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BACHELOR THESIS

The Theory of Capital in Past Economic Thought

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Declaration of Authorship

Hereby I declare that I compiled this thesis independently, using only the listed resources and literature. I also declare that the presented work was not used to acquire any other academic degree.

Prague, May 17, 2011

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Signature

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Abstract

The objective of this thesis is to provide an overview of the development of the theory of capital until 1950´s. We identify the main questions that are to be answered in the theory of capital and then recall the respective opinions of several well-known economists, including Adam Smith, Eugene von Böhm-Bawerk, Fridrich A. von Hayek and Joan Robinson. Main focus of our thesis is on the role of capital in production. We discuss the importance of time factor in capital theories. To illustrate the possible employment of time in the theory of production, we present the concepts of roundaboutness and production period, which are typical for the Austrian economic school. Three capital controversies are described to show the contrast between various theories of capital and to suggest the implications of their disaccord for the whole economic theory.

Keywords: capital, interest, profit, production function, capital controversy

Abstrakt

Cílem této práce je poskytnout přehled o vývoji teorie kapitálu do konce padesátých let dvacátého století. Rozpoznáváme nejdůležitější otázky, kterým by se teorie kapitálu měla věnovat, a poté přibližujeme odpovídající názory několika známých ekonomů, mezi kterými je Adam Smith, Eugen von Böhm-Bawerk, Fridrich A. von Hayek a Joan Robinson. Zaměřujeme se zejména na úlohu kapitálu ve výrobě. Rozebíráme důležitost časového faktoru v teorii kapitálu. Jako příklad možného užití času v teorii výroby představujeme koncepty oklikovosti a období výroby, které jsou typické pro rakouskou ekonomickou školu. Abychom naznačili rozdíly mezi jednotlivými teoriemi, zahrnujeme popis tří velkých sporů v teorii kapitálu. Z něj by rovněž měly být zřejmé možné implikace těchto nejasností pro celou ekonomickou teorii.

Klíčová slova: kapitál, úrok, zisk, produkční funkce, capital controversy

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1 Introduction

Capital, seen mainly from the perspective of a production process, lies in the core of this work. The reason to choose capital as the subject of investigation is this: out of the three production factors, it seems to be the most complicated one. Since the 18th century, many economists strived to develop their own, proper definition of capital, followed by an explanation of its role in an economy. Looking at the variety of past works concerning capital can be a bit puzzling nowadays. On the other hand, seeking help in understanding capital in current textbook might not be successful either: few of them describe capital in detail. This work should provide a clear guidance to the most important past contributions to the theory of capital.

There are of course several books that summarize the development of the theory of capital, but their extent is often enormous. Examples include *Capital theory* edited by Bliss and Cohen (2005), three volumes of articles on this topic. On the other hand, introductory articles, such as *Austrian Capital Theory and The Future of Macroeconomics* (Garrison, 1991) offer only the basic notions. We can find a lot of information, especially on capital controversies, in articles dealing with one separate topic at a time such as *Some Cambridge Controversies in the Theory of Capital* (Harcourt, 1969). However, to find one text that would give a brief, but sufficiently deep summary of the past theory of capital might be difficult. That is exactly what our work attempts to do. We choose several distinguished economists whose opinions on capital it discusses to illustrate the development of the theory of capital. Special focus is laid on capital controversies to help the reader realize the difficulties which accompany any serious capital treatment.

We proceed chronologically, each chapter devoted to one big period in history. After the general introduction to the basic concepts (definition of capital, capital market, roles of capital) in this chapter, Chapter 2 will recall capital treatment of several famous classical economists, beginning with Adam Smith. In Chapter 3, we move to the period following the marginal revolution of 1870´s and describe two distinct approaches to capital: Austrian, represented mainly by E. Böhm-Bawerk, and neoclassical, as can be found in the works of J. B. Clark. Chapter 4 will contrast the views of economists of the 1940´s, with special attention devoted to F. A. von Hayek and his theory of capital and investment. The last chapter is included to provide a brief exposition of the Cambridge capital controversy and to show how deep into the economic theory the issues concerning capital may lead.

1.1 Basic definition of capital

We assume that everybody has a basic notion concerning the meaning of capital. In spite of that, we will include a few definitions here: they should serve as a starting point of our investigation. In the course of our work, when we examine the treatment of capital by many famous economists, we will see that these simple definitions do not sufficiently cover the complicated nature of capital.

Although **capital** is a term commonly used in accounting or business practice, the images each usage of the term evokes might vary a lot for different people. Elementary economic textbooks do not provide much clarification on this point. Capital is often presented as one of the three basic **factors of production**: land, labour and capital. One sentence is usually considered sufficient for its definition. For example Mankiw in *Principles of economics* writes:

> "Economists use the term capital to refer to the stock of equipment and structures used for production." (Mankiw, 2008, pp. 408)

On the basis of such a definition, his remark that the definition of capital is somewhat trickier than in the case of labour or land does not have to be understood.

Other definitions will probably all seem similar, but even small differences at the beginning might prove to be important later on. For example Arnold speaks about "produced goods", an often mention characteristic of capital lacking in Mankiw. (Arnold 2008)

Modern economics works with much more than just machines and other **physical capital**. The word is often used in a broader sense. **Human capital** and other intangible assets are attracting even more attention among researchers. Other sources identify capital with **wealth**. World Bank in its publication *Where is the Wealth of Nations: Measuring Capital for the 21st Century* speaks about four distinct components of wealth: natural capital (natural resources), produced capital, human capital and **institutional capital**. The estimates of total wealth suggest that the last two classes are the most important in all countries.

Human capital designates the skills and knowledge an individual has acquired at school, on the job or by experience. Institutional capital expresses the quality of institutions represented by government and other public agencies, in a country. It can be measured as the rule of law. As these two categories have not been much investigated by economists until a couple of decades ago, we will not include them into our work. Instead we focus solely on the origins of theories related to physical capital.

1.2 Capital market and its equilibrium

Mankiw´s description of the capital market stems from the neoclassical income distribution theory. This is undoubtedly the mainstream approach to economic teaching. Here, students encounter the simple laws of **diminishing returns** and **decreasing marginal productivity**. Supply and demand for capital determine the equilibrium on the market: this gives us the price paid to the capital owners (rental price of capital in Fig.1). Supply of capital is determined by the existing conditions in the economy – capital first needs to be produced before it can provide useful services. Demand for capital is given by the value of its marginal product. The law of diminishing returns means that with increasing quantity of capital, its marginal product decreases.

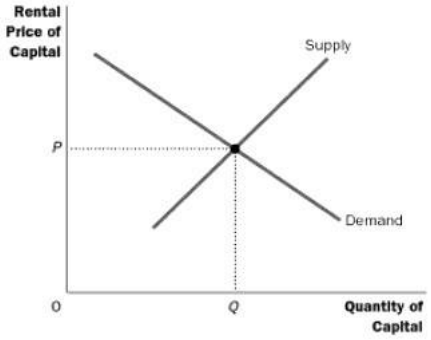

Fig. 1 Market for capital (Mankiw 2008)

If one stops to thing about this fact, they might come to a question about the meaning of the "**quantity of capital**" given that we define capital as a stock of physical objects. The answer cannot be found in the introductory chapter, as no simple answer exists. However, such an early confrontation with one of the deep problems of economic theory might be unsettling. The simplified picture a student gets from the book is much more positive – an analogy can be drawn between the three factors of production, land, labour, and capital. After some investigation into the theory of capital, we realize the need to abandon this analogy and study capital separately.

1.3 The role of capital in different parts of current economic theory

When we recognize the multiple occurrences of the term "capital" in economic theory, we might ask about the true subject of the theory of capital, or even if there exists such a part of economics deserving this name. Instead of a theory of capital, we might speak about a theory of investment, theory of interest or theory of economic growth. Now

we will look at the individual parts of economic theory where we are likely to encounter capital. This should give the basic notion about topics treated further in this work.

1.) Capital in production: capital possesses "productive powers" and helps to produce new goods, including new capital items. Graphically, the basic tool is a **production function**, showing the relation between factors of production and their output.

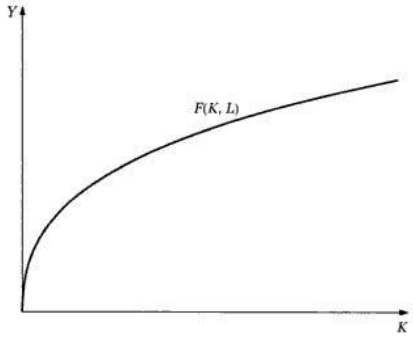

Fig. 2 Production function with fixed quantity of labour (Barro 1997)

2.) Capital and its relation to interest: interest is both the price for loanable funds and the return on capital goods, as these tend to equality. (Arnold 2008) This is because entrepreneurs choose to invest their funds until the highest possible **rate of return** equals the rate of interest. This is depicted in Figure 3. We find the desired level of capital at the point where marginal product of capital (a decreasing function) reduced for **depreciation** equals the real rate of interest.

