competition is against historical experiences of division of labor and basic law in thermodynamics. The creative nature of the firm and selective role of institution can be understood by Maxwell's demon in living boundaries and increasing complexity in industrial economy. Finally, we will explore the creative nature of the firm and the selective role of institution from an alternative approach to evolutionary dynamics.

1. The Coase Theorem and the Symmetry Assumption in Equilibrium Economics

Different formulation of basic ideas may be a bridge to new thinking. Physicists did not realize Newton's hidden assumption on absolute time and space until Einstein reformulated mechanics in the form of relativity theory. The basic message from the symmetry principle in mechanics is the existence of equilibrium order, which is described by stability in dynamical systems. The fundamental idea of symmetry breaking in thermodynamics is a time arrow or history in living order that is the origin of diversity in nature and society.

Many controversies around the Coase Theorem are rooted in the Coasian world with zero transaction costs that conflict with basic laws in physics and basic concepts in economics. We will reexamine the Coase approach and his cases by symmetry analysis.

1.1. Controversies on the Ill-formulated Coase Theorem

There are two versions of the Coase Theorem. The first version was made by Stigler in 1966 but Coase accepted it with a strong reservation (Coase 1988a p.174-175).

"Stigler dubbed the 'Coase Theorem': '… under perfect competition private and social costs will be equal.' … it would seem that the qualifying phrase 'under perfect competition' can be omitted"

A similar version was given by Cooter: "The initial allocation of legal entitlements does not matter from an efficiency perspective so long as they can be exchanged in a perfectly competitive market" (Cooter 1987).

Coase preferred to replace the textbook condition of perfect competition with his trade mark of zero transaction costs (Coase 1960, p.104, Coase 1988a, p.14):

"… the ultimate result (which maximizes the value of production) is independent of the legal system if the pricing system is assumed to work without cost."

For better understand the original idea of the Coase Theorem, we reformulate it in terms of the modified Cooter version that social conflicts can be solved by bilateral exchange, since its economic efficiency is independent of institution and regulation in the (Coasian) world with little transaction costs.

However, this idea was criticized by Samuelson, because of an "insoluble bilateral monopoly problem with all its indeterminacies and non-optimalities" (Coase 1988a p.159, Samuelson 1995).

Coase defended his position with three arguments. First, he tried to disarm his critic by claiming in the opening statement his Nobel lecture that "I have made no innovations in high theory" (Coase 1992). It reminds us that any flaw in Coase theory should be traced back to the very foundation of equilibrium economics. Second, he took the Friedman argument for an efficient currency market by asserting that non-negotiators "have little survival value" in reality (Friedman 1953, Coase 1988a, p. 161-162).

So far the debate focused on the empirical issue on whether the Coasian world with zero-transaction costs made any sense in the real world. Many economists and legal scholars considered transaction costs were high in the real world, therefore institution and regulation did matter (Cooter 1987). However, Coase insisted that "transaction costs are not significantly affected by the change in the legal position regarding liability, which will commonly be the case," so that he had serious doubt to any regulation including antitrust law, environment regulation and legislature on commercial bribery (Coase 2004, 1979). We will start with theoretical problems in the Coasian world, and then study his empirical cases.

1.2. Impossibility of the Coasian World in Physics

When Coase first came to Chicago, he tried to change the research direction in industrial organization without a success. In his own words (Kitch 1983):

> "When I first came to Chicago, in the industrial organization shop, people used to talk about monopoly and concentration. … and I used to say then that monopolizing was a competitive industry… But as no one ever listened, I gave up saying it."…. (Then he changed his marketing strategy. His social cost paper got immediate attention by using a title he did not like: "social cost" used by Frank Knight.)
> "I don't think the concept of social cost is a very useful one, and I don't refer to it. But it did indicate to people what I was talking about."

This is a good example that marketing strategy is aimed to catch a larger market share but is done by increasing transaction costs (i.e. using the misleading title of "social cost" but real meaning is "private cost" instead).

This time, the Coasian world of zero transaction costs became a magical argument against government regulation by using a physics analogy (Coase 1988a, p.14):

> "A world without transaction costs has very peculiar properties. As Stigler has said of the 'Coase Theorem': 'The world of zero transaction costs turns out to be as strange as the physical world would be without friction. Monopolies would be compensated to act like competitors, and the insurance companies would not

exist.' "(Stigler 1972, Coase 1988a, p.14). "In the absence of transaction costs, there is no economic basis for the existence of the firm. ..... the assumption of private property rights can be dropped.... it costs nothing to speed them up, so that eternity can be experienced in a split of second." (Coase 1988a, p.2, p.14-15).

As trained as a physicist, can we accept that the Coasian world is a good abstract for relevant reality? The answer is NO. It is absolutely a bad abstraction, since it violates basic laws in physics. Specifically, Coase made four grand errors in physics:

First, an inertial world without friction is not a "strange world" but a good approximation of physical movements in space, which has been confirmed by accurate prediction of planet motion and repeated success of launching artificial satellites. Later we will see that the Coase theorem often makes conflicting policy suggestions without clear analytical power.

Second, zero information cost could not happen in a physical world. According to the uncertainty principle in quantum mechanics, any transmission of information must consume some minimum amount of energy (Brillouin 1962). So-called perfect information in economic models only implies a chess-like game with rigid rules and finite choices. It has nothing to do with marketing war in business, which is filled with false information and misleading image.

Third, there is no possibility of infinite speed even without friction, since the theory of relativity sets the light as the speed limit. Therefore, the static model of demand and supply curve is not capable of explaining macro dynamics including business cycles and financial crisis.

Forth, the nature of transaction costs is useless high entropy waste such as heat and CO_2 while the nature of production cost is useful low entropy materials such as raw material and electricity (Ayres 1998). An organization or institution with zero transaction costs implies a heat engine without release any wasted energy in the form of heat dissipation. This engine cannot be made since it violates the second law of thermodynamics.

In short, Coase even failed to understand elementary physics. The Coasian world cannot serve as a theoretical argument for the Coase Theorem.

1.3. Confusing Economics of the Coase Theorem

Let us assume that Coase could drop the false analogy in physics but still maintain his popularity among economists. Can we get economic insight from the Coase Theorem in decision making?

We may first examine the issue of the Coase conjecture that a durable goods monopolist would adopt a marginal pricing (Coase 1972). Like his 1960 paper on social costs, it triggers a new round of controversy without a clear conclusion (Fehr and Kühn 1995). Coase himself may realize that it contradicts his earlier finding that marginal pricing was difficult to work even for public utility, since he excluded his 1972 paper from his 1988 collection (Coase 1972, 1946, 1988a). There is a remarkable divergence between single equilibrium picture based on demand-supply approach and multiple equilibriums in game theory. Both approaches are based on representative agent models. So far, economists have not develop a working approach similar to statistical mechanics

and molecule kinetics, which can answer the question how interacting particles can reach an equilibrium level of speed or temperature without the need of a homogenous group.

When Coase accepted Cheung's definition of transaction costs as institution cost, Coase did not realize that Stigler (and himself) and Cheung had conflicting interpretations of competitive price.

For Cheung, if transaction cost is zero, monopolies would have perfect information of consumer's preferences, so that they could exercise perfect price discrimination (Cheung 2007).

It is known that the concept of competitive equilibrium is based on arbitrage free opportunities, which in turn implies linear pricing (Ross 1976). Perfect price discrimination is nonlinear pricing or different price for different people. It rules one price law in perfect competition, which is the core of market fairness by property right school and self-corrected stability in equilibrium economics (Alchian 1987).

Therefore, the Coasian world is not a consistent theory in economics too. We have to find a new perspective in studying the transaction costs approach.

1.4. Cheung's Reformulation Based on the Symmetry Assumption

To save the Coase idea of transaction costs, a symmetry assumption was proposed to reformulate the Coase Theorem (Cheung 1998):

> "The transaction costs paradigm in which I was brought up – and here I am sure Coase fully shares my view – has the merit that it entails only the simplest of economic tools. In fact, this paradigm contains no new theory whatsoever to speak of.
>
> Only three fundamental propositions are present in the (transaction costs) paradigm. First is the postulate of constrained maximization. Second is the downward sloping demand curve, which (because there is no need to separate consumption and investment activities) also covers diminishing marginal productivity. Third is the notion that cost is the highest-valued option foregone."

Originally, Coase only proposed one specific symmetry: "the reciprocal nature of the (externality) problem" where "both parties (say, the polluter and the victim) cause the damage" (Coase 1960). Cheung further identified the hidden symmetry assumption in equilibrium economics: the symmetry between consumption and investment, or the symmetry between demand and supply, which was justified by the principle of diminishing marginal returns.

1.5. The Symmetry Principle in Classical Physics and Equilibrium Economics

The symmetry principle plays a fundamental role in the theory of equilibrium physics. It is known that basic laws in physics can be characterized by some types of symmetry.

There are two fundamental symmetries in classical physics: time symmetry from the law of energy conservation, and space symmetry from the law of momentum conservation, which are valid in Hamiltonian systems, i.e. the world without friction.

Symmetry principles in classical physics have important implications: stability and reversibility. In another words, history does not matter in simple Hamiltonian dynamics.

A simple structure with a high degree of symmetry can be constructed, including a perfect gas, crystal, or fluid.

Symmetric construction is widely used in modeling a laissez-faire economy. For example, linear demand and supply curves have visible symmetry in economic textbooks. Especially, the popular Cobb-Douglas utility and production function have symmetric forms. Information symmetry is implied in perfect competition. Symmetric formulation of players in game theory, consumers and producers in the micro model and macro models are widely used in economic theory.

The symmetry argument also played an important role in the debate against the Keynesian economics. For example, Keynes' monetary theory of unemployment violated the symmetry property in mathematical economics, since demand and supply function with price and quantity should be homogeneous function of degree zero (Leontief 1936).

Technically speaking, symmetry between demand and supply is assured by a downward demand curve or a decreasing return to scale. Coase could justify his reciprocal relation between farmer and rancher only if the rancher's cattle business was operating under diminishing returns.

The question remains whether the Coase-Cheung symmetry principle has solid foundation in theory and reality?

2. Symmetry Breaking in Evolutionary Thermodynamics and Division of Labor

The macro world greatly differs from the micro world in physics, which is characterized by symmetry breaking in thermodynamics. A time arrow played a constructive role when life emerged as a symmetry breaking process in open systems (Prigogine 1984). Fundamental causes of a time arrow are rooted in nonlinearity and the many-body problem.

Life evolution has shown a series of symmetry breaking process: say, from point symmetry in drop-like creatures in the sea, to line symmetry of a higher kind in plants and animals. Similarly, social evolution such as the division of labor, war and revolution, is also a symmetry-breaking process. The symmetry principle in equilibrium thinking and symmetry breaking in evolutionary thinking provide a theoretical platform for debates among different school of thoughts (Foster 1993).

2.1. Asymmetry in Economic Complexity and Market Disequilibrium

All economic complexity, irrational behavior, and market failure can be traced to some form of asymmetry of dynamic mechanism. For example: information asymmetry in exchange and loss aversion in decision making is responsible for market failure and irrational behavior (Akerlorf 1970, Kahneman et al. 1990). Asymmetry in demand and supply can be visualized by an S-shaped demand curve and a Z-shaped supply curve (Becker 1992, Dessing 2002). Asymmetric power also appears in game theory in the study of cooperation and conflicts.

The most remarkable feature in an industrial economy is the asymmetry between consumer numbers and firm numbers, which signals the tremendous power of industrial organization (Chen 2002).

Cheung once reframed the Coase question on the nature of the firm in such a dramatic way: "Why, in a free-enterprise economy, would a worker voluntarily submit to direction

6

by an entrepreneur or an agent instead of selling his own output or service directly to customers in the market?" (Cheung 1987).

Any unemployed worker could easily perceive the asymmetric power between poor labor and an organized capital. No worker would submit to a self-appointed boss without compensation above his previous income as self-employed. The common-sense answer to the nature of the firm is certainly creating value, rather than reducing transaction costs! Coase reversed the order simply because equilibrium economics denies the existence of profit in a closed system without innovation.

Stable price equilibrium in the Arrow-Debreu model is relevant to atomic economies without product cycles, product innovations, supply chain and networks. For an industrial economy, symmetry breaking between consumption and investment resulted from round-about production and product cycles (Hayek 1935, Chen 2006).

2.2. The Creative Nature of The firm and the Asymmetric Aspects of Transaction Costs

In the case of GM acquiring its supplier Fisher Body, Coase did not gave any empirical evidence on the scale of transaction costs, but did provide two clues of other factors: First, GM's previous contract with Fisher Body was based on the mark-up pricing rather than marginal pricing; its profit was fixed at 17.6% of cost. Second, reducing business uncertainty seemed a main motivation in acquisition (Coase 1937, 1988b, 1988c, 2000). His argument for transaction costs was a theoretical assumption that the firm size was determined by the balance between deceasing transaction costs and increasing organization costs within the firm. This logic implied non-convexity of varying (first increasing then decreasing) returns to scale, which was a visible departure from his belief in diminishing returns in price theory. It is also an inward looking view of corporate strategy, or a firm theory without competitor.

The Coase concept of transaction costs has two implicit assumptions: one was that transaction costs were symmetric to both sides of exchanges; the other was that market competition would drive down transaction costs, just like the similar mechanism for production costs.

Coase ignored possible asymmetric aspects of transaction costs in market competition (Vogel 1987, Glaeser, Johnson, and Shleifer 2001). For example, deregulation policy could reduce transaction costs for producers, but increase information asymmetry and transaction costs for consumers. The firm boundary itself implies an increasing information barrier to outsiders but a decreasing information barrier to insiders. There are numerous examples of increasing transaction costs under market competition. For conservative producers, reducing marketing cost as overhead would increase current profit; but for aggressive producers, increasing marketing expense as a strategic investment might increase market share. For high tech firms like Microsoft, marketing costs may be even larger than production and development costs.

To have a new understanding of the origin of the firm, we may consider a similar question in biology: What is the origin of life?

It makes no sense to say that the emergence of life is driven by reducing entropy production, rather than increasing adaptability or learning at the costs of increasing heat emission. As Georgescu-Roegen pointed out (Georgescu-Roegen 1976):

"Thermodynamics is at the bottom a physics of economic value … and the Entropy Law is the most economic in nature of all natural laws. … The Entropy Law is the taproot of economic scarcity."

The cost-benefit analysis is meaningful only if the cost can be compared with the value being created. We may better consider the other side of the coin: the creative nature of the firm in Schumpeter economics, since transaction costs are difficult to measure in the dissipative process. Firms create value or increase organizational capability by several means: developing a scale and scope economy, increasing innovation in developing new products and new services, decreasing risk and uncertainty, say, controlling external shocks in vertical integration and diversifying risk in horizontal integration, etc (Chandler 1992).

Economics of contracts and governance did reveal some factors in incentive mechanism and internal control (Cheung 1964, Williamson 1979, Hart 1995, Holmström and Roberts 1998). However, in the simpler case of sharecropping, it was found hard to make a choice between different forms of contracts, say, wage, rent, or sharecropping, based on a comparison of transaction costs. It was relatively clear for decision making based on risk analysis (Cheung 1969, Stiglitz 1974).

Here is a dramatic example in recent events. During economic transition in the former Soviet Union in 1990s, Russia's real GDP declined 43% and Ukraine 61%, but their currencies devalued more than 5000 times and 70000 times respectively (Chen 2006)! Even if you know your business and your market, how could you predict that the shock therapy in liberalization would generate inflation spiral and break down your cash flow? Does the Coase Theorem can estimate the magnitude of coming transaction costs for financial market deregulation?

If the nature of the firm and its governance is design of contract (Cheung 1983, Williamson 1979), we may consider a new conductor who takes over an orchestra with music score at hand. For some reason, he fired all the members of the old orchestra and recruited new members for his own team. Do you expect that this orchestra would perform as well as before?

2.3. The Wallis-North Paradox and Historical Trend of Division of Labor

All grand theories in economics seek inspiration from history. There seem two ideal candidates for the Coasian market with minimum transaction costs: "hunting bands" and "(financial) markets in which transactions are highly regulated" (Coase 1988a).

However, the Coase belief of a decreasing trend in transaction costs was challenged by the Wallis-North paradox, it showed that the aggregate transaction costs in the US grew from about 25 % of GDP in 1870 to more than 50% in 1970 (Wallis and North 1986). This finding is consistent with self-organization theory and complexity science but a paradox for the transaction costs paradigm (Forster 1993, Chen 2005).

To explain China's recent reform by the transaction costs approach, Cheung proposed a different scheme; it assumed that a market transition was a process from infinite transaction costs with trade barrier before, and much less transaction costs after reform (Cheung 1986, 1998). If we compare the simplistic life style in Mao's era before the 1970's and an affluent variety in Deng's market economy, the increasing trend of transaction costs is visible from a rapid growth of marketing, accounting, lawsuits, and

regulations along with rapid economic growth. In any case, there is no possibility of a decreasing trend of transaction costs suggested by the transaction costs approach.

If we accept that the primitive tribe has little information and asymmetry and least marketing cost, then the transition from the hunter-gatherer society to proto-type market needs a quantum jump in transaction costs rather than an increasing trend. This scenario is a counter-historic view of human civilization. It is noted among economists (Georgescu-Roegen 1976):

> "Thermodynamics is at bottom a physics of economic value – as Carnot unwittingly set it going – and the Entropy Law is the most economic in nature of all natural laws."

Transaction costs may have a small U-shaped dip or wavelike movements with technology progress, in addition to an upward trend. However, the whole history of the division of labor has been characterized by increasing discovery of new resources and increasing consumption of energy along with increasing release of waste and heat. Government inaction is a dangerous policy for pollution, SARS, and global warming. How can we imagine a Coasian world with decreasing transaction costs?

2.4. Barriers to Exchange and Sources of Social Conflicts

Coase simply disregards the possibility of persistent conflicts without a negotiated solution, he argued that "traits (of neither buy nor sell)… have little survival value" (Coase 1988a). Therefore, we should discuss the barriers to exchange and the sources of social conflicts.

Coase did make significant contributions in promoting a market solution for public goods and externality. With symmetry analysis, we can easily judge the working condition for bilateral bargaining with some limitations, since competitors are near symmetrical in auction radio frequency, selling pollution rights, or operating a lighthouse (Coase 1959, 1974, Noam 1988).

In contrast, there was much doubt about the Coase solution for social conflicts, such as a noisy neighbour, pollution, and animal trespassing (Rusmusen 1998). Empirical studies found no empirical evidence for the Coase assumption of symmetric relation.

First, non-convexity, such as an increasing return to scale and fixed costs, can be a significant cause of symmetry breaking in bilateral bargaining. In the case of California's animal trespassing law, ranchers would increase cattele without bounds if they had the property rights. Historically, switching the property rights from pro ranchers to pro farmers did change people's behavior and the agriculture structure in California (Vogel 1987).

Second, the downward sloping demand curve is reasonable only for a positive utility generated by pleasure. For a negative utility such as noise or pollution, the demand curve must be upward if the polluter had no pollution rights and had to pay compensation to the victim. There is no symmetry between the polluter and the victim. In addition, free legal service (in the sense of reducing transaction costs) may encourage lawsuits rather than further settlements outside the court (Simpson 1996). The real issue for proper regulation and government action is not a simple argument for choosing smaller transaction costs,

9

but a careful balance among market efficiency, social stability, and economic development.

Third, income and wealth effects are essential factors in social cost (Hurwicz 1995). Friedman pointed out that the condition for downward sloping demand was invariance of real income, not nominal income, which implied a macro foundation on the non-existence of unemployment (Friedman 1953, Cheung 2001a, Chen 2002). This condition sets further constraint to the Coase proposal of government inaction, since social stability demands government policies in managing business cycles, including monetary, fiscal and tax policies.

Fourth, power asymmetry may lead to a breakdown of the political Coase theorem (Acemoglu 2003). Economic intrestets for a privileged group may outweigh the welfare of the majority of people.

Finally, political and ideological factors of conflicts and war also have an economic source. The endogenous root of a business cycle, in the form of excess capacity or banktrupcy, is the price paid for creative destruction. There are tremendous sunk cost and learning uncertianty associated with replacing technologies (Chen 2005). Strategic competition, not price competition, greatly increases transaction costs in an innovation game.

From the above analysis, we can see that Coase made little cases which had convincing evidence for supporting the Coase Theorem, the Coase Conjecture, or the Coase belief. Coase made a constant call of observing the real world, which got a cold review on Coasian economics (Rusmusen 1998):

> "Poor Professor Coase, What ironies he has inspired! He is known almost exclusively for three papers: … (1937, 1960, 1972). Each of these is theory, albeit verbal theory, with almost no empirical content. Yet for many years Coase has called for an increase in the amount of intelligent descriptive empirical work in economics, and has shown how to do it with his own careful case studies. These case studies are little cited, but they are even less initiated."

Intrestingly, Samuelson, one of the founders of neoclassical economics, had much better assessment in the limit of current economics (Samuelson 1995):

> "Allocation of property rights – and how they are to be defined - matters mightily. They are the chips in the game of dickering, threatening, and litigating. …… Only in certain Santa Claus situations – constant returns to scale, infinite divisibility, free entry, dispensed ownership of each grade of factor, shared knowledge, complete markets – only then will Smithian self-interest be compelled to achieve Pareto-Optimality.
>
> To try to capture all that which contributes to deadweight loss under the verbal rubric of "transaction costs" weakens a useful concept without gaining understanding of incompleteness of markets, asymmetries of information, and insusceptibilies of various technologies to decentralized pricing algorithms.

The vogue of vulgar and vague Coaseism, one hypothesizes, is strongest among libertarians and other devotees of laissez-fair who believe to find in it ammunition against regulation and voter's activism."

Coase criticized that mainstream economics (Arrow-Debreu model, we guess?) has "consumers without humanity, firms without organization, and even exchange without markets (Coase 1988a, p.3)."

To paraphrase the Coase critic, we are still short of a more general theory, which could better understand consumers with characters and fashions, firms with innovations and competitors, and markets with cycles and rules. That is our hope for a better alternative perspective.

3. Evolutionary Dynamics and Economics of Organization and Institution

We have seen that the transaction costs approach does not provide a consistent framework in understanding organization and institution, since transaction costs are like heat in physics, which are results not caused in dynamical processes. The limitation of the transaction costs lies in the very foundation of equilibrium economics, which is a closed system without innovation and history. To understand the origin of the firm and sources of social cost, we better shift to the evolutionary perspective.

More than a century ago, Veblen asked a sharp question "why is economics not an evolutionary science", and pointed out that "realism" in dealing with facts did not make economics an evolutionary science (Veblen 1898). Methodologically, the oversimplified view of human nature perceived in mainstream economics:

> "The hedonistic conception of man is that of a lighting calculator of pleasures and pains…..He has neither antecedent nor consequent. ….Self-imposed in elemental space, he spins *symmetrically* about his own spiritual axis ……" (Here, Italian style was emphasized by the author)

Interestingly, Coase began with Knight's deep observation of complex human nature, but quickly return to the one-sided man in equilibrium economics (Coase 1988a, p.4):

> "There is no reason to suppose that most human beings are engaged in maximizing anything unless it be unhappiness, and even this with incomplete success. Knight has expressed the thought very well: '… [the] argument of economists … that men work and think to get themselves out of trouble is at least half an inversion of the facts. The things we work for are 'annoyers' as often as 'satisfiers,' we spend as much ingenuity in getting into trouble as in getting out, and in any case enough to keep in effectively… A man who has nothing to worry about immediately busies himself in creating something, gets into some absorbing game, falls in love, prepare to conquer some enemy, or hunt lions or the North pole or what not.' (Knight 1936, p.32)."

There are new understandings in the evolutionary mechanism of organization more than that in the Veblen's time.

First, organizational theory is a three-layer (macro-meso-micro) problem (Chen 2005, Dopfer 2005). Organization economics must consider three interacting layers in organization behavior: ecological economics at the top, macroeconomics in the middle, and micro economics at the bottom, which is similar to the biological analysis of animal size and hierarchical structure (Schmidt-Nielsen 1984, O'Neill 1989). Selection mechanism must be operated at multi-levels (Hodgson 1993). A reductionism or so-called microfoundations approach is not capable of analyzing organization and institution.

Second, non-equilibrium physics and complexity science develop new ideas on the role of living boundaries and the limit of equilibrium thinking. Many economists consider that the essence of institution is the fair rule of games (Dopfer 2005). We further emphasized the selective nature of the rules in the development process.

Third, Social evolution in the division of labor also shares a key feature in Darwinian evolution: the tree-like bifurcation process (Chen 1990).

Let us see what we can learn from a new perspective of evolutionary dynamics.

3.1. Maxwell's Demon, Emerging Order and the Selective Role of Boundaries

Economics used to treat boundaries as a negative mechanism to market, such as trade and entry barriers. However, boundary is a necessary condition for an organism such as a membrane in a living cell. Can we have a new understanding of boundaries in emerging order?

The physics concept of order as emerging difference can be illustrated by a thought experiment--Maxwell's Demon. There is a wall separating two compartments filled with gas. A little demon sits by a tiny trapdoor in the wall. He could separate fast- and slow-moving particles by selectively opening the trapdoor. It would create a non-equilibrium order with a difference in temperature between the two compartments. The issue becomes whether or not there is a free lunch for "perfect information" needed by the demon in the order creating process. According to the uncertainty principle in quantum mechanics, find speed information must cost more than minimum energy. Therefore, perfect information without costs is impossible in a real world.

Prigogine learned a positive lesson that enzymes resembling Maxwell's demon for a cell membrane. A membrane works as a filter, which selectively absorbs useful materials but excludes harmful objects. Certainly, its operation costs dissipating energy. This theoretical insight inspires us a new understanding of development policy.

In this regard, highly regulated stock exchange is a good example of selective institution, but a bad case for the Coasian world. Only selected companies are listed at the New York Stock Exchange. Their financial information and asset trading are strictly regulated by Security Exchange Commission. The high transaction costs for listing and monitoring are paid for reducing information asymmetry and destructive speculation such as inside trading and manipulating the market. These efforts are hard to justify by a transaction costs approach, but are easily understood by their goals of an expanding market and by reducing uncertainties.

The creation of the Euro provides an interesting example of lowering "transaction costs" by the public (here is super-national) service, not by market competition (Niehans 1998). SZE (the Special Economic Zone) is also a successful story of selective opening during China's transition (Chen 2006).

3.2. Trade-Off between Stability and Complexity

There was a misconception both in biology and economics that the survival system must be stable. However, theoretical biologists once asked a thoughtful question: does increasing complexity imply an increasing stability of the underlying ecological system? The answer is surprisingly NO (May 1974).

Earlier, Stigler found out a similar Smith paradox (Stigler 1950). The two theories by Adam Smith are conflicting: the invisible hand implied a competitive market with numerous small firms, while the Smith Theorem asserted that the division of labor was limited by the market extent (with few monopolies). How can these two patterns coexist in a market economy? Coase had a similar problem: if a firm has an optimal size, then how can one explain the observed pattern of greatly varying size in industries and economies? This is the fundamental issue on the basis of biological and economic diversity.

Our answer, based on complexity science, is that there is a trade-off between stability and opportunity; division of labor is limited by resource variety, market extent, and environmental fluctuations (Chen 2005). Contrary to wide perception, China's land privatization developed much earlier than West Europe's. The Chinese Empire lasted much longer than the Roman Empire, because the small family farm was more stable than a large commercial economy; its cost was equilibrium trap or technology stagnation (Chen 1990).

Corporate strategy is a dynamic process, not an optimal structure in the financial market. In an expanding market, spin-off of new firms could create a higher market value. But in a shrinking market, merger and acquisition are a better guard against risk. There are persistent waves of organizational changes along with business cycles. Organizational form and institutional arrangement have to adapt to the wind of technology and environment changes.

3.3. Life Cycle in Mixed Property Rights and Institution for Protecting Innovations

New institutional economics tries to attribute the rise of science and capitalism in the West to the system of protecting property rights (North and Thomas 1973, Landes 1998). This view has some important insight in western history but may be an over-simplified in economic theory.

The indeterminate outcome from the MM theorem in corporate finance questioned the important role of ownership structure, which found that the debt structure was irrelevant to the firm's value under perfect competition (Modigliani and Miller 1958, Chen 2006). Miller pointed out that there was no optimal structure of private ownership: American-British firms were dominated by short-term behavior and insufficient investment while German-Japanese firms were characterized by long-term behavior and over-investment (Miller 1995). The increasing role of financial intermediates and diversification of ownership in public traded companies add further difficulty to the logic of private ownership, since many large public companies do not have shareholders with controlling power.

The ecological constraint imposes another limit to property right systems. It was widely believed that the tragedy of commons may have been avoided by private ownership (Hardin 1968). However, private ownership may encourage over-exploitation of renewable resources when the discount rate is high (Clark 1973). Both equilibrium

economics and new institutional economics ignore the critical issue of resource constraint and its impact to human preference, a starting base of classical economics and evolutionary biology (Gowdy 1998).

Schumpeter highly appreciated the innovative role of entrepreneurs in the initiative stage. He differed with the current property right school in two aspects: first, the ability of entrepreneurship had limited supply and could not be inherited; second, entrepreneurs themselves often missed their fruits; therefore, capitalism must have its own life cycle (Schumpeter 1934). Schumpeter and Coase had one thing in common: both of them had deep doubt about perfect competition, and emphasized the competitive aspect of monopoly. Is there a unified framework to understand an historical experience in institutional change?

If we consider organization and institution like organisms, we may naturally come to a life cycle theory of changing property right during a dynamic process of creative destruction. Let us consider the rise and fall of a new technology or industry, such as electricity or computer technology. A simple cyclic pattern may behave like the following:

At the very beginning, only scientists or amateur researchers, say, in a university or public sector, were working on interesting ideas without a clear clue of profitable applications.

At the second stage, private businessmen and venture capitalists would join the effort when they saw a business opportunity in market. The entrepreneurs would take their lead from scientists for expanding the market.

At the third stage, many imitators would follow the successor; which would drive down the profit margin and saturate the market. Anti-trust policy and patent expiration would discourage monopoly and leave room for new competitors.

Finally, the old industry would be replaced by new technology: a new round of the life cycle would begin.

Through a life cycle, the changing role of institution in western history can be better described by *protecting innovation* in addition to *limited protection of property rights*. The patent system only provides protection for an innovative monopoly within a limited time period. Bankruptcy laws offered more protection for failed entrepreneurs but less protection for creditors. Anti-trust laws and competition policy aimed to restrain the monopoly power in the mature stage. A progressive tax, government credit for starting a new business, and social insurance are designed to reduce the pain of creative destruction including income polarization, unemployment, and barriers in learning. Even in the US, innovations were mainly supported by university systems including land-grant universities and non-profit endowments, which contributed much more than the intellectual property right system (Nelson 2002).

Based on the life cycle theory of institutional changes, we may integrate valuable insights from competing economic thoughts, including property right school and evolutionary economics. We will further discuss the issue elsewhere.

3.4. Fundamental Link among Physics, Biology, and Economics

It is often complained that unrealistic models in economic literature are a result of the wrong role model of physics. This perception sounds reasonable, but a misunderstanding. The problem in economic thinking is a double-edged issue. It is certainly true that human

14

nature could not be reduced to biological cells or moving particles, this is the limit of reductionism. However, it is also true that that human nature must be bounded by laws of physics and biology. There were repeated lessons of alchemy and perpetual motion machine in history. Some popular models in equilibrium economics simply had a false claim in physics, but actually groundless in physics.

We all accept that economic phenomena are more complex than biology and physics. The question is how to understand economic complexity. One way is paying a lip service to free will, but living on a research strategy of easy mathematical modeling. Another strategy is analyzing empirical issue by a multi-level and multi-dimensional analysis, then simplifying the issue by identifying pertinent mechanism. Whether we need a theory with proper technique, (say, linear or nonlinear, few or large number of variables; mechanic or biologic model), should be determined by theoretical perspective and empirical (including historical) evidence. More importantly, any conclusion should be made with open mind and policy cautions. In this regards, we should learn more from biologists, since they behave much more humble than "imperialist" physicists or economists.

For example, the Lucas model of rational expectations sounds like a nice model of human rationality with free will, but the degree of freedom of any economic agent is near zero, while a particle in perfect gas has 6 degree of freedom in space and speed. In another words, the agent in the general equilibrium model acts like a slave labor rather than a free man (Lucas 1972, Chen 2002). The Frisch model of noise-driven cycles in macro econometrics and the Coasian world of zero transaction costs in new institutional economics are two cases that go against the second law of thermodynamics, since they are essentially perpetual motion machines without temperature difference or endogenous mechanism within economy or organization (Chen 2005).

A human is a special kind of animal, and any animal's behavior should follow the laws of physics. Certainly, any model in physics and biology may not have a counterpart in economics. However, any model in economics cannot exist in the real world if it violates the basic laws of physics. The lesson here is to exam a theory not by its philosophical claim, but by its behavioral pattern. Mathematics is a useful tool in sharpening theoretical argument, but also can be a disguised weapon for an ideological claim.

The origin of a firm is similar to the origin of life, whose nature is symmetry breaking in time and space. Therefore, the emergence of the firm and the origin of market and a division of labor must be a physical process of increasing entropy, which also implies increasing transaction costs. Technology advancement and biological adaptation may improve its energy efficiency, but have no chance of violating thermodynamical law. History has witnessed a trend of increasing complexity of division of labor, driven by an increasing dissipation of energy, matter, and information.

We should point out that the basic framework of the Arrow-Debreu model in equilibrium economics is more rigid than Newtonian mechanics. It has no restriction of the mathematical form of interacting forces, so it is capable of studying modern subjects, such as nonlinearity and chaos. However, the functional form in equilibrium economics simply rules out non-convexity, which essentially rules out almost all important subjects in evolutionary dynamics, including innovation, instability, and complexity. Now, modern physics provides new tools to study biological complexity such as the biological

clock and evolutionary dynamics. Many important concepts in evolutionary economics, such as path-dependence and emerging property, can be described by models in nonlinear dynamics. Why should we confine to the Euclid geometry in a non-Euclid world?

We do not share the belief of reductionism in physics and biology. From the view of complexity science, we find interactions among micro-meso-macro are not only occurred along the reductionist line, but also move upward. In light of pollution, global warming, water shortage, population explosion, and AIDS, ecological constraint to economic growth and international coordination is an urgent agenda for economists. The macro environment for individual and firm behavior has more weight for microfoundations in managing unemployment and ecological crisis. History and culture also matter in understanding the diversifying pattern of economic development.

In short, an interdisciplinary dialogue could be more fruitful in advancing economic science.

4. Conclusion: Missing Asymmetry in Equilibrium Economics and the Selective Nature of Institutional Evolution

Coase started his adventure by asking a question about the nature of the firm. He made a quantum jump to the concept of transaction costs with a strong intonation that market competition would drive down transaction costs, just like production cost in equilibrium economics. Coase further asserted that social conflicts could be solved by bilateral bargaining without the need of government action or legal assistance, if the transaction costs in the real world were insignificant. Coase justified his position by the simplest version of price theory (the downward sloping demand curve) and a physics analogy of an idealized world without friction.

It was found that the Coasian world with zero transaction costs does not exist, since it is against the basic laws of physics and its implication of perfect price discrimination is incompatible with competitive equilibrium in equilibrium economics.

Coase' adventure did contribute a new understanding on the nature of neoclassical (equilibrium) economics. He found a symmetry condition for a voluntary market exchange, which was the core of the Coase Theorem. Cheung further identified a hidden symmetry assumption between consumption and investment in equilibrium economics. We believe that the symmetry criterion can serve as a better policy gauge between market solution and non-market solutions (such as government regulation, legal interference, and public participation). The reason is that the concept and measurement of transaction costs have conflicting characters and implications in decision making.

However, the Coase approach made only limited progress in understanding contract and institution. The limits of transaction costs have several sources: First, transaction costs only play a minor role in firm behavior in comparison with risk control and corporate strategy. Second, the dual character of transaction costs generates conflicting implications in market competition, such as the uneven trade-off between short and long term contract. However, few economists realize a fundamental flaw in the Coase theory of firms. The unfounded belief of decreasing transaction costs is against the law of thermodynamics and the historical trend in industrialization.

Our analysis of the Coase Theorem revealed significant limitations in the current stage of microeconomics: the hidden symmetry assumptions between demand and supply, between consumption and investment, and between an individual producer and an

organized firm. In addition to information asymmetry, more missing asymmetries in textbook economics should be addressed in future research. We need to develop a larger framework of microeconomics, which should integrate important findings in economic complexity, social interaction, and ecological constraint.

Acknowledgements

References

Acemoglu, Daren. "Why Not a Political Coase Theorem: Social Conflict, Commitment, and Politics," *Journal of Comparative Economics*, 31(4), 620-652, (2003).

Akerlof, G. "The Market for Lemons: Quality Uncertainty and the Market Mechanism," *Quarterly Journal of Economics*, 89, 488-500 (1970).

Alchian, Armen A. "Property Right," in *The Concise Encyclopedia of Economics*, (1987), at: http://www.econlib.org/library/Enc/PropertyRights.html

Arrow, Kenneth and Gerard Debreu, "Existence of an Equilibrium for a Competitive Economy," *Econometrica*, 22(3), 265-290 (1954).

Ayres, R.U. "Eco-Thermodynamics: Economics and the Second Law," *Ecological Economics,* 26(2), 189-209 (1998).

Becker, G. "A Note on Restaurant Pricing and Other Examples of Social Influences on Price," *Journal of Political Economy,* 99, 1106-1116 (1991).

Brillouin, Leon. *Science and Information Theory,* Academic Press, New York (1962).

Chandler, Alfred D. "Organizational Capabilities and the Economic History of the Industrial Enterprise, *Journal of Economic Perspectives*, 6(3), 79-100 (1992).

Chen, Ping. "Needham's Question and China's Evolution - Cases of Nonequilibrium Social Transition," George Scott ed., *Time Rhythms and Chaos in the New Dialogue with Nature,* University of South Dakota at Vermillion, Iowa State University Press (1990).

Chen, Ping. ″ Microfoundations of Macroeconomic Fluctuations and the Laws of Probability Theory: the Principle of Large Numbers vs. Rational Expectations Arbitrage,″ *Journal of Economic Behavior & Organization,* **49**, 327-344 (2002).

Chen, Ping. "Evolutionary Economic Dynamics: Persistent Business Cycles, Disruptive Technology, and the Trade-Off between Stability and Complexity," in Kurt Dopfer ed., *The Evolutionary Foundations of Economics,* Chapter 15, pp.472-505, Cambridge University Press, Cambridge (2005).

Chen, Ping. ″ Market Instability and Economic Complexity: Theoretical Lessons from Transition Experiments,″ in Yang Yao and Linda Yueh eds., *Globalisation and Economic Growth in China*, Chapter 3, pp.35-58, World Scientific, Singapore (2006).

Cheung, Steven N.S. The Theory of Share Tenancy, Chicago University Press, Chicago (1969).

Cheung, Steven N.S. The Contract Nature of the Firm, *Journal of Law and Economics,* 26(1), 1-21 (1983).

Cheung, Steven, N.S. *Will China Go "Capitalist"?* 2nd Ed. Institute of Economic Affairs, Sussex, UK (1986).

Cheung, Steven N.S. "Coase, Ronald Harry," in J. Eatwell el al. eds., *The New Palgrave: A Dictionary of Economics,* Vol. I, p.455-457 (1987).

Cheung, Steven, N.S. "The Transaction Costs Paradigm," *Economic Inquiry,* 36, 514-521 (1998).

Cheung, Steven, N.S. Economic Explanation, Vol. I. Science of Demand (in Chinese), Arcadia Press, Hong Kong (2001a), p.140.

Cheung, Steven N.S. Private discussion with the author, April 2007.

Clark, Colin W. "The Economics of Overexploitation," *Science*, 181(4100), 630-634 (1973).

Coase, Ronald H. "The Nature of the Firm," *Economica,* 4(16), 386-405 (1937).

Coase, Ronald H. "The Marginal Coast Controversy," *Economica,* 13(51), 169-182 (1946).

Coase, Ronald H. "The Federal Communications Commission," *Journal of Law and Economics,* 2(1), 1-40 (1959).

Coase, Ronald H. "The Problem of Social Cost," *Journal of Law and Economics,* 3(1), 1-44 (1960).

Coase, Ronald H. "Durability and Monopoly," *Journal of Law and Economics,* 15(1), 141-149 (1972).

Coase, Ronald H. "The Lighthouse in Economics," *Journal of Law and Economics,* 17(2), 357-376 (1974).

Coase, Ronald H. "Payola in Radio and Television Broadcasting," *Journal of Law and Economics,* 22(2), 269-328 (1979).

Coase, Ronald H. *The Firm, the Market, and the Law,* University of Chicago Press, Chicago (1988a).

Coase, Ronald H. "The Nature of the Firm: Origin," *Journal of Law, Economics & Organization,* 4(1), 3-17 (1988a).

Coase, Ronald H. "The Nature of the Firm: Meaning," *Journal of Law, Economics & Organization,* 4(1), 19-32 (1988c).

Coase, Ronald H. "The Institutional Structure of Production," *American Economic Review,* 82(4), 713-719 (1992).

Coase, Ronald H. "The Acquisition of Fisher Body by General Motors," *Journal of Law & Economics,* 43(1), 15-31 (2000).

Coase Ronald H. "My Evolution as an Economist," in William Breit and Barry T. Hirsch eds. *Lives of the Laureates: Eighteen Nobel Economists,* p.189-207, MIT Press, Cambridge (2004).

Cooter, Robert D. "Coase Theorem," in J. Eatwell, M. Milgate, and P. Newman eds., *The New Palgrave: A Dictionary of Economics,* Vol.I, pp.457-460, Macmillan, London (1987).

De Meza, David. "Coase Theorem," in Peter Newman ed., The New Palgrave Dictionary of Economics and Law, Vol.I, pp.270-281, Macmillan, London (1998).

Demsetz, Harold. *The Economics of Business Firm: Seven Critical Commentaries,* Cambridge University Press, Cambridge (1996).

Dessing, M. "Labor Supply, the Family and Poverty: the S-shaped Labor Supply Curve," *Journal of Economic Behavior and Organization*, 49(4), 433-458 (2002).

Dopfer, Kurt, *The Evolutionary Foundation of Economics*, Cambridge University Press (2005).

Fehr, N.M. von der, and K.U. Kühn. 1995. "Coase versus Pacman: Who Eats Whom in the Durable-Goods Monopoly?," *Journal of Political Economy,* 103(4), 785-812 (1995).

Foster, John. "Economics and the Self-Organization Approach: Alfred Marshall Revisited?" *Economic Journal,* 103(419), 975-991 (1993).

Friedman, M. *Essays in Positive Economics,* University of Chicago Press, Chicago (1953).

Georgescu – Roegen. Energy and Economic Myths: Institutional and Analytic Economic Essays, Pp.87-9, Pergamon, New York (1976).

Glaeser, Edward, Simon Johnson, Andrei Shleifer, "Coase versus the Coasians," Quarterly Journal of Economics, 853-899 (Aug.2001).

Gowdy, John. *Limited Wants, Unlimited Means, A Reader on Hunter-Gatherer Economics and the Environment,* Island Press (1997).

Hardin, Garrett. (1968). The Tragedy of the Commons. *Science* **162**(3859), 1243-1248.

Hart Olivier. *Firms, Contracts and Financial Structure,* Clarendon Press, Oxford (1995).

Hayek, Friedrich A., *Prices and Production,* Routledge, London (1935).

Hodgson, Geoffrey M. "Transaction Costs and the Evolution of the Firm," in Christos Pitelis ed. *Transaction Costs, Markets and Hierarchies*, p.77-100, Blackwell, Cambridge (1993).

Holmström, Bengt and John Roberts, "The Boundaries of the Firm Revisited," *Journal of Economic Perspectives*, 12(4), 73-94 (1998).

Hurwicz, Leonid. "What Is the Coase Theorem?" *Japan and the World Economy,* 7, 49-54 (1995).

Kahnaman, Daniel, Jack L. Knetsch, Richard H. Thaler, "Experimental Tests of the Endowment Effect and the Coase Theorem," *Journal of Political Economy*, 98(6), 1325-1348 (1990).

Kitch, Edmund W. "The Fire of Truth: A Remembrance of Law and Economics at Chicago, 1932-1970," *Journal of Law & Economics,* 26(1), 163-234 (2000).

Knight, Frank H. *The Ethics of Competition,* 2nd Ed. p.32, Harper, New York (1936).

Landes, David S. *The Wealth and Poverty of Nations: Why Some Are So Rich and Some So Poor?* Norton, New York (1998).

Leotief, Wassily W. "The Fundamental Assumption in Mr. Keynes' Monetary Theory of Unemployment," *Quarterly Journal of Economics*, 51(1), 192-197 (1936).

Lifshitz, E.M. and L.D. Landau, *Course of Theoretical Physics: Mechanics,* 3rd Ed. Butterworth-Heinemann (1982).

May, R.M. *Stability and Complexity in Model Ecosystems,* Princeton University Press, NJ: Princeton (1974).

Miller, Merton H. Speech at Shanghai Symposium on China's State Own Enterprise Reform (1995).

Modigliani, Franco, and Merton H. Miller, "The Cost of Capital, Corporation Finance, and the Theory of Investment," *Amer. Eco. Rev.* 48(3), 261-297 (1958).

Nash, John F. "Equilibrium Points in n-Person Game," *Proceedings of National Academy of Sciences,* 36(1), 48-49 (1950).

Nelson, Richard R. and Sydney G. Winter. *An Evolutionary Theory of Economic Change,* Harvard University Press, MA: Cambridge (1982).

Nelson, Richard. *Frontiers in Evolutionary Economics*, Lecture at China Center of Economic Research, Peking University, China, Mar. 27 (2002).

Noam, Eli, "Spectrum Auctions: Yesterday's Hreresy, Today's Orthodoxy, Tomorrow's Anachronism. Taking the Next Step to Open Access," *Journal of Law & Economics*, 41(2), Part 2, 765-790 (1998).

North, Douglas C. *Institutions, Institutional Change and Economic Performance,* Cambridge University Press, Cambridge (1990).

O'Neill, R.V. "Perspectives in Hierarchy and Scale," in S.A.Levin ed. *Perspectives in Ecological Theory,* Princeton University Press, Princeton (1989).

Prigogine, Ilya. *Order Out of Chaos,* Bantam, New York (1984).

Rasmusen, Eric. "Review", *Journal of Economic Literature*, 36(4), 2171-2172 (1998).

Ross, Stephen A. "Return, Risk, and Arbitrage," in I. Friend and J. Bicksler eds., *Risk and Return in Finance,* Ballinger, MA: Cambridge (1976).

Samuelson, Paul. "Some Uneasiness with the Coase Theorem," *Japan and the World Economy,* 7, 1-7 (1995).

Schmidt-Nielsen, Knut. *Scaling: Why Is Animal Size So Important?* Cambridge University Press, Cambridge (1984).

Schumpeter, Joseph A. *The Theory of Economic Development,* Harvard University Press, Cambridge (1934).

Simpson, A.W. Brian, "'Coase' v. 'Pigou' Reexamined," *Journal of Legal Studies,* 25(1), 53-97 (1996).

Stigler, G. J. "The Division of Labor Is Limited by the Extent of the Market," *Journal of Political Economy,* 59, 185-193 (1951).

Stigler, George J. "The Law and Economics of Public Policy: A Plea to the Scholars," *Journal of Legal Studies,* 1(1), 1-12, (1972).

Stiglitz, Joseph E. "Incentives and Risk Sharing in Sharecropping," *Review of Economic Studies,* 41(2), 219-255 (1974).

Veblen, Thorstein. "Why Economics Is Not an Evolutionary Science," *Quarterly Journal of Economics,* 12(4), 373-397 (1898).

Vogel, Kenneth R. "The Coase Theorem and California Animal Trespass Law," *Journal of Legal Studies,* 16(1), 149-187 (1987).

Wallis, John J. and Douglas C. North. "Measuring the Transaction Sector in the American Economy, 1870-1970," pp.95-148, and "Comments" by Lance E. Davis, pp.149-161, in Engerman, Stanley L. and Robert E. Gallman eds., *Long-Term Factors in American Economic Growth,* Studies on Income and Wealth, vol. 51 (National Bureau of Economic Research), University of Chicago Press, Chicago (1986). Pp.95-148.

Williamson, Oliver E. "Transaction-Cost Economics: the Governance of Contractual Relations," *Journal of Law and Economics*, 22, 233-260 (1979).