Why Capital Controversies Occur Repeatedly: A Methodological Interpretation

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This study explains the causes of capital controversies that occurred thrice in economic history, namely, at the turn of the 20th century, in the 1930s, and in the 1960s. Recurrence of controversies seeks answers from various theoretical frameworks. Differences between the Classical and Neoclassical schools are used to explain such controversies. The former explains long-period position using cost-of-production theory, whereas the latter explains short-run equilibrium using demand-and-supply theory. Results reveal neglected aspects of the controversies, *i.e.*, methodological positioning. Hence, controversies result from differences in the methodologies of scientific approaches, *i.e.*, deductionist *vs*. inductionist and/or individualist *vs*. holistic.

Keywords: Capital controversies, Deduction vs. Induction, Individualist vs. Holistic

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I. Introduction

A. Methodological approach

This study compares three capital controversies,[1] namely, at the turn of the 20th century, in the 1930s, and in the 1960s; this paper suggests an answer to the inquiry on why similar controversies surrounding the concept of "capital" occur repeatedly.

One easy answer to this question is a technical response. Capital controversies occur and continue until all theoretical troubles concerning the measurement of capital and their ramifications are cleared out. This line of interpretation is partly acceptable because it shows theoretical development in the process of controversies. However, this response does not provide satisfactory explanation on the causes of the recurrence of similar controversies. Some participants of earlier controversies had already realized the impossibility of measuring the value of capital in a single physical measure and the complications that follow. For example, as pointed out by Vellupillai (1975), Fisher recognizes the possibility of reswitching in the appendix of *The Rate of Interest* (1907). Participants in the 1930s, including Hayek, Knight, and Kaldor, all recognize the analytical complexity that arises from measuring multiple capital goods.

Another line of approach is to locate capital controversies in the structural development of theoretical frameworks, which is similar to the suggestion of some Sraffians. Garegnani (1976); Petri (1978); Milgate (1979) imply that early neoclassical economists between the 1870s and the 1930s attempted to explain the long-run position where all rates of returns would be equalized across industries based on demand-and-supply theory, without fully recognizing the incompatibility of their theory with the object they explained. Thus, earlier neoclassical economists tried to define "capital" in a single measure that corresponds to the uniform rate of return. This interpretation may illuminate the cause of development of the concept of inter-temporal equilibrium in which rates of returns are different. However, this reasoning cannot explain why some neoclassical economists continue to search for the single measure for capital, even after the "general equilibrium revolution" in the 1950s.

To explain the continued occurrence of capital controversies, more attention should be given to methodological aspects. Hence, the present

[1] Several good surveys on capital controversies in various periods were written by Harcourt (1972); Hong (1989, 1990); Cohen, and Harcourt (2003); and Cohen (2003, 2006, 2008).

study presents a simple methodological framework that positions and compares the theoretical orientations of scholars However, this study does not attempt to set up a complex framework to understand the methodological stances of economists. The use of two basic standards is sufficient for the purpose of this paper. The first standard considers whether an economist relies on more abstract and deductive approaches vis-à-vis other contemporary participants. The second standard determines if an economist starts a research by looking at the behavior of an individual or by observing the trend of an entire economy (or any unit larger than an individual). For convenience, we call the former position as "methodological individualism" and the latter as "methodological holism."

By using this framework, we can understand the reason some controversies were resolved easily whereas others were not. We can also find that the effects of some controversies were almost negligible, although they appeared to be fierce when they occurred.

To demonstrate how the methodological framework works, the next sub-section describes the methodological positioning of various scholars and schools. The second, third, and fourth sections explain three major capital controversies, namely, at the turn of the 20^{th} century, in the 1930s, and in the 1960s, respectively. Among these three controversies, considerable attention is given to the second one because methodological divergences are clearly shown in the second controversy. The final section concludes the argument and suggests an explanation of methodological problems with respect to the empirical justification of economic theories.

B. State of economic theories during the 1870s

As the dominance of classical economics faded away in the 1850s, three or four theoretical approaches competed in the field of economic science. These approaches are Neo-classical, Austrian, Historical/ Institutional, and Marxian theories. Table 1 shows the methodological positioning of these four distinctive approaches.

As Table 1 is drawn for the purpose of comparison, two points should be mentioned. First, only the relative positioning of scholastic stances vis-à-vis others is shown and not the absolute judgment of each school. Given that the table merely shows the relative positioning of these approaches in economic theories, we cannot characterize one specific approach as entirely deductive or individualistic. We can only tell that the argument of a certain scholar is more abstract or individualistic compared with the members of other schools.

TABLE 1
METHODOLOGICAL POSITIONING

Classification	Less abstract	More abstract
More individualistic	Austrian	Neoclassical
More holistic	Historical/Institutional	Marxian

The other caveat is the "fuzzy" demarcation line in the sense that the individualistic characterization of one scholar in terms of the above standard becomes more persuasive when taken in a more extreme position. The classification may not fit well with the research of individual scholars and may be difficult to determine on one point. However, understanding why controversies occurred across different schools and even within the same camp is important.

II. Capital Controversies in the 1890s: Boehm-Bawerk and Others

A. Boehm-Bawerk vs. Clark

The main figure in the first controversy surrounding the concept of capital is Eugen von Boehm-Bawerk, who published the very inquisitive three-volume book, *Capital and Interest* (1884, 1889, 1921). Boehm-Bawerk characterizes capital-using economy based on the roundabout method of production. He suggests measuring this roundaboutness by the average period of production, *i.e.*, the duration from construction to marketing weighted by the proportion of labor at each point of time throughout the stage of the production process.

J.B. Clark harshly criticized this concept. Clark believes that time span does not need to be considered in cases of stationary state, in which the same amount of outputs would be produced with the same amount of inputs. Thus, Clark measures the amount of capital goods in terms of very abstract notions of "true" or "ideal" capital, which would transcend the transient and variable nature of individual capital goods:

> "True capitalization is permanent, and non-transient. It does not consist in saving wealth to-day, with the intention of spending the principal so accumulated at any future period. It consists in saving with the intention of never spending the acquired principal at all.... It is evident that there is in society a fund of capital that never disappears, and that always

draws interest." (Clark, 1893, pp. 303-04)

Clark likens permanent capital to a waterfall, which is "an abiding element, owning its continuance to the constant wasting and replenishing of its substance" (Clark, 1893, p. 308) or water in a full reservoir in which individual drops of water could be ignored:

> "Drops of water that flow into a reservoir have periods of mechanical production. It takes time for them to ripen into the motion of wheels; but the water power as such has no such periods.... If a full reservoir be presupposed, the inflow causes motion at once." (Clark, 1893, p. 310)

Clark then applies the principle of marginal productivity to explain the rate of interest under the assumption of a given amount of capital. Clark concludes that the interest rate would be determined by the marginal product of capital.

In response to Clark's criticism, Boehm-Bawerk emphasizes the usefulness of production period in the dynamic state, "where concrete capital goods are, as it were, changing their stratification and production-periods no longer interlock in a perfect circle" (Boehm-Bawerk, 1895, p. 127). He further points out the need to construct theory in a more realistic set-up in which the problems of both construction and depreciation could be studied:

> "Professor Clark does not touch the question why the product imputable to a given capital good is not to be ascribed to the previous labor which created that good. If so imputable, the whole product of capital would be identical with its wear and tear, and no net product of capital would remain. But according to the reasoning now under consideration no question of wear and tear can arise, nor any need of considering previous labor." (Bohem-Bawerk, 1907, pp. 267-8)

From the modern point of view, both authors have flaws in their attempts to measure the amount of "capital" or "roundaboutness" in terms of a single physical unit, when the production process has either multiple capital goods or complex time distribution with multiple parameters. This common error cannot be easily ignored, but an interesting point more worthy of consideration is the methodological positions of the two authors. Boehm-Bawerk aims to set up a theory based on a more realistic assumption, whereas Clark tries to construct his theory on a very

abstract world.

B. Fisher and others

Another criticism on the capital theory of Boehm-Bawerk is the work of Irving Fisher. Fisher believes that Boehm-Bawerk's theory places too much emphasis on the role of the technical aspect of roundaboutness in explaining the positive rate of interest. By contrast, Fisher explains the positivity of interest according to the psychological grounds of positive time preference, in which the present good would be preferred to the future good of the same amount.

Although the exchange between these schools of thought is philosophical, the verdict of present micro-theory is simple. Both are right on their own assumptions. The modern growth model explains[2] the modified golden rule, wherein the rate of interest is equal to the marginal product of capital and the ratio of marginal utility of present over future consumption.

One interesting aspect of the exchange between Boehm-Bawerk and Fisher is the ground for the superiority of roundaboutness. Fisher argues that the selection of longer projects under a lower interest rate is a result of individual choice:

> "It is not true that, of all possible productive process, the longest are the most productive; but it is true that, of all productive processes actually employed, the longest are also the most productive. No one will select a long way unless it is at the same time a better way. All the long but unproductive processes are weeded out." (Fisher, 1907, p. 353)

In response to Fisher's comment, Boehm-Bawerk asserts that the superiority of roundaboutness is based on facts, and not on the result of selection:

> "Fisher denies the existence of an objective rule that is based on technical facts; I maintain that such an objective rule exists. According to Fisher, the appearance of a rule is the consequence of selection. I maintain that the regularity lies in existing facts before and independent of our selection. Fisher concedes the regularity merely in the production process actually selected. I maintain that such a regularity exists in all processes eligible for selection." (Boehm-Bawerk, 1889, Vol. 3, p. 49)

[2] See R. Dorfman (1969) on this point.

Given that the exchange between Boehm-Bawerk and other economists occurred within the broader camp of Marginalists, the discussion looks merely technical. Such discussion often occurs in the development of new concepts. However, further examination reveals subtle differences in methodological positions and attitudes during the development of theoretical frameworks and the environment in which these debates occur.

R. Dorfman (1995) notes some contextual differences between Austrian and American theories of capital. The former is more interested in defending capitalism against socialist attacks, whereas the latter has a more pragmatic orientation.

Differences exist among American economists, even within the broadly defined neoclassical camp. Clark uses the aggregate concept of capital to defend ethically the distribution of income in the long-run state. By contrast Fisher is more concerned about explaining the short-run operations of a market. This difference appears to be related to their background. Clark was influenced by the German historical school in his earlier days, whereas Fisher was more oriented toward developing operational tools to deal with practical matters.

In relation to methodological orientation, it is also useful to look into the debate between Fisher and Institutional economists. Fisher (1906) defines the concept of capital as the sum of present values of capital goods; this work did not explain the rate of interest based on the amount of capital. This definition is logically possible because Fisher (1907) explains the rate of interest rate in terms of the relative prices between present and future goods of the same kind in a single good world. However, the impact of changes in money value of capital is uncertain. Thus, it is measured based on other economic variables, which behave in the same way as the changes in the amounts of individual capital good.

Setting aside the analytical problem of Fisher's value measure of capital, we find that the Institutionalists have criticized his suggested measure. For example, Veblen criticizes Fisher for accepting the businessman's vocabulary of *pecuniary* concept without differentiating the idea from *industrial* equipment.[3]

> "A money economy and the consequent credit transactions which give rise to the phenomena of interest can emerge only on the basis afforded

[3] J.R. Commons, an Institutionalist, also criticized the Fisherian notion of capital on the same ground.

TABLE 2
POSITIONING OF PARTICIPANTS OF EARLY CONTROVERSIES

Classification	Less Abstract	Abstract	More Abstract
More Individualistic	Austrian	Boehm-Bawerk	Fisher(1)
Medium		Fisher(2)	Clark
More Holistic	Veblen, Commons		Marxian

Note: 1. The locating rule follows the same pattern in Table 1. The upper right-hand corner takes the extreme deductivist and individualist approach within economics, and the lower left-hand corner takes the less abstract/less individualistic approach.
2. Fisher (1) denotes his microeconomic approach to interest and Fisher (2) denotes his macroeconomic application of the concept of capital.

by the mature development of the institution of property. The whole matter lies within the range of a definite institutional situation which is to be found only during a relatively brief phase of civilisation. ... interest is a business proposition and is to be explained only in terms of business, not in terms of livelihood, as Mr. Fisher aims to do." (Veblen (1909), p. 142)

Both Institutionalists and Austrians reject the concept of the money value of capital because they want to analyze the effects of physical capital goods. By contrast, Marxian and early Neoclassical economists support the concept of abstract and aggregate capital.

C. Methodological assessment

Based on the arguments above, we can locate the position of each participant as indicated in Table 2. Three observations will help understand the positioning in Table 2.

First, positioning may vary according to the judgment of the observer. However, this judgment may not matter significantly in determining the relative location of one scholar vis-à-vis that of other participants. For example, in contrast to Fisher's individualistic explanation, Clark resorts to holistic approach in explaining interest rate. To construct his theories, Boehm-Bawerk uses casual observations, such as technical superiority of making nets before catching fish, whereas Fisher deduces his explanation from the optimizing behavior of a rational agent.

Second, Fisher appears twice in Table 2 because his microeconomics and macroeconomics concepts take different approaches, at least in terms

of observation procedures. In his microeconomic explanation of prices including factor prices, he follows the explanation based on optimizing behavior. However, his macroeconomic explanation is oriented toward a more inductive direction because he invents several tools to measure current movement. In Table 2, the former approach is denoted as Fisher (1), and the latter as Fisher (2), which roughly match the research achievement in his earlier and later periods, respectively.

His micro- and macro-economic views follow the same methodological stance. His microeconomic explanation is a tool of analysis, whereas that of macroeconomics is a tool of testing. However, he does not fully specify the process of extending his micro-explanation in the entire economy. Thus, we may differentiate between two Fishers in this table.

Third, for further comparison, we include other approaches, such as Austrian and Marxian. If scholars from these schools directly participated in the controversy, it could have been extended into a larger battle-ground, even if earlier participants agreed with the points raised at that time and technical difficulties were resolved immediately.

III. Controversies in the 1930s

A. Overview

In 1930, Hayek published his seminal theoretical work, Prices and Production. Hayek argues that an extremely long investment project induced by a lower interest rate would be aborted because of changes in relative prices. His book generated controversies surrounding the measurement of capital in terms of production period and the macro-economic implication in the business cycle.

The controversy in this period appears more complex in three aspects. First, the structure of controversies is complicated. Three main figures, namely, Hayek, Knight, and Kaldor, disagree with each other and drag the controversy in a curved direction. Debates initially occurred between Hayek and Knight from 1931 to 1935, then between Kaldor and Knight from 1936 to 1939, and finally between Kaldor and Hayek from 1937 to 1941. The controversy stopped because Hayek did not study further the issues of capital after he published his final work on this topic, *The Pure Theory of Capital*, in 1941.

Second, during the controversies, the position of each participant seems to change more or less drastically. For example, Kaldor, who was influenced by Hayek and supported the Austrian side during the early

period, became more favorable to the Keynesian aggregate analysis. Hayek in *Prices and Production* seems to suggest the very simple equilibrium business framework, but emphasizes complexities in both capital and business cycle theories.[4] Knight intensifies his pragmatic view on a theory as heuristic by suggesting that a simple model based on the representative agent would be quite applicable in explaining the basic feature of a market economy.

Third, the topics in the 1930s are broader than that in the 1890s. In the earlier controversy, the concern of every participant is the explanation of the positive interest rate at the long-run state. In the 1930s, however, the theoretical concerns of participants were more diverse. Their microeconomic issues are not only the explanation of long-run equilibrium prices, but also for the short-run ones, as in the case of Hayek. They are also concerned about the application of their microeconomic framework to the macro-problem, such as depression and growth. In this regard, similar to Kaldor, the theorists advocate practical positions at the expense of rigorousness in microeconomic details.

With these points in mind, we proceed to review the controversies in the 1930s, which are comprised of three small debates, namely, the first one between Hayek and Knight, the second one between Kaldor and Knight, and the third one between Hayek and Knight.[5]

B. Hayek vs. Knight

In the early 1930s, Hayek and Knight argue over the issue of measuring capital. Hayek uses the period of production to characterize production process with the time span between construction and marketing. In his book, *Prices and Production* (1931), Hayek demonstrates the possible disruption of initial long-term investment due to the change of relative prices. This outcome is called the "Ricardo effect," in which

[4] Hayek seemed contradictory in the cyclical character of capital intensity: In *Prices and Production*, wherein he suggests the pro-cyclical movement of capital intensity, *i.e.*, upward movement of capital intensity in the boom. In a later work related to the "Ricardo effect," he proposes the anti-cyclical movement of capital intensity. In this regard, Thirwall (1987); Kimura (2006) believe that there were two Hayeks, but Desai (1991) interprets the latter work as analysis focused only on a certain phase of business cycle (downturn from a peak). Thus, no inconsistency exists between the earlier and later positions of Hayek.

[5] We may add a debate between Hayek and Keynes, but we omitted the argument because it is more related with the methodology of macroeconomics (See Zouache, 2008 for reference).

long-term investment cannot be accomplished. Given that a longer investment project brings about shortage of a consumption good, the price of this commodity rises and relative wages decrease. This situation, in turn, decreases the profitability of the original investment projects, and the new plan is aborted due to liquidation or shortage of credit.

In the same way that Clark criticized Boehm-Bawerk, Knight criticizes Hayek's usage of production period because Knight believes the concept has no meaning in the equilibrium-state.

> "It cannot now escape that 'capital' is an integrated, organic conception, and the notion that the investment in a particular investment comes back periodically in the form of product, giving the owner freedom to choose whether he will reinvest or not, is largely a fiction and a delusion ... the capital structure and every unit in it is typically planned itself, and not for liquidation." (Knight, 1935a, p. 83)

Knight further argues erroneously[6] that the production period would be zero at the equilibrium state or infinite with durable inputs.

> "Passing over the case of a society in the course of liquidation, the interval by which production precedes consumption is either zero or infinity. It is zero for the production of final product current consumed.... The interval is infinity, as regards the consumable product, for that "production" in which present services of productive agent are used to create new productive agents to be used in the future to produce consumable services. (Knight, 1935b, p. 625)

In response to Knight's criticism, Hayek agrees with the impossibility of measuring "capital" in terms of a physical unit. The period of investment is the sum of input flow weighted by the incurred interest rate.

> "It is for this reason, too, that it is impossible to substitute any one-dimensional magnitude like the "average period of production" for the concept of the investment function. For there is no single average period for which a quantity of factors could be invested with the result that the quantity of factors would be the same as if the same quantity of factors had been invested for the range of periods described by a given investment

[6] Dorfman (1959) proves that the average production period at the equilibrium state is positive and finite even when commodities are produced by commodities in the reproduction process.

function, whatever the rate of interest. The mean value of these different investment periods which would satisfy this condition would have to be different for every rate of interest." (Hayek, 1934, p. 217)

However, Hayek did not accept Knight's concept of a permanent fund of capital. Hayek calls the concept a "mythology" of eliminating "time" from the analysis of production process. Hence, the methodologically distinct positions of two authors are obvious.

C. Kaldor vs. Knight

In the latter half of the 1930s, capital controversy became more complicated because Kaldor appears on the scene. In his survey article on contemporary capital theories, Kaldor (1937) favorably writes on Hayek's contributions, following the Austrian tradition. Knight, who is more aggressive in attacking the Austrian treatment of capital, shifts his target from Hayek to Kaldor, and the capital controversies enter the second stage. Cohen (2006) summarizes three issues in the exchange between two scholars. The first issue is whether capital is a distinct factor of production. The second issue is whether capital is quantifiable in a theoretically consistent manner. The third issue is whether there is a need to process stories about changes toward different equilibrium interest rates. According to Cohen, Kaldor's answers are "Yes" but Knight's responses are "No" to all three points.

First, Kaldor views capital as a distinct factor because it is a result of time-consuming accumulation. Knight opposes this concept of capital. For Knight, the value of capital is merely a sum of all future incomes:

"The total capital in a system means simply the aggregate present worth of all its capitalizable income items, however defined.... The capitalization rate measures the yield of new investment at the margin of growth. The choice of items to be capitalized is certainly not affected by their origin or past history." (Knight, 1938, p. 79)

For the second issue, both authors agree on technical points, but they have different opinions on the usefulness of "time" element in the analysis of production. Knight abandons any index as the proxy for the production period.

"The notion of an investment period should be used only in connection with a careful statement of conditions. The notion of capital can hardly

be dismissed as meaningless, but no 'index' can have any high degree of accuracy. (Knight, 1938, p. 82)"

Nonetheless, Kaldor (1938) still believes in finding a meaningful index that represents the variations of investment period, such as initial cost over annual operation cost.

One interesting topic related to these issues is the cause of "diminishing returns." If all factors are treated equally, as Knight does in his analysis, no a priori reason could explain why some factors are limited. In this regard, Knight views "knowledge" as a candidate for fixed factor, whereas Kaldor presupposes the existence of other "fixed factor" as the cause of decreasing marginal rate of return on investment.[7] Kaldor (1937) criticizes Knight for not offering any explanation on why an increase in capital should lead to a fall in interest. Knight does not respond directly to this criticism because he thinks that the normal-equilibrium price analysis could not be applied to a capital market. Knight does not feel the need to develop a "dynamic" framework to explain the equilibration process. This perspective contradicts the Austrian approach, wherein the events in the "process" were one of the utmost concerns.

D. Kaldor's break away from Hayek

The controversy between Kaldor and Hayek was rather odd because Kaldor appears initially to support the Austrian concept of capital in terms of production period. Kaldor, who was a student of Hayek, even joined in translating Hayek's German works into English in the early 1930s. However, the time and the reason Kaldor changed his position are undetermined.[8]

However, Kaldor and Hayek certainly ended up with very different

[7] Cohen (2006) points out one interesting finding wherein Knight explains the cause of growth in terms of accumulation of knowledge, as suggested by the modern theory of endogenous growth. This view is logically natural because this is perhaps the only possible way of explaining continued growth in the individualistic account of growth as a macro-phenomenon.

[8] Desai (1991) offers a three-stage story of Kaldor's break-up from Hayek's adherence in the early 1930s, from a decisive break in 1939 and finally to the state of speaking totally different languages in 1942. However, based on the biographical account of Thirwall (1987); Kimura (2006) argues that Kaldor was not so adherent to the Austrian thought. He started to lose respect for Hayek's contribution when he was translating Hayek's works because it did not give a clear-cut answer to real-world problems.

policy views on depressions in the late 1930s. Kaldor (1942) criticizes Hayek's "Ricardo effect" for lack of any real ground. The increase of consumption demand would bring about investment and thus help overcome depression. This view is different from the explanation of Hayek. According to Hayek, the price increase of a consumption good due to excess demand or shortage of supply would lead to a decrease in real wage, which will consequently abort a long investment project. In a word, Kaldor's position moves further away from the Austrian school and closer to Keynes.

In addition to his shift in policy view, Kaldor's analytical framework is more similar to Keynesian aggregate tools. Kaldor abandons the concept of investment period and uses capital intensity and aggregate production function. He is more concerned with broad and long-term tendencies, rather than with tiny complexities during transition.

Hayek still does not accept Kaldor's criticism even though he agrees that the "Ricardo effect" might not have considerable impact on the real world:

> "What Mr. Kaldor and Mr. Wilson completely disregard is that in comparing the profits obtained from producing with different methods they are comparing methods employing different amounts of capital without counting in any way the cost of creating their extra real capital required for the one of the two methods. They do this by omitting to give any attention to what will happen during the period of transition before the new equipment is available." (Hayek, 1942, p. 142)

Hayek still pays considerable attention to the dynamic process and aims to keep the concept of "period" in whatever dimension the concept would be analyzed:

> "It is rather unfortunate that the time aspect of production should have been first introduced into theoretical analysis in this form, for it has led to much unnecessary confusion. But since use of the expression "changes in the length of the process" is a convenient way of describing the type of change in a whole process where the changes in the investment periods are predominantly in one direction, there is probably something to be said for retaining it, provided it is used cautiously..." (Hayek, 1941, p. 70)

Like other Austrians, Hayek was mainly concerned with the equilibration process. He searched for an analytical tool to deal with dynamic

processes. Thus, a compromise between two parallel positions of Kaldor and Hayek is unlikely.

E. Methodological divergence

The capital controversy of the 1930s is not a simple replay of one in the 1890s. All participants in the 1930s are aware of the impossibility of measuring capital in terms of a single physical unit and measuring the complexities arising from a compound interest rate in calculating the value of capital. Thus, the topics of the controversy look less technical than structural or methodological. Now, we turn our attention to methodological positions of participants.

First, Hayek's position in methodology is typically Austrian. He concentrates on individual behavior and its causal implication. Hayek's deductive position is not clear, but his attitude toward the empirical aspects of theory was not similar to the mainstream Neoclassical position of testing. Steele (2007) interprets Hayek's empirical investigation of causal process:

> "Deductive reasoning is pertinent only in respect of the decisions of a single agent, but empirical propositions are essential if the formal apparatus of economic of economic analysis is to serve as a basis for explanations of socio-economic coordination between individuals. An empirical proposition is one that relates to a number of agents and which says that 'if we find such and such conditions, such and such consequences will follow." (Steele, 2007, p. 91)

Second, Knight adheres to his basic approach even though his specific models vary over the years. One interesting model at the final stage of Knight's research was "Crusonia," in which the interest rate can be explained by the growth rate of this one-good economy. The original position of Knight can be called the "old Knight," and the simple "Crusonia" model as the "new Knight." Whatever the difference between the old and new Knight is, the direction of Knight is perhaps similar to the extremist position in modern economics in dealing with the discrepancy between micro- and macro-analysis. Knight goes farthest to the individualist-deductive direction, even denying the need for finding rigorous empirical ground, as Gonce (1972) suggests:

> "There are no similar use tying the pure science onto empirical phenomena; the applied science cannot be decisively verified; and the conclusion that

TABLE 3
POSITIONING OF PARTICIPANTS IN THE 1930S

Classification	Less Abstract	More Abstract
More Individualistic	Hayek	Knight
Less Individualistic	Kaldor	

> the pure science is analogous to an empirical theory in the natural sciences would contradict his thought. On the contrary, ... it implies that the pure science is useful propaedeutic, for by guiding empirical research that results in its being corrected and supplemented, it can yield approximately empirical laws." (Gonce, 1972, reprinted in M. Blaug ed., 1992, p. 31)

Third, we find that Kaldor's position is closer to that of Keynes when he begins to use the aggregate approach in analyzing the trade cycle. Kaldor is concerned with such macro issues as trade cycle and growth that he tries to find "stylized facts" at the aggregate level. In this light, Lawson (1989) characterizes the Kaldor methodology as realist:

> "Since facts, as recorded by statisticians, are always subject to numerous snags and qualifications, and for that reason are incapable of being accurately summarized, the theorist, in my view, should be free to start off with a 'stylised' view of the facts—*i.e.* concentrate on broad tendencies, ignoring individual detail, and proceed on the 'as if' method, *i.e.* construct a hypothesis that could account for these 'stylised facts' without necessarily committing himself to the historical accuracy." (Kaldor, 1961 recited from T. Lawson, 1989, p. 59)

The methodological stances of the three positions are shown in Table 3.

By comparing the methodological positions of participants, we can see why the controversy was prolonged, although all participants in the 1930s agreed on many technical aspects of capital theories. To overcome the difficulty of measuring capital, all participants had to find their own way of describing a capital-using economy. Hayek provides a more detailed description of the process of production. Kaldor begins to concentrate on the accumulation and growth at the macro-level. Knight analyzes the economy from the perspective of "representative agent," treating all factors on equal footing.

Thus, the controversy appears less technical than conceptual. This description is probably the reason such controversy did not draw consi-

derable attention in the 1960s. Another reason was the presence of a situational factor regarding the Great Depression, which was a more serious issue.

One noteworthy point in this controversy is whether the debate has an impact on the development of further economic theories, especially with respect to the neoclassical "General Equilibrium Revolution" in the 1950s. Milgate (1979) raises this issue and implies that Hayek has invented the concept of "intertemporal general equilibrium" for the first time in theoretical history. Hayek noticed that the long-run equilibrium would be incompatible with the demand-and-supply theory of prices. However, as some Austrians argue, *e.g.*, S. Boehm (1986), Hayek's invention does not mainly owe to logical inconsistency, but to his intention to inquire into the actual process of market mechanism.

The answer to this question is not simple because the development of a specific concept is related to several factors, such as the effect of mathematical skills, shift in the interests of economists, and changes in the research environment. The final answer may be drawn when all related factors are considered. However, Hayek's invention clearly did not draw much attention in the 1930s because he was more concerned with the adjustment process and did not try to develop the equilibrium tools further.

IV. Methodological look at modern capital controversies

A. Sequence of events

The modern capital controversy in the 1960s was one of the most famous controversies in the history of economic theory. The participants were front runners in two Cambridge campuses across the Atlantic, *i.e.*, J. Robinson, and P. Sraffa in Cambridge, U.K. and P. Samuelson and R. Solow in Cambridge, MA, U.S.A.

The problem of measuring "capital" was first raised by J. Robinson (1954). She points out that the explanation of interest rate based on the marginal product of "capital" is bound to fail because measuring the aggregate capital would require interest rate. Sraffa (1960) criticizes the marginalist explanation of distribution on the same ground. He gives a simple numerical example, in which one technique could be chosen twice with the increase of interest rate. This strange-looking case is called "reswitching."

Samuelson (1962) refutes the criticism of U.K. Cambridge economists

by suggesting that "reswitching" would not occur under the continuous production function with substitutable factors. He constructs the "surrogate" production function by collecting points on the factor-price frontier under the assumption of optimizing the behavior of a firm under given factor prices. Solow (1963) suggests an alternative way of measuring interest rate, *i.e.*, the concept of "rate of return on investment" or the proportion of change in income to change in the amount of capital. In defending Solow's new measure and his own tool, Samuelson emphasizes the empirical usefulness of these concepts despite lack of theoretical rigor.

> "... instead, by heroic abstraction, he has carried forward the seminal work of Paul H. Douglas on testing a single production function for society and has had a tremendous influence on analyst of statistical trends in the important macroaggregates of our economy. One might almost say that there are two Solows-the orthodox priest of the MIT school and the busman on a holiday who operates brilliantly and without inhibitions in the rough-and-ready realm of empirical heuristics. Just as red wine and white wine are both good, so are both Solows of vintage quality." (Samuelson, 1962, pp. 193-4)

However, Gareganani (1966, 1970) shows that the new measures suggested by both authors will only be valid under very limited conditions. Samuelson's "surrogate" production function can be generated only under the assumption of equal factor intensity for all sectors, and Fisher's "rate of return" requires the assumption of fixed relative prices. Even with continuous production function, a "capital reversal" or a positive relation between the increase of the value of capital and the interest rate could happen.

In a symposium recorded in the *Quarterly Journal of Economics*, Samuelson (1966) summarizes the discussion results that indicated the various schools of thought that agree with the main findings. The battle appears to end with a partial victory of the British side, wherein Levhari, and Samuelson (1966) admit their errors of disproving the possibility of reswitching. However, the long-term effects of the war were different.

B. Methodological account of "method"

No agreement was reached regarding the real impact of the modern controversy. However, incompatibility between the long-run equilibrium position and the Neoclassical account of interest rate was harshly at-

tacked by Gareganani and others. Neoclassical economists downplay the importance of reswitching and capital reversal on two grounds. Neoclassical economists empirically argue the slim possibility of these paradoxes to occur in the real world. The famous author of a micro-economics textbook states that:

> "If there is 'enough' substitutability in the economy, either between factors of production or between commodities in demand, neoclassical theory emerges unscathed. Otherwise not. The crucial point to emphasize is that the validity of neoclassical theory is an empirical, not a theoretical question." (C.E. Ferguson, 1969, p. 258)

More importantly, a change occurs in the object of theory from the long- to short-run positions. This change initially looks subtle, but it becomes outright and clear. Stiglitz (1973) and Bliss (1975) argue that the long-run position should not be treated seriously because the long-run position would be obtained in a special steady-state in which all variables would move proportionally.

> "The rate of interest is not a legitimate concept outside the particular and special conditions of semi-stationary growth with a constant-rate-of-interest price system. The orthodox vision includes the statement that the rate of interest will decline as capital accumulation proceeds. Strictly, in the present case, that statement cannot be interpreted. We have a whole structure of interest rates, even in one week, not a single rate of interest. Which rate of interest should decline to validate the orthodox vision? The question is otiose." (Bliss, 1975, p. 294)

In the same fashion, Dixit (1976) proclaims a clear detachment from the earlier Neoclassical position by stating that, "what we should give up is slavish subservience to the shibboleth of *the* rate of interest, and not the general structure of intertemporal equilibrium" (Dixit, 1976, p. 17).

Sraffian researchers do not accept the neoclassical interpretation of the controversy. Sraffians argue that the long-run position of an economy would not be a special case of short-run equilibrium, but rather an outcome of a general tendency toward which short-run equilibrium would gravitate. Moreover, the theoretical possibility of paradoxes concerning capital cannot be neglected on an empirical ground.

TABLE 4
POSITIONING OF PARTICIPANTS IN THE MODERN CAPITAL CONTROVERSY

Classification	Less Abstract	Abstract	More Abstract
Most Individualistic			Bliss and others
Individualistic		Solow	(Early) Samuelson
Less Individualistic	Joan Robinson	Sraffians	

"Because they are essential propositions about alternative equilibrium states, they are not subject to empirical falsification as some econometricians and neoclassical exponents have argued." (Harcourt, 1973, p. 1263)

These two contrasting positions regarding the significance of reswitching phenomenon are related to a method of inquiry and their practices of conducting the "sciences." For instance, what should we look for in analyzing the market economy, long-run or short-run positions? Should we describe a capital-using economy as class interest or individual optimization? In the present standpoint, each side of modern capital controversy seems to look at a different object with a different method and follows its own route after the controversy as if nothing happened.

In summary, the following table shows that similar shifts in methodological positions have been repeated for a century, but the analytical level of discussion has advanced.[9]

V. Methodological wrap-up

Given that the theory of distribution is one of the most frequently debated issues in the history of economics, several controversies have occurred concerning the measure of capital. One of the earliest controversies on the measurement of capital in a capital-using economy occurred in the 1890s and 1900s. The main figure of this controversy was an Austrian economist, Boehm-Bawerk, who suggested the measurement of capital in terms of production period. Most of the participants in this controversy belonged to the neoclassical camp in a broader sense and the contents of this controversy are basically technical. The arguments could have been resolved easily had they mastered more advanced mathematical skills, such as dynamic optimization.

[9] Neoclassical macro-analysis similar to that of Solow is somewhat awkward because it cannot avoid using aggregate variables without microfoundation.

One subtle but noteworthy difference is that Boehm-Bawerk aimed for a more realistic assumption, whereas Clark and Fisher wanted to deduct their arguments from more abstract postulates. The other difference lies in individualist/holistic dimensions. Fisher seemed to depend more heavily on individualist methodology than Clark.

The controversies in the 1930s appeared to be a simple replay of the first one. However, the theoretical concern of participants was quite different. Hayek was more concerned with the process of market adjustment, whereas Knight was more concerned with steady-state equilibrium. Thus, the debate on the method to measure capital might be regarded as a side-show in their theoretical orientations without generating technical development.

The modern capital controversy in the 1960s looked fierce because it touched upon technical and conceptual issues. In the first phase, the participants seemed to throw deadly blows at each other. The Neoclassical players sustained serious wounds as the Neoclassical economists agreed with the technical aspects raised by Sraffian economists. However, the only fruitful result is that both sides confirmed that they were observing different objects of the economy, wherein one observed the short-run position, whereas the other focused on the long-run.

Based on the theoretical structures, we conclude that measuring capital in aggregate physical terms may not be needed by any side. Neoclassical microeconomics depicts individual behavior in a short-run market, and the Sraffian theory of prices can be constructed under the multiple fixed input techniques.

However, the concept of capital is not needed in defending their theories on empirical grounds. The aggregate production function in Neoclassical economics is used to test a hypothesis, similar to the relation between factor intensity and distribution. Neoclassical economists seem to justify their practice based on the methodology of "positive economics," as suggested by Friedman. According to Friedman, the usefulness of prediction is more important than the validity of assumption.

In Sraffian macroeconomics, the concept of capital is used to describe the behavior of capitalists, although Sraffians seem to avoid linking the amount of capital to the interest rate. However, finding appropriate data on the long-run rate of interest may be more difficult. The current situation reflects the difficulty in analyzing the production process in such a simple way as to easily conform to testing, which is required to support theories constructed deductively.

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