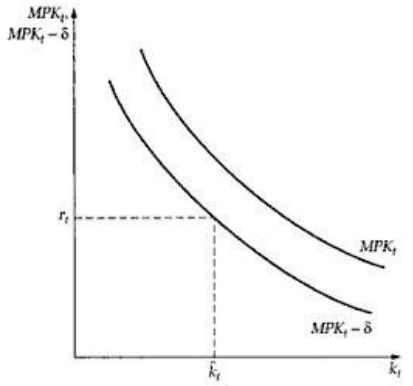

Fig. 3 Desired level of capital (Barro 1997)

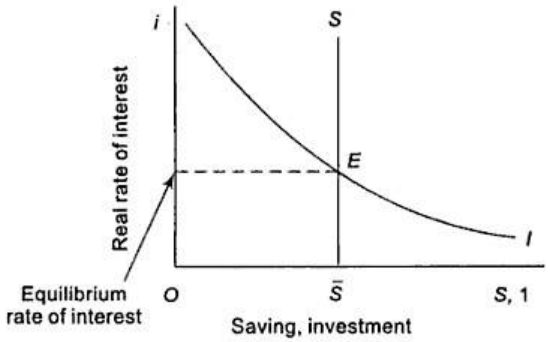

Fig. 4 Rate of interest determination (Deepashree 2006)

Interest rate is sometimes said to be simply the **price for capital**. The question of interest rate determination has more than one answer. A possible way how to calculate the interest rate is offered in Figure 4 above. We can see a part of the standard neoclassical model where savings are constant and investment is a function of the rate of interest. Saving must equal investment: this gives us the equilibrium rate of interest.

3.) Capital in growth theory: capital is one of the determinants of economic growth, as capital **investment** can lead to an increase in labour productivity. However, to invest capital means to abstain from present consumption, i.e. to save. Another determinant of growth, **technological changes**, can also mean introducing new, more efficient capital goods. There are several basic growth models: Harrod-Domar or Solow model. The equilibrium in such models, called steady state, is a (hypothetical) situation when the quantity of capital does not change, in other words, it is the end of capital accumulation.

1.4 Problems of the theory of capital

Since its beginnings, the theory of capital has not been developing as one homogeneous body. There was never an accord even on the definition of basic terms like capital and interest. No theory managed to secure the status of the widely accepted mainstream. The theory of capital moved forward in a series of **controversies**, with two opposing sides unable to decisively falsify the other theory, so that it would never find new followers, willing to add some fresh thoughts to it. Unsuccessful attempts of many generations of economists in search for the optimal theory of capital led, in the end, mostly to a complete refutation of the underlying problem, with lots of questions remaining open. Economists started to claim that the key question is badly posed, and abandoned the theory of capital in favour of other, less problematic approaches towards macroeconomics.

If we do not accept this radical proposition and try to uncover the theory of capital, to investigate its nature and various forms it took in the past, we are bound to encounter a

great number of varying opinions. Below is a list of several key points we will follow in discussing the particular works more in detail. Not all of them touch all these issues, and the list was designed mainly for an improved orientation in further discourse. Having them in mind and knowing what to observe, contrasting different views and opinions should become a lot easier.

1. The exact formulation of the definition of capital
2. Productivity as a feature of capital
3. Dual nature of capital
4. The origin of capital and its accumulation
5. Measuring the quantity of capital
6. Determinants of the rate of interest and profit
7. Relationship between profit and interest

2 First notions of the theory of capital

2.1 Origins of economic science – mercantilism

Mercantilism, widely known doctrine that advised countries to keep **positive trade balance,** or, in its most primitive form, to keep all gold and „treasure“ within the country, was far from a homogenous school of though. (Screpanti, Zamagni 2005) The interpretation of their opinions about capital, then, might not be so easy and straightforward. However, it has its place in almost every book tracing the history of economics, so we will begin with their treatment of capital. After all, it can well illustrate the problems recurring with every future attempt to define capital.

One thing we have to realize is the fact that capital was a term known from business practice. Even though no clear definition of capital existed, all businessmen were able to speak about their capital or to estimate its value. This might be the cause explaining why capital entered the economic literature without a proper definition, a disregard of something seeming obvious - that later proved to be far more important than most would expect.

Capital equals money

Putting equivalence between these two terms would explain mercantilists´ overemphasis on positive trade balance as the only source of wealth. For Adam Smith, this is one of the basic points of his critique of mercantilism. It his eyes, it is a theory build on the false assumption of capital being equal to money, and thus promoting erroneous methods for accumulation of wealth.

Adam Smith´s assertion is not completely wrong, but there is available evidence that some mercantilists (Thomas Mun, John Locke) were well aware of the difference and their description of capital would include not only money, but also land, buildings or even consumable goods. (Blaug 1985, pp. 11) The problem is thus not in the description itself, but in the way of its usage. The majority of works that give such a list of goods constituting capital forget about it when it is time to use capital to explain other economic phenomena. Capital is again reduced to money, whose homogeneous nature makes it easy to incorporate them into any theory, in opposition to the troubles we are facing when we choose to have capital in economic models.

2.2 Classical political economics

Still a long way from becoming an exact science with sophisticated methodology and a wide application of mathematics, economics in this period received firm foundations, the first truly theoretical works being published, where economics was build not only for its practical implications and the need for rules in economic policy.

Classical writers discuss capital under the **theory of distribution** rather than production, and their ultimate goal related to it is to explain the causes of **economic growth**. The attempt to include all substantial economic knowledge into one work, which was quite common at that time, makes the theory sometimes a bit puzzling, some economic laws are formulated very vaguely and some questions (e.g., the determination of the rate of interest) are left open.

Since the beginnings, we may observe different branches of economic though with important disaccord on key points among them, and this makes the study of general principles quite complicated. An example of varying opinions in the theory of capital can be found in the distinction between fixed and circulating capital. Smith and Ricardo work with different criteria to determine the character of concrete capital goods in question. The only chance is maybe looking directly into particular writings and then comparing different views of their authors.

2.2.1 Adam Smith

We start our examination of the role of capital in major economic works by a look at Adam Smith´s *The Inquiry into the Wealth of Nations*, the book that had a great importance on the history of economics. Instead of identifying capital with money, a simple solution that would give no reason for the term capital to exist, Adam Smith takes a great care to provide the reader with a proper definition of capital, enumerating its parts and then developing a theory of capital accumulation as an engine of growth. In this section, we will describe his views on the most important issues related to capital: first, what is capital and why it is important for the society, and then its quantity, price and productivity.

Capital facilitates division of labour

In the book, the division of labour, presented as a key way how to bring the society to a more developed stage, is inherently related to the concept of **stock**. Stock is a general term for all the useful resources a society has accumulated. Capital itself is considered part

of that stock. Adam Smith tries to describe the process of a transition of the original, raw state of society, towards a more developed one. This process is put into motion by the **division of labour**, which itself requires some stock to be accumulated in advance.

This stock has to sustain the labourers, whose produce can now satisfy only a small part of their wants. They have to buy the rest of necessaries in exchange for their produce. However, to live through the time that elapses till their produce is finished, they have to draw the resources needed from the stock already accumulated. (Smith 1904, chapter II.I.2) Its accumulation offers two different types of benefits: first, with more stock, the productive powers of labour are increased, second, the same quantity of industry is able to employ more labour.

Thus, the general frame which holds the concept of capital could be seen as a theory of growth, that searches the causes of progress in the society, and when it identifies the division of labour as one of them, it includes capital accumulation in the conditions for it.[1]

Capital as a part of stock

Smith defines **capital** when he speaks about a stock of a man.

> "His whole stock, therefore, is distinguished into two parts. That part which, he expects, is to afford him this revenue, is called his capital. The other is that which supplies his immediate consumption." (Smith 1904, II.1.2)

The purpose of capital is to increase the wealth of the society, to help it consume more, without drawing from the already existing stock of capital. We encounter a remarkably thorough classification of capital into different kinds, and this classification marks the form of the succeeding discourse. Smith´s distinction between fixed and circulating capital is based on the ways of its employment. If it stays with its owner for the whole time, it is **fixed capital**. **Circulating capital**, on the other hand, can make profit only by changing hands. It is those employed in „raising, manufacturing and purchasing goods and selling at a profit". (Smith 1904, II.I.4) Fixed capital is used to cultivate land or purchase machines that facilitate production.

Money as a part of circulating capital

Money is a part of circulating capital, other components being materials, provisions and finished work yet unsold to the final consumer. At the same time, according to A. Smith, money in some aspects is similar to fixed capital: as they do not form part of a net

[1] In the rude state of society, all stock was consumed, whereas progress has made possible to use part of it for other purposes, and only then capital becomes important for the economy.

revenue of a society, which is the gross revenue minus the expense necessary for the replacement of fixed capital. On the contrary, the maintenance of circulating capital, money excluded, does not decrease the net revenue of a society. (Smith 1904, II.2.9.)

The special attention devoted to money and lots of exceptions from the general statements about circulating capital[1] makes the reader think about the reasons for including money in the circulating capital. Is there other approach A. Smith could adopt, though? Money certainly do not satisfy the necessary conditions for being classified as fixed capital, and excluding it from capital altogether, in spite of most capital being expressed in money, seems to be a too radical move. Other possibility is to redefine the two categories so that money would fall into one of them without the need for so many exceptions, the other to designate a special third category reserved for money only.

Obtaining revenue from capital

The two types of capital are closely linked. All fixed capital was originally circulating capital, and it can not yield revenue without its continuous support. Circulating capital that is not money is regularly transformed into fixed capital, or goods for immediate consumption.

Smith claims that all sensible men will employ all their capital to obtain the maximum profit possible, unless there is a considerable degree of violence and insecurity in the country, which forces them to leave part of their capital idle as a treasure. (Smith 1904, II.1.31)

Changes in the quantity of capital

After defining capital, we should be able to describe the factors that can cause a change in its quantity. Here, we are led to consider the character of people and their behaviour. The assertion that "capital is increased by parsimony, and decreased by prodigality and misconduct" is made. (Smith 1904, II.3.14) Smith assures the reader that positive features of our character prevail, and that our want for better future prevents us from consuming more than we should to satisfy the passion for present enjoyment and thus diminishing the level of capital existing at present. Smith further believes in the abilities of entrepreneurs, that successful undertakings are more common than failures, and, therefore, level of capital will not decrease due to widespread misconduct. In general, capital can be increased only by **savings** from revenue.

[1] e.g. it is the only part of circulating capital that is not regularly withdrawn from it to bring revenue

Broader context to changes in the level of capital is given by looking at the annual produce of a country. It naturally divides itself into two parts: one goes to **replacement of capital**, and the second becomes profit of the capital owner, revenue. He has the deciding power about its use: one possibility is to invest it to buy more productive labour,[1] the other spend it unproductively. This choice has deciding impact on changes in the quantity of capital.

Capital and wealth of a society

Historical development enters the analysis here to illustrate the righteousness of the theory: in feudal Europe, little capital was employed in production, so that only a small part of annual product had to go to its replacement, the rest was a revenue, which supported the rich, who were not forced to save much, and their excessive spending did not allow for the increase in capital. Smith relates the quantity of capital directly to the industrious or idle character of society: with more capital, most annual produce goes to productive hands (this includes capital replacement), and little rests for idleness. He concludes this exposition by stating positive impact on exchangeable value of goods and, in the end, real wealth of the society. Next, a link between capital the annual produce of land is shown: both ways how to increase annual produce, namely increase in the number of labourers or in their productivity, demand increase in the quantity of capital, either circulating or fixed.

Profit of capital and its share in prices

Concerning **profit of stock**, it is considered as a part of price that consumer pays, together with wage of labour and land rent. The theory is not so transparent here: it has difficulties to explain what determines the share of profit in price. Given that wage is at subsistence minimum, we still have to resolve the question of division of the rest between rent and profit.

Smith was well aware of different rates of profit in different industrial branches: in an attempt for explanation, he constructs another classification where he divides possible employment of capital into four categories. (Smith 1904, II.5.2.) The first category combines the use of the power of capital with the original productive powers of land, mines, fisheries. In the second category, capital is employed in manufacture, and wholesale and retail trade makes for the rest. All four parts are essential, for example, if retail trade would be omitted and we would be forced to buy everything in large quantities, less capital

[1] in Smith´s view, the manufacturing sector is productive, whereas services are not (Smith 1904, II.3.1)

would be available to employ productive labour, because part of it being tied in goods for immediate consumption not consumed right after its purchase.

Possible employments of capital and their productivity

The contribution of the same quantity of capital to annual produce of land then varies according to the sector where it is employed. Smith proceeds case by case in discussing how much each way of employment of capital adds to annual produce. His analysis ends with a conclusion that the first possible employment, in agriculture, puts into motion the greatest quantity of labour, by cooperation with the powers of nature. It is thus most advantageous to the society.

He offers a general scheme how a society should advance: first employ capital in agriculture, then in manufacture, then in foreign trade. The reason why, in reality, capital takes up all four employments, although more land for agriculture is available, is, according to Smith, the discrepancy between the goals of individual capital owners and the whole society. (Smith 1904, II.5.36) An individual seeks to maximize his own profit, which is the sole base for his decision on how to invest. Since profit in agriculture does not have to be higher than profit in other branches, decisions of individuals do not automatically put the society on the best track to development. By observing this, Smith only leaves the most interesting part – the explanation of different rates of profits – unanswered.

After reading this, we might ask whether Smith ascribes to capital direct productivity, or whether it is its cooperation with labour and natural powers that results in extra productivity (in comparison with the same quantities being used without the support of capital).[1] Smith´s criterion for productivity of capital, the quantity of labour it can employ, suggests that his answer would be probably no - capital does not posses any independent productive powers.

Interest as the price for capital

The topic of interest, deserving so much attention in the past (more in the form of moral judgments then positive investigation of its origin), is the last component of Smith´s analysis we will describe here.

Capital owner can provide a loan to somebody, by letting him dispose with a part of his capital. For this service, he expects to get interest, which thus becomes the price of

[1] This question might seem unimportant at first – the focus is on the increased product, not on its sources – but we will later see (section 3.4.1) that it constitutes one of the most controversial points on which economists cannot agree.

capital. Smith justifies this extra money going to the creditor as a price for the risk he undertakes by parting with his capital. As capital is a part of stock that brings revenue, some revenue should belong to the owner even if he lets somebody else employ the capital. If not, he would have no motive to borrow, unless we assume some specific character features, as solidarity with others and possibly satisfaction derived from helping them.

What the recipient will use the loan for is completely up to him, but he can get into serious troubles if he uses the money as a stock for immediate consumption. Then, he will have to find some other fund from which to repay the loan, as he chose not use the productive capacity of borrowed capital. (Smith 1904, II.4.1)

Rate of interest related to capital and rate of profit

Smith states the law that interest diminishes when the supply of loans increases. (Smith 1904, II.4.8) In his opinion, it is the **competition between different capitals** that lowers the rate of interest, and not exogenous changes like the discovery of more gold or silver and its inflow into the country. He claims that for a change in the value of interest, the value of capital must change as well, and that is not the case of an inflow of gold (as capital can increase only by more savings from revenue).

Another important statement is that the **rate of interest** is linked to the rate of profit. When fixing the interest rate by law, he warns against setting it too high or too low in comparison with the market rate. Both will decrease the amount of loans, in the first case, no sober people will dare to borrow and the risk of not getting the money back will be extremely high, in the other, the rate of interest will not be a motivation strong enough for the prospective creditors to borrow.[1]

Conclusion – what can we learn from Smith

Smith deserves the credit for giving a thorough definition of capital. He has a clear vision about its role in the economy – capital is a condition for economic development. He tackles practically all the issues related to capital: its productivity, quantity of capital, the phenomena of interest and profit. The richness of Smith´s work, the great number of topics it tries to cover, and the lack of any strict methodological approach Smith would consistently use throughout the book, may leave the reader a bit puzzled. Comparing various passages of Smith´s works, a discovery of several paradoxes is unavoidable.

[1] One more observation ties the ordinary price of land to the rate of interest, as investing the capital in land can be seen as an alternative to providing a loan – the owner does not have to take much care about his capital invested either way.

Some of his followers adopted a different approach, not to make the same mistakes – they focused on one clearly defined and delimited topic. Then, it is easier to build a concise theory based on several key ideas. That was the case of Ricardo – in his theory of distribution, he introduces the concept of differential land rent, much referred to in later works and later being one possible inspiration for marginalists, who generalized this idea to obtain marginal productivity theory for all factors of production.

2.2.2 David Ricardo

Main task addressed in Ricardo´s theory is the **division of surplus** between rent and profits. His views differ from Smith´s in many aspects – his negative feelings about the irrevocable **end to capital accumulation** are one of them. New meaning is given to the distinction between fixed and circulating capital.

Capital in labour theory of value

In the theory of value, Ricardo insists on labour being the only source of value. He refutes the equality of labour needed to produce any particular commodity and labour that commodity can command, and says that the exchangeable value, comparative value of commodities, should be based solely upon the first quantity, as only that one stays invariable in time. (Ricardo 1821, 1.1) The amount of fixed capital (machines, instruments) used in the production enters its value through labour exerted to produce the instrument. (Ricardo 1821, 1.31) Concerning the **definition of capital** itself, we find this:

> "Capital is that part of the wealth of a country which is employed in production, and consists of food, clothing, tools, raw materials, machinery, &c. necessary to give effect to labour." (Ricardo 1821, 5.9.)

Fixed and circulating capital

Ricardo uses again the distinction between fixed and circulating capital. His view is slightly different than that of Smith – making a seemingly simple classification another possible source of confusion for future economists: it is based mainly on the durability, or perishability, of capital.

> "According as capital is rapidly perishable, and requires to be frequently reproduced, or is of slow consumption, it is classed under the heads of circulating, or of fixed capital." (Ricardo 1821, 1.47.)

He explicitly mentions that with decreasing **durability**, fixed capital approaches circulating capital, so no clear dividing line can be set. With a rise in wages, only those commodities with less than average quantity of fixed capital required for production will rise in price, the others will fall. The entrepreneur finds an extra motivation to change his production technique to one which employs less labour and more fixed capital. If he

manages to do this and still charge the same price, his profits will rise. However, in a long term, high profits would bring more capital to his industry, and profits would be lowered back to a normal rate.

Falling rate of profits and the accumulation of capital

The consideration of possible sources of changes in the rate of profit cannot be omitted from Ricardo´s examination. Variations in the interest rates, then, are perceived to be a consequence of a change in the rate of profit.

He observes that with a progress in society, profits have a general tendency to fall. (Ricardo 1821, 6.29) A key role in this mechanism is ascribed to land. With rising wealth and population, food production has to increase. Only lower quality land is available for cultivation, and to get the same quantity of food, more labour is required. This raises the prices of food and subsistence wage, and it has been already remarked that profits move in the other direction than wages.

Till some point, **technical progress** can provide new machines and technologies so that the process of production becomes less labour intensive and more effective. However, the progress is too slow, and when wages reach the upper limit, which is, in the case of agriculture, the revenue of farmer, capital accumulation stops, since non-existent profits no longer provide motivation to accumulate. In reality, the end of accumulation comes much earlier, as low profits do no compensate for the risk included. Thus, Ricardo´s vision is a pesimistic one: the **limited supply of land** is a barrier to further development and overcoming this obstacle almost impossible. (Ricardo 1821, 6.36)

Profits in the theory of distribution

One of his main goals is to explain the **wage/profit ratio**. In his theory, there exists an indirect relation between them: when wages are high, profits must be low. (Ricardo 1821, 6.3) The basic division rule has the same three components as before: wages, profits and land rent. Wages cannot permanently stay above the subsistence minimum, and this determines the part of produce that must be expended on them. After paying land-rent, which increases with growing scarcity of land, we get profits: from this, it is clear that wages rise together with prices and that causes profits to fall.

In different countries, capital accumulation has lower or higher impact on profits depending mainly on the fertility of land: when the country is poor in fertile land, and we do not account for foreign trade, even a small accumulation of capital will lead to a great reduction in profits. **Foreign trade** can help the countries poor in fertile land when they decide to import cheaper food from abroad. This is, according to Ricardo, the only way

how to slow down the diminution of profits due to rising cost of necessities. (Ricardo 1821, 6.38)

Capital accumulation that is not accompanied by rising food prices will not cause a drop in profits, Ricardo claims. He is sceptical to the idea that the pressure of competition will have the same impact and there is just one more thing he accepts to have the power to lower profits temporarily: and that is the situation of capital growing much faster than population.

A problem common to most classical writers transpires here: how to justify the tendency to average rate of profits proportional to the whole capital when, at the same time, labour is considered the only source of value. Moreover, we may ask whether profits are only the residual we get by the subtraction of wages and rent from total income, or they are determined independently on those other quantities. In that case, land rent would have to be the residual variable.

Measuring the rate of profits

The problem of measuring the rate of profit is perceived to be a difficult one. Ricardo admits that the development of the rate of interest can be taken as an indicator, but the movement of the rate of interest reflects other factors than just rate of profits, so this is very inaccurate. (Ricardo 1821, 21.15)

2.2.3 Jean Babtiste Say

Back to the Smithian lines of thought, let us briefly recall the views of a French economist J. B. Say.[1] What is worth noticing, here, is the concept of **capital as a value** rather than a collection of material objects – by doing this, Say inclines to the other side of the problem featuring the **dual nature of capital**, heterogeneous set of goods or homogeneous permanent fund of value. We will see what advantages this can bring to the theory.

Say builds his theory of production using three different productive factors: labour, land and capital. The reward for their productivity naturally returns to them in the form of wages, rent and profit. This explains the principle of the righteous division of the product.

Capital is value

More in detail, he introduces capital as a precondition of every industry: he compiles a list of necessaries and calls the value of the objects on the list **productive**

[1] Say, who considered himself to be a follower of Smith, is known for his clear style of writing, to such an extent that some economists blame him for oversimplifying and carelessness.

capital. (Say 1855, I.III.2) Like Smith, he also explicitly mentions money as belonging to capital, but stresses that the ratio of money to total capital in ownership of a manufacturer or other industrious man is likely to be low.

Say´s perception of capital as a value rather than as a collection of heterogeneous commodities allows him to work easily with the transformation of capital in the process of production. Although capital is consumed, its original physical form disappears, the value is not lost, as capital can undergo **reshaping** and continually change in the process without losing its value. From this perspective, the actual durability of a commodity used in production does not matter. Capital, seen as a value, cannot perish with the commodity, as its value is reproduced in its product. (Say 1855, I.X.7)

Using capital surplus: choice between saving and consumption

Not only that, the productive power of capital creates a surplus that goes to its owner after capital replacement. The way of spending this surplus determines whether capital will be increased, or just kept constant. The only way how to augment our capital is to use the surplus productively, employ more productive powers, or, in other words, by saving. (Say, 1855, I.XI.10) This guarantees not only the reproduction of the existing value, but also an extra surplus, which can be again either consumed or invested productively.[1] The choice between saving and consuming capital for present enjoyment is discussed in the general context of the character of man, in the same way as in Smith´s work. In the development of our society, Say observes the growth of both consumption and savings, which is consistent with continuing accumulation of capital.

It seems that by choosing to invest all that we can at each decision point, we are certain to obtain more and more surplus, to ensure a perpetual growth of our capital. Say lacks the negative feeling of Ricardo about a limit of capital accumulation: in his opinion, this can progress forever, leading to a great bright future of man. (Say 1855, I.XI.27)

Pure interest and risk compensation

The link of interest and profits does not cease to attract attention. Smith identifies two cases of how the revenue of capital might be composed. When the owner himself employs his capital productively, the whole profit of capital becomes his revenue. If he decides to let somebody else use his capital productively, he must then be satisfied with a

[1] As for the third possibility, which is to leave the surplus intact and inactive, Say conceives it worth consideration only in times of a great insecurity and uncertainty in a country. When this happens, it implies only negative consequences for the country: accumulation of treasure in this shape only disables the choice of the most prosperous path to development.

revenue that equals the interest paid by the borrower, who receives the extra profit he was able to gain from the capital by combining it with his own talents. (Say 1855, II.VIII.2)

In Say´s view, interest is composed of two parts: *pure interest*, the rent for using the productive powers of capital, and the risk insurance. He offers three factors determining the risk of the transaction: personal character and abilities of the borrower, character of employment of capital, and the conditions ruling in the country. Compensation for risk often forms the major part of interest paid. (Say 1855, II.VIII.8)

Level of the rate of interest and profit

The level of interest rate is given by the proportion of supply of disposable capital to the demand for it. The capital which is tied in a production process and cannot be easily withdrawn to be lent does not form a part of the supply. (Say 1855, II.VIII.24) As to the medium of the loan, being that money or other commodity, this makes no difference. This is consistent with Say´s conception of capital as a value. Then, interest is proportional to the value lent, and the expression "interest of money" does not really make sense.

As for the profit itself, it is related to the risk and duration of the employment of capital. (Say 1855, II.VIII.37) The method how to discern it from the profit of industry where it is employed is not clear. Say concludes that profit is the compensation for productive power of capital, but does not demonstrate the way of measuring it. Again, we encounter the problem of income distribution: that to derive profit, productive powers of capital have to be combined with those of land and labour, and each of these three factors receives its proper compensation.

Different profitability for individuals and the whole country

When comparing the most profitable employment of capital for individual and for the whole country, we do not find equality here: the most profitable business for an individual will not necessarily bring the biggest profit to the society as a whole. Here, too, Say adopts a positive attitude by saying that generally, the society´s way to progress is not obstructed by the decisions of people who have a tendency to prefer engagement in carrying trade to agriculture: the feeling of risk is increased with the distance which their capital reaches in its employment, so, especially capital owners with a smaller capital at their disposal have a strong preference of agriculture over risky foreign trade. (Say 1855, II.VIII.50)

2.2.4 W. N. Senior and abstinence

We include this section mainly to introduce Senior´s term abstinence. It is something many economists refer to when searching for early notions of time factor incorporated into the theory of capital.

Definition of capital

Senior makes some interesting remarks about the functioning of the term capital in our ordinary language, where its meaning spans the whole range between wealth and money. He revises its usage in past economic writings and then introduces his own definition:

> "an article of wealth, the result of human exertion, employed in the production or distribution of wealth"(Senior 1854, 3.107).

This definition seems to provide several conditions an object must satisfy to be classified as capital. It specifies the character of capital as something produced, valuable and not laying intact. Moreover, Senior stresses that capital is the result of savings of individuals. The reason for having such a detailed definition might be the awareness of its author of how big problems for the whole theory of capital a small inaccuracy here might cause – man learns from history and the history of theory of capital seems like a good source of warning examples.

As for the division of capital, he recognizes not only fixed and circulating capital, but also capital which is reproductive, simply productive and unproductive. (Senior 1854, 3.144) Reproductive capital can be used to produce capital of the same kind, simply productive capital produces other things, distinct from itself, and unproductive capital is destined to other than productive use. He argues that unproductive capital, e.g. consumption goods still in the hands of retailer, rightly belongs under the heading of capital: as it will bring a revenue to its owner.

Abstinence

The most remarkable contribution of Senior´s is his term **abstinence**, which should replace capital in the role of a production factor.

> "To the Third Principle, or Instrument of Production without which the two others are inefficient, we shall give the name of Abstinence*:* a term by which we express the conduct of a person who either abstains from the unproductive use of what he can command, or designedly prefers the production of remote to that of immediate results." (Senior 1854, 3.104)

He explains this move by the characteristic feature of capital, the fact that capital is created by cooperation of all three instruments of production: labour, abstinence, and

natural agents (land, mines, etc.). Abstinence is made equal to the use of capital, which bears in itself the act of giving preference to remote rather than present enjoyment. By postponing our consumption and employing more capital productively, we hope to achieve greater capacity to consume in the future. The advantages derived from abstinence are of two kinds: the use of implements and division of labour. (Senior 1854, 3.152)

Abstinence seems to lack the heterogeneous character of capital goods, as it occurs whenever we decide to employ our capital instead of consuming it for our enjoyment, no matter what kind of capital it is. However, measuring abstinence might not be less cumbersome than measuring capital itself. It bears a strong subjective aspect: each individual may have different feelings about the urge of present consumption. Besides other factors of production, abstinence seems to be more abstract, hard to capture by any available means.

Capitalist´s profit

Capitalist is described as a person who devotes his powers to the production of remote goods. As a reward, he can expect some profit, the volume of which depending on the success of his investment.

An interesting insight is offered into the real division of produce, while having the time needed to complete the process of production in mind. As workers and landowners are not paid for abstinence, they expect to get some reward before the production is completed. Only the capitalist, who is paid directly for his abstinence, for the sacrifice of present consumption, has to wait till the production process is finished. He then is entitled to most of the produce, receiving his profit. However, the character of an entrepreneur´s work is adventurous – no guarantee of profit can be given at the time of original investment.[1]

> "The employment of capital, therefore, is necessarily a speculation; it is the purchase of so much productive power which may or may not occasion a remunerative return". (Senior 1854, 4.20)

2.2.5 John Stuart Mill

Before we move away from classical political economy, I will add one more definition of capital and try to summarize the main problems and obscurities that were present in the treatment of capital mentioned so far.

[1] This corresponds to the image given by Hayek many years later. (see section 4.4.3)

Mill is very cautious when speaking about capital. He refuses the expression productive powers of capital: capital, as a whole, has no productive power. Productive power resides in labour, materials and implements, and part of capital serves only to buy the productive power of labour, by paying wages to the labourers.

Thus, correctly speaking, capital is that part of our possession which we intend to employ productively – to purchase means of production for it. Capital must be saved, not wasted in present consumption.

> "Whatever things are destined for this use—destined to supply productive labour with these various prerequisites—are Capital." (Mill 1848, I.4.2.)

Here, Mill bases his distinction of capital on the intention of an individual. The question is whether this is a reasonable idea, to have such a subjective basis of the term capital. Are we then allowed to speak of capital as something given, as a quantity that can be determined objectively, though maybe by exerting a great effort – that is not clear at all, capital does not seem to be some definite magnitude.

On the other hand, what might seem to be an advantage of this definition, it ensures that all capital is used productively, we do not have to consider the effects of a consumption of capital, since capital can never be consumed.

2.2.6 Conclusion – capital in classical economics

Although the theories presented so far seem to differ a lot, we can find some common denominator. We could approve that capital is needed for production and for economic growth, as it helps to raise the productivity of labour and it also permits to employ more labourers. When an entrepreneur uses capital, he can expect some profit as a reward. When he decides to lend it to somebody else, he is justified in demanding interest from the debtor.

Concerning the nature of capital, several issues remain open. The duality of capital makes us choose between heterogeneous capital goods and a homogeneous fund. Thinking about the origin of capital, we might even pronounce capital equal to savings. One of the main disagreements is over the productive powers of capital: whether capital is productive by itself or it only enhances the productive powers of labour. Second, we have the question of income distribution: the rule that governs the division of produce between profits and wages was a frequent subject of inquiry that was not resolved. One of the problems was how to combine the average rate of profit attained in all branches with the explanation of

profit by labour costs, or labour included in production. Different durability of capital and varying length of time for which it is employed both cause complications.

It is not easy to say which conception of capital is more appropriate when we have a further treatment of capital in economic theory in mind. We will see that such a basic term as capital will be defined over and over again. What seems to be unquestionable, though, is the importance of capital in economic theory: as it is used to explain so many economic phenomena, it certainly deserves a proper definition, and we will keep looking for it in the next part of our work.

3 Introduction of marginalist approach

The character of 1870´s as a revolutionary period for economics is sometimes overemphasized, as the change did not happen all of a sudden, without previous signs. However, for the theory of capital, these events are very important. Both Austrian and neoclassical economics developed as a reaction on the fundamental changes in economic science of that time. Although they share the same roots – the principle of marginalism applied to utility and productivity, they stand in direct opposition to each other in many points concerning the theory of capital.

The heterogeneousness is present even among the writings of both schools, which does not allow for easy generalization of the problem. The first approximation might say that Austrians accentuate the role of time, which leads to the concept of **roundaboutness** and the **production period**, while neoclassics try to conceive capital more as a **perpetual fund**, thus incorporating the other part of its dual nature to their theories. American neoclassics will deserve special attention here, as their conception of capital is often discussed and contrasted with the picture given by Austrians.

A remarkable change happened in the context of the whole theory. As microeconomics became the leading part of economic theory, capital now appears mostly in the theory of production. The behaviour of an individual entrepreneur is examined before an attempt for generalization to the whole society is made.

3.1 William Stanley Jevons: wage fund theory

Jevons, often classified as one of the great trio of economists who brought the marginalist revolution, is a quite notable personality in the history of economics. His radical views did not find any true follower and neoclassical economics in England is said to have been developing since Marshall, not Jevons.[1] Nevertheless, Jevons´ wage fund theory inspired many later writers in treating the capital as a **subsistence fund**, a term to be found, among others, in many works of Austrian economists.

Frequent use of mathematics is another feature of Jevons´ work. At some points, more attention devoted to the assumptions of his models before jumping into equations might be welcomed. Without it, it seems that his reasoning combines the notion of capital

[1] Marshall published his first great work some twenty years after Jevons. Although sharing substantially the same beliefs, Jevon´s radical and complete dismissal of classical theory created a strong wave of antagonism against his writings. Marshall, then, managed to get support for his theory by stressing the continuity with the past works, not the differences.

as a wage fund common to all branches of production with capital as concrete productive, interest generating instruments. His work arises many questions: how we measure the value of capital or what exactly is the product that stands in the interest rate determination. We may also think about his solution to the problem of **circularity**: explaining interest via the quantity of capital and vice versa.

Capital supports labourers

Jevons reduces capital to a **wage fund**: the sum of commodities that are required to support labourers, to sustain the existing workforce.

> "The notion of capital assumes a new degree of simplicity as soon as we recognize that what has been told a part is really the whole. Capital, as I regard it, consists merely in the aggregate of those commodities which are required for sustaining labourers of any kind or class engaged in work." (Jevons 1957, pp. 223)

The unique function of capital then becomes the opportunity it gives to the capitalist to start long-lasting production processes, to span the waiting time between the investment and the completion of our product. Jevons finds some evidence for this in literature (including J. S. Mill), and thinks the authors in past were not brave enough to call this the only function of capital. The division of labour or the frequency of exchange is, in his view, irrelevant: the only thing that matters is the time between the original expenditure of labour and the completion of its final product. (Jevons 1957, pp. 226)

Structure of capital and investment

Quantification is complicated by the two-dimensional structure of capital. We can either compute the amount of capital invested, which nevertheless lacks a substantial information about the length of investment, or we can express **the amount of investment of capital** by multiplying the capital invested by the time for which it remains invested, the time that elapses till the day it is consumed– this must not necessarily be the day the production is finished, if some part of the goods obtained is stored and consumed later. (Jevons 1957, pp. 229)

Although capital is simply a commodity, we are more interested in its investment, whose meaning is close to abstinence defined by Senior. Jevons, as a marginalist, uses utility to measure the suffering one experiences when investing capital instead of consuming it. Time is also an important factor for our suffering, so we are led to work with the double dimension of lost utility over time. In estimating the cost of an investment, Jevons stresses the need to include compound interest in our computations. (Jevons 1957, pp. 240) For investments of long duration, the interest may form a great part of its cost.

Free and invested capital

The distinction between fixed and circulating capital is, in Jevons´ view, quite unnecessary, because he finds an exact correspondence between that and the durability of capital.[1] More interesting is the passage where Jevons makes an attempt to distinguish free and invested capital. **Free capital**, meaning the wages of labour, is what makes embarking on a longer production process possible. On the other hand, fixed capital in the usual interpretation, such as machines, buildings etc., represents only capital that is sunk and can be no longer freed and used to sustain more labourers. We can call it **invested capital** – it is the wages that were paid to labour needed to produce those machines, buildings, etc. This capital remains invested until the work has returned profit – when the building is finished and sold, its stops being capital. (Jevons 1957, pp. 243)

Calculation of the rate of interest

Seeing free capital as a wage fund gives us a chance to explain the equilibrating tendency of interest. Since the capital needed to support labourers stays the same throughout branches, interest must be the same and the market for capital behaves in the same way as other markets: it has just one price at a time. The decision to employ capital in certain industry is then made by employing more capital up to a point when it yields only the **market rate of interest**. In Jevons´ theory, calculation of a rate of interest using derivatives is an easy task:

> "The interest on capital is, in other words, the rate of increase of the produce divided by the whole produce." (Jevons 1957, pp. 247)

His expression for the rate of interest is found to comply with the conclusion of past economists who pronounced the idea about the tendency of profits to fall to a minimum. This further implies that at some point, interest will be so low that capital accumulation stops and the whole development of society ceases.[2] However, the rate of interest does not determine the advantage of capital to industry, which is given not by the marginal utility, but by the total utility, and the interest rate tells us nothing about it.

Wages and profit

Jevons refutes the simple Ricardo´s proportionality between these two variables, high profits being tied with low wages. The problem of this statement is that the produce,

[1] As Ricardo suggested, no precise line exists and the most fixed capital is the same as the most durable one.
[2]The causes of this phenomenon, however, differ from the causes put forward by David Ricardo or other classics. Jevons´ formula shows that if the advantage from the additional capital stays constant, more capital in a country means lower interest. In this view, interest on capital is independent on the compensation for labour. (Jevons 1957, pp. 255)

which is to be divided, is a variable itself, and it is impossible to determine two variables from one equation only. (Jevons 1957, pp. 269) In Jevons´ theory, profits are the first to be calculated, wages only after that. Wage fund theory, stating that a given amount of funds (when the recompense for the risk and abstinence of the capitalist is deducted) to be divided between a certain number of workmen will determine average wages, holds in a short run: in a long run, the character of an individual´s skills, including the scarcity of these skills in the whole population, will correspond to the level of their wage. (Jevons 1957, pp. 273)

Conclusion: comparison with classical writers

Besides above mentioned indirect wage/profit relation, there are other points Jevons would not agree on with classics. One claim from the work of Adam Smith, which Jevons strongly opposes to, is the fact that nothing in the hands of consumers can be capital. (Jevons 1957, 259) Jevons argues that it is absurd for the same thing to stop being capital just on the grounds of changing ownership. No more agreement he finds for the sector of services being unproductive, that is, creating no extra value over the capital invested in it.[1]

More important is however his influence on future generations. Calculating interest as the marginal product of capital is simple and elegant. It is also something that seems obvious to current students of economics.[2] For his treatment of time, Jevons can be considered a true predecessor of Austrian economic school. The simple triangle he draws to illustrate the process of production and gradual deterioration of capital goods reappears in Hayek´s *Pure theory of capital* when he speaks about the structure of investment. (section 4.4.1)

3.2 Austrian economic school: Eugen v. Böhm-Bawerk

Following in the steps of Menger, the founder of the Austrian school, Böhm-Bawerk uses the methodological foundations (including strict individual, psychological approach) already built to develop a theory that might compete with the neoclassical partial or general equilibrium analysis and offer an alternative explanation of the price creation. Strong subjectivism as the basis of value and price theory and refusal of simple aggregate concepts makes it somehow more intricate then the elegant supply-demand curve cross.

[1] The reason that might lead us to believe in this might be the fact that all what is created is directly consumed and cannot be stored and used for further production.

[2] In spite of the fact that the development of the theory of capital rejected this approach. (see 5.4.3)

In the theory of capital, however, the situation is a bit different - the emphasis on the time factor seems to be well in place and the comprehensiveness of Böhm-Bawerk`s theory, as developed in his famous *Positive theory of capital*, sets a standard to be reached by competing theories.

3.2.1 Key terms of Austrian theory

Roundaboutness of capital

The key term, **roundaboutness**, is explained as the time between the exertion of human labour and completion of production process. The longer this waiting time is, the more roundabout process we are talking about. Roundaboutness is considered to be probably the most important feature of any **production process**. Böhm-Bawerk is convinced that roundabout ways are always more productive than direct ones, one evidence for this being that some products cannot be obtained at all without embarking on a roundabout production processes. (Böhm-Bawerk 1891, pp, 20)

Terminology then becomes simple. **Capitalist production** is the one using roundabout methods, **capital** is the set of intermediary products that are created and consumed in production processes before they reach their final stage. The logic of this definition is clear: capital is defined by its function[1], which gives us an unambiguous rule how to categorize heterogeneous goods, and we do not have to bother with listing all the different categories of capital with their exemptions.

Cause of past problems – two lines of thought

Böhm-Bawerk seeks to find the roots of deep variations in the concepts of capital in past writings, and comes to a fundamental statement that two distinct theories have been combined into one, this being the cause of so many misunderstandings. (Böhm-Bawerk 1891, pp. 27) First, we have the theory of production, which forms the background for his own definition, with capital being close to "produced means of production". Second, economists use capital to shed light on the origin of interest and its rate. In their considerations, they often identify capital used in production with capital that bears interest. But if it is not necessarily so, this only leads to severe troubles, obscuring one or the other problem by relying upon the wrong conception of capital since the beginning. When economists use the word capital to define essentially different objects, their theories, which naturally incorporate their own conception of capital, logically differ as well and a

[1] The same is true for Jevons – in his case, capital supports labourers, whereas here it is rather a support in production.

comparison has to take the underlying differences into account. The possibility of unification is excluded, we can only decide which line of thought serves us best in illuminating the problems we want to solve, and adopt this one approach only. The rest must then be discarded as maybe interesting historical excursion, but nothing more.

True conception of capital, private and social capital

Under the heading of "true conception of capital", Böhm-Bawerk builds his definition in accordance with the criteria he chooses in advance.[1] His approach does not bring any radical turn, he wants to follow the traditional usage of the word capital and just remove the darkness surrounding it.

To be able to work with the two branches of theory separately, he introduces the distinction between **acquisitive capital**, which corresponds to **private capital** and stands as a key factor in the theory of interest, and **social capital**, narrower concept of productive capital, briefly described as **intermediary goods**.

> "Capital in general we shall call a group of Products which serve as means to the Acquisition of goods. Under this general conception we shall put that of Social capital as narrower conception. Social capital we shall call a group of products, which serve as means to the socio-economical Acquisition of Goods; or, as this acquisition is only possible through production, we shall call it a group of products destined to serve towards further production; or, briefly, a group of Intermediate products." (Böhm-Bawerk 1891, pp. 38)

This system can be seen as a success in two ways: first, capital remains a common denominator for all the problems treated under this heading in the past, second, it gives us a clear answer as to which definition of capital we should use when dealing with different and not so closely related questions of production and distribution of income/theory of interest.

To show the deviation from past theories and clarify the distinction between private and social capital, Böhm-Bawerk composes a list of categories of goods belonging to the social capital, and by adding a few more, he gets to the private capital. It is questionable whether his claim about having wider and narrower definition at the same time as two independent concepts is sustainable. From the point of view of two independent occurrences of capital in economic theory, it probably is.

Subsistence fund excluded from capital

What lacks on his list, maybe surprisingly, is the means of sustenance for labourers. Böhm-Bawerk explains that this is rather a completely different conception of capital,

[1] One of them is usefulness for economic science: Böhm-Bawerk wants to choose that definition of capital that would best serve him to resolve the questions concerned with the theory of production.

which does not fit into his own definition – no relation between intermediary products and funds sustaining labourers is found. A theory can be built upon capital composed of stock of food, clothes, etc. However, Böhm-Bawerk is convinced about the superiority of his own approach. (Böhm-Bawerk 1891, pp. 43)

Extra support for Böhm-Bawerk´s theory should come from the comparison with past conceptions. From these, I select **abstract theories** as a sample how easily Böhm-Bawerk is in a few words able to completely refuse and discredit this approach. Another reason for noticing what his early remarks on these theories say is that this will lie in the core of his dispute over the nature of capital with American economist J. B. Clark, which will be discussed shortly (section 3.4).

Refusal of the abstract concept of capital

Böhm-Bawerk rejects the abstract conception of capital as being something too unnatural, artificially build by economists who by this move hoped to evade serious troubles. (Böhm-Bawerk 1891, pp. 57) But he believes that economic science, not unlike other disciplines, should not run away from obstacles instead of trying to overcome them, to use its potential to find a solution. Böhm-Bawerk´s critique obscures this alternative approach by asking how an immaterial sum can achieve what is generally ascribed to capital, how it can help to do the work needed to produce objects of desire. There can be no doubt it is the tools, machines, etc. that support physical human labour in creating products for consumption. However, no divine rule claims that the word capital is reserved uniquely for those material products used in production processes, that capital must be itself productive. The abstract view, which understands capital directly as the value of those goods, just starts from the other end and tries to avoid problems with the **measurability of capital**, with the **aggregation** of heterogeneous commodities. It is not in the least apparent how this aggregation should be done, and the simple methods usually contain great pitfalls.

In our opinion, the abstract view was maybe born from too careless approach of Say, but if others were able to develop it into a working theory, it might not be so useless as Böhm-Bawerk asserts.

3.2.2 The process of capitalist production

Böhm-Bawerk feels the need to discuss two questions: how does capital originate, and what is the nature of its productive powers. Both questions have seen a variety of different answers in the past: some economists have claimed that capital originates in

production whereas other opposed that it is born only by savings, some ascribe to capital direct productive power, others say this productive power is derived from others and the most radical view gives no productive power to capital at all.

Productive powers

In his own theory, Böhm-Bawerk discerns only **two productive powers** – those of nature[1] and human labour.

> "Thus all that we get in production is the result of two, and only two, elementary productive powers – Nature and Labour. This is one of the most certain ideas in the theory of production. Man finds ready to hand an abundance of natural processes, and allies his own powers with them." (Böhm-Bawerk 1891, pp. 79)

Although capital is not included in the list of factors of production, it has a crucial role in the theory of production.[2] With capital at our disposal, we are offered the choice between direct and **roundabout production methods**. By experience, roundabout production methods are proven to be the most productive, at the cost of their longer duration in comparison to direct methods. (Böhm-Bawerk 1891, pp. 84) Increased technical productivity can be further explained by the fact that by choosing methods wisely, more natural powers become engaged in the process. The prolongation of time is the basis of the dependence of workers on capitalists, who are obliged to support them in the interval between the first use of labour and the completion of final product. This interval can be very long, so the workers need some funds to ensure them basic living conditions.

Average period of production

Considering the amount of time needed to complete roundabout process of production, Böhm-Bawerk comes to define his famous **average period of production**. The length of production process cannot be expressed simply by the time that elapses since the moment of first investment till the point when the product is made. Instead of that, we have to measure the average period between the expenditure of land or labour and the completion of final product. (Böhm-Bawerk 1891, pp. 89)

We imagine that the computation of the average period of production would look like this: we add all the periods of investment of individual factors (magnitude of two dimensions: duration and the quantity of each factor employed) and then divide it by the

[1] For economics, only the productive powers of nature whose supply is scarce (such as land) have to be taken into account.

[2] Capital works as a store of original production powers: some of them must have been employed in its production. Unlike in the case of consumption goods, these production powers are not used up as soon as the product is complete. The "borrowed" production powers then make capital seem productive.

number of such factors. Blaug (1985, pp. 507) points out that Böhm-Bawerk discusses solely the **continuous input-point output case,** in which heterogeneous factors applied over a certain time contribute towards production of a homogeneous output maturing at a single point of time. Nevertheless, Blaug adds that this simplifying assumption does not prevent us to realize the importance of time in production.[1]

As far as the productivity of such roundabout processes is concerned, a general rule says that with increasing average period of production, the productivity increases as well, but at a decreasing pace. This rule has been known as the **law of decreasing marginal productivity** (when we identify increasing average period of production with increasing amount of capital) and has been formulated by Thünen in the context of productivity theory, which Böhm-Bawerk rejects as mistaken. (Böhm-Bawerk 1891, pp. 87) The rule itself is however in his book regarded to be correct, as we can see by experience.

Role of capital in production

The role of capital in production can be summarized in several points. First, Böhm-Bawerk mentions its importance as a symptom of profitable production. This gives us some information about the state of development of society (more roundabout processes indicating society on a higher level of development), but is definitely not the central function of capital. Second, capital is said to be the intermediate cause of consummation in roundabout production processes, meaning capital serves as a temporary store of value, it contains the original productive powers and thus makes further production easier. Briefly, capital is the tool of production. Thirdly, when more capital has been produced, more roundabout production processes can be started and less of the free productive powers of present is consumed for satisfaction of present needs. This means less of present funds is spent unproductively and more invested to obtain greater product in the future. (Böhm-Bawerk 1891, pp. 93)

On the other hand, it is essentially incorrect to assert that to be able to use roundabout methods of production, society must have enough capital accumulated before. What the society needs is not capital but consumption goods[2] which will sustain it for a time long enough to complete the roundabout process. As the creation of capital is inherently part of roundabout production process, this cannot be taken as an obstacle to it.

1 Hayek later attempts to discard it and study the most general case of continuous input and output, see chapter 4.4.1.

2 By Böhm-Bawerk´s definition, consumption goods are not capital. He sees capital understood as a subsistence fund as an alternative conception. However, he begins to treat capital like that in his discussion of interest.

Capital as a product

From all that has been said, it must be clear that Böhm-Bawerk does not believe in any independent production power residing in capital and sees this as one of the great errors of past capital theory.

One common way of thought leading to failure is based on the wish to match each production factor with the income that it earns. The resulting theory then explains a connection between capital and interest on the same basis as the relation between labour and wage and land and rent. But the theory cannot be built upon our wishes, it has to reflect the reality, which is not favourable to this symmetry. One more source of problems is, according to Böhm-Bawerk, the vagueness of the notion of productivity itself. (Böhm-Bawerk 1891, pp. 99) In some sense, capital definitely is productive, although it has no independent productive powers that could equal the original productive powers of land and labour.

3.2.3 The origin of capital

Can savings or production alone, lead to a formation of capital? While both of these views appear in the history of economic thought, Böhm-Bawerk ´s answer is strictly negative: no, we need both **savings and production**. Capital, when understood as a collection of intermediary goods, has to be produced, but to be able to produce capital, we have to give up a part of current productive powers for present enjoyment, we have to save them to bring us greater benefits in the future.

A society in the primitive stage of development cannot afford to do this, because its direct methods of production let it produce only as much as needs to be consumed. This corresponds to the vision of development along with capital accumulation, as depicted in some works of classics. Böhm-Bawerk emphasizes that it is the productive powers that are saved, not the goods which constitute capital, as only these productive powers are the original means of production that help us produce more. To save productive powers, man must follow one rule: consume the produce of less past and current productive powers than come into existence in current period. (Böhm-Bawerk 1891, pp. 116) When consuming the same amount, no capital creation can occur, when consuming less, he draws on the current supply of capital which is diminished by his doing.

Concentric circles representing various stages of capital

Böhm-Bawerk illustrates the process of formation of capital by the means of **concentric circles** representing capital at various stages, differing by the **remoteness**

between the intermediary goods and the final product. (Böhm-Bawerk 1891, pp. 108) The most remote class of capital lies in the centre of the circle, the stage only one step from final goods is situated on the outskirts. The increasing area of the circles points at the fact that the amount of capital grows with its growing proximity to final goods. Two reasons for this are mentioned: first, the number of industrial branches using capital increases, as does the amount of capital used in its production.

It is remarkable how such a simple picture can provide a great visualization of the structure of capital, which seems to be a real thing, and not only an abstract economic term.

3.2.4 Böhm-Bawerk ´s theory of interest – source of interest

Present vs. future goods

According to Böhm-Bawerk, theory of interest has to be based upon the **theory of value**. The basic proposition to build on is this: **present goods** are worth more than **future goods** of the same kind and number. (Böhm-Bawerk 1891, pp. 238) He tries to explain both the reasons for this statement and the way how it leads us to the explanation of interest. What we need to know from the theory of value is that the subjective valuation of goods determines the objective, exchange valuation. And if we manage to explain that individuals value future goods lower than present ones, we can successfully conclude that our argument about the lower value of future goods holds.

Future impact of present decisions

The liaison between future and present is given by the length of the production process. Our present economic decisions are bound to have impact mostly in the future. As man strives to satisfy all his wants, our decisions are subjected to our wants, but these are future wants in majority. And the key is that the nature of our future wants is different from that of the present ones. We can only anticipate what needs and wishes we will have in the future, there is always some degree of **uncertainty** about it. (Böhm-Bawerk 1891, pp. 245) However, as we usually cannot satisfy our wants if we did not anticipated them and altered our decisions accordingly, our present prediction about future is vitally important for our future satisfaction. Böhm-Bawerk later shows that man tends to make several mistakes in his anticipation.

Three causes of different valuation

This is a very famous part of Böhm-Bawerk´s work: a discovery of **three independent reasons** why interest exists. Their universal validity is sometimes doubted,

and other economists came up with theories admitting only some of these reasons. But let us describe them all here: they are needed for a good understanding of Böhm-Bawerk´s theory.

Subjective use value of both present and future goods is given by want and provision for want. The first cause of the excess of value in present goods is the **difference in provision**. Our present conditions given, there is still uncertainty about our situation in the future. In many cases, the analysis of present and future state will lead us to present consumption – especially when our present situation is so bad that we expect to be only better off in the future.[1] As present goods can be used both in the present and in the future, whereas future goods have only their future use, the value of present goods can be equal or greater than that of future goods, no lower. (Böhm-Bawerk 1891, pp. 251) This argument presupposes durability of goods, but according to Böhm-Bawerk, that is mostly the case and only a minority of goods has to be consumed now because of their fast deterioration.

Second reason, the fact that **people tend to underestimate future**, should rather be explained from the view of psychologists. However, Böhm-Bawerk himself finds a few interesting propositions. First, our imagination is imperfect, and there is a possibility of completely new wants appearing in the future. Second, even a man who knows the future suffering might outweigh present enjoyment from consumption will sometimes prefer present pleasures, just because our suffering far in the future seems remote and not inevitable. (Böhm-Bawerk 1891, pp. 255) Last, the uncertainty of life: it is pointless to wait for a pleasure which might not arrive because we will not live long enough to enjoy it. Although this is usually not considered when only short intervals of time separate the present and future use, Böhm-Bawerk sees a possibility of indirect causality, when the valuation of future wants in the distant future has some impact on the valuation of less remote future needs. All together, these three assumptions form the grounds to justify the fact that man tends to underestimate future.

Technical superiority as the main reason

Technical superiority of present over future goods is the third cause of their greater value. As such, it is independent on the preceding two, and interest could be explained using this factor only. (Böhm-Bawerk 1891, pp. 269)

[1] We may distinguish two groups of people that will prefer present over future goods for this reason. First, those who live now beyond subsistence level, and need present goods "for survival". Second, people expecting increased income in the future but do not want to wait for improved living conditions.

In the past, the illusory greater productivity of present goods led many economists to call only this kind of goods capital and speak about the direct productivity of capital as its main feature. Böhm-Bawerk asserts that what they did was that they misinterpreted the actual technical superiority of present over future consumption goods and then commenced to designate consumption goods as capital, which was a great mistake.

One way how to illustrate this fact is to compare two situations. In the first one, there are some present consumption goods at our disposal, so we can employ present production powers in more productive, roundabout methods. In the other, no present consumption goods are ready, so we have to set part of productive powers aside for production of goods to satisfy present needs in direct production processes. These are less productive, and the second situation is notably worse than the first one. This gives one possible proof of superiority of present over future goods. (Böhm-Bawerk 1891, pp. 271)

Cooperation of three sources of interest

When we have these three causes established, it remains to say what their relation is. The greater value of present goods is given either by the third cause alone, or by the sum of the first and second, depending on which of these is higher. This only supports the idea that most people value present goods over future one, which means that the objective exchange value will also be higher. What has to be examined, is how exactly the value gets determined, or, in this specific case, how we can estimate the interest rate. So far, we can conclude that this difference in value is the true source of interest on capital, which holds for all circumstances where interest is born. (Böhm-Bawerk 1891, pp. 285) The definition of interest given by Böhm-Bawerk might assert that interest is profit of the suppliers of present goods in exchange for future goods.

Loan interest

The simplest case of loan interest is discussed first. For Böhm-Bawerk, **loan** is an **exchange of present goods for future goods**, and the higher value of the former is the reason why the creditor should be paid something over the value of the goods given in exchange, and this surplus being interest. ((Böhm-Bawerk 1891, pp. 286)

Thanks to this conception of a loan, Böhm-Bawerk manages to avoid many troubles previous economists had run into when seeing loan as a temporal transfer of a goods. When the goods in question is perishable and is entirely consumed before the end of a loan, so it cannot be returned, it is doubtful whether we can speak about its temporal transfer. Also, interest cannot be taken as a separate part of the repayment, what is paid for

the utility we get over the utility from consumption of borrowed goods. The solution that finds a source of interest in the different value of goods in exchange is much more elegant.

Profit from investment

Profit of capitalist undertaking can be explained in the frame of interest theory as well. We have to realize that means of production, present goods of remote uses, fall into the category of future goods. (Böhm-Bawerk 1891, pp. 300) When they are gradually turned into present goods in the process of production, we observe a growth of value. When compared to present goods, the estimated value of means of production is lower than the value of goods that can be produced using them. The surplus value, as it has been sometimes called, then naturally belongs to the capitalist. Profit is born by the passage of time that brings future goods to mature into present goods and thus leads to an increase in value.[1] (Böhm-Bawerk 1891, pp. 302)

Present goods: supply and demand

The supply of present goods is met by demand from the side of those who are willing to pay greater sum of future goods for them: workers whose only productive power is their own labour and who need to get the means of satisfaction of basic needs in exchange for it, producers to whom extra present goods will enable to prolong the process, and, only a minority of those who seek credit for the purpose of present consumption. The **willingness to pay more** is characteristic for all these classes of buyers of present goods, and this gives rise to interest which in this case equals profit of the suppliers of present goods. (Böhm-Bawerk 1891, pp. 331)

As to the comparative quantity of supply and demand, it is practically sure that the demand will be greater – since it is basically infinite, whereas the amount of current wealth in a country limits the supply, so, interest must appear. The existence of an agio on present goods also helps us explain the division of capital among different branches of production, each branch adopting the most favourable length of process, each further extension unsustainable. (Böhm-Bawerk 1891, pp. 335)

Interest on durable goods

Explanation of interest on durable goods runs along the same track. Each durable goods offers services for a certain amount of time. Each service has its own value, their sum being the value of the goods. Again, the value of the most remote service is the

[1] Böhm-Bawerk then goes on to further examine market for labour and market for subsistence goods and his conclusions only confirm the hypothesis he has started with.

lowest. In a year, our **gross return** is the value of a current service, and we have to deduct the **wear and tear**, which is, in this case, the value of the most remote service, which cannot be replaced. The difference forms our **net profit**. (Böhm-Bawerk 1891, pp. 345)

Land can be counted amongst durable goods, from which follows immediately the explanation of **land rent**. The misleading fact that the durability of land is actually infinite, which has caused so much troubles in the past, is not a problem here. It only pushes down the value of most remote services to zero, and that is why the gross, current return of a land owner equals his net return, nothing is deducted and the land rent stays the same throughout the years.

3.2.5 The rate of interest – quantitative determination

Interest rate as a price

Interest rate is a price, so its height must be governed by the same laws as other prices. In Böhm-Bawerk´s theory, it is only the subjective value of goods that decides about the objective exchange price. In the case of interest, the basic rule says that the price of present goods in exchange will be fixed between its subjective valuation by the seller and that by the prospective buyer.[1](Böhm-Bawerk 1891, pp. 375) The first must naturally be lower than the second, else no exchange would be made.

Determinants of the rate of interest

Deeper investigation into the ways of subjective valuation leads to different results in the case of **consumption and production loan**. In the case of production loan, all depends on the difference in productivity between the shorter and longer process. As the marginal productivity of a process is a decreasing variable, the value of a present loan falls with the length of the process. The willingness to pay interest in consumption loan is given by the urgency of need, the underestimate of future and the assessment of the ease of repayment.

Böhm-Bawerk then moves from isolated exchange to the more complex case of a rate of interest in market transactions. Based on the assumption of given labour supply and given subsistence fund, interest rate will correspond to the marginal productivity of the last extension of production period that can be carried out. The exact determinants of this productivity are listed in Böhm-Bawerk´s conclusion: interest will be high when the

[1] This is an instance of Böhm-Bawerk´s concept of marginal pairs determining the ultimate price of goods. By this concept, he avoids the use of any aggregated supply and demand curves, which serve the purpose of price determination in neoclassical theory.

national subsistence fund is low, the surplus returns with longer production period are high and the number of labourers is high. (Böhm-Bawerk 1891, pp. 401)

To explain: increased subsistence fund can employ the same labour as before only due to an extension of the average period of production, and this means lower surplus returns. Increase in the number of labourers is analogous to decrease of subsistence fund, and thus has the same effect. Higher surplus returns with given subsistence fund and labour supply mean higher productivity, and we already stated that interest reflects the marginal productivity of production period.[1]

Labour-capital market interactions

For Böhm-Bawerk ´s explanation of the undertaker´s conduct when hiring labour, a few words should be said. First consideration might bring us the idea that the undertaker chooses the most favourable production period first, and hires workers with this in mind. The problem is that the production period itself is more or less favourable given the wage rate fixed on the labour market. So, to find a fixed starting point, we turn to the supply of labour, which is a given quantity in his theory. His assumption is that the whole labour will be purchased, as any stock of wealth is able to purchase it, with the help of varying production period. (Böhm-Bawerk 1891, pp. 384)

Now, it might seem that Böhm-Bawerk, in the end, treats **capital as a subsistence fund**, a notion he was so sceptical to in the passage discussing his theoretical concept of capital. We can conclude that this only highlights the fact that the dual nature of capital cannot be ignored. Although we may choose to favour one side of capital to the other, there is a great likelihood the other side will slip into our theory somewhere. The question can be posed, then, whether this is completely wrong, or whether we should accept it as a matter of fact and turn the dual nature of capital to our advantage.

The behaviour of labourers on one side and businessmen on the other guarantees that what was described above really happens, any supply of labour will be met by demand, as it is profitable for both sides. What then determines the actual period of production is the fact that all labour and present goods are tied in a mutual exchange together with the law of competition that governs other prices as well. (Böhm-Bawerk 1891, pp. 386) When the wage is too low or high, pressure from the side of unemployed or competition among undertakers will shift the wage until all labourers are employed using

[1] Böhm-Bawerk explains the influence of these three factors in detail, together with numerical examples, in his book, see Böhm-Bawerk 1891, Book VII., chapter III.

the whole wage fund of the community and the production period is the most profitable one.

Approaching the productivity theory

The concept of marginal pairs appears again to give us the exact rate of interest. Using its general principle, the rate of interest is determined by the last extension of the process that is profitable, and the shortest extension that is not realized. (Böhm-Bawerk 1891, pp. 393) When we consider the difference between these two to be small enough, we may choose only the first rate and say that the rate of interest equals to this, which is the same result as the productivity theory, developed since Thünen and saying that the rate of interest is the marginal return on the last dose of capital applied. Only here the production period is emphasized by saying that the rate of interest is given by the **marginal productivity** of the **last lengthening of the average period of production** economically permissible. (Blaug 1985, pp. 506)

Böhm-Bawerk´s heritage – an extremely comprehensive theory of capital

In the final chapter of the book, Böhm-Bawerk discusses some more subtle properties of actual market, but the essential results stay the same. What he achieved is the most complex theory of capital and interest existing in his time, the theory that others working in the same field must definitely take into account. Although great attention is paid to the incorporation of time factor into the theory of capital, his explanation of interest remains static: we learn how to calculate the interest rate at one point of time and do not examine or try to explain changes through time. Böhm-Bawerk´s criticism of neoclassical productivity theories of capital is not fully justified: his own theory of interest finally resorts to something very similar.

We will look at the arguments that managed to falsify the concept of average period of production, but first, we would like to introduce Böhm-Bawerk´s American contemporary J. B. Clark, to see what he has to say on the topic of capital. This will lead us to discuss the debate known as the first capital controversy.

3.3 J. B. Clark and his permanent fund of pure capital

After the detailed look at Böhm-Bawerk´s theory of capital, we will not immerse ourselves into the study of his Austrian followers, but seek to explain an alternative approach developed by the representatives of neoclassical school.

Neoclassical economics treated capital in a different way. The general principle of marginal productivity is directly applied to the theory of capital. For that, it is necessary to

describe capital as a certain value, not a sum of heterogeneous goods. Only then, we are able to determine the advantage stemming from the last unit employed, the marginal productivity of capital, and, based on this quantity, the rate of interest.

3.3.1 Role of time in the theory of capital

Interest in a static theory

One example of such a theory can be found in the work of J. B. Clark. In his famous article *Distribution as Determined by a Law of Rent*, he develops the idea that the Ricardian theory of **land rent as a differential gain** can be generalized and the term rent should apply to income from capital and labour as well.

> „The principle that has been made to govern the income derived from land actually governs those derived from capital and from labor. Interest as a whole is rent; and even wages as a whole are so." (Clark, 1890)

These incomes are static in nature, meaning that they can be earned in a state of unchanging amount of capital and labour. On the other hand, **profit** arises only when there is some development in the society, and has to be explained in a completely different way.

For this study, he considers capital and labour alike to be funds of **permanent productive power**, whose value remains constant in a static state of society. To measure the differential gain, we look at the benefit of the last quantity of capital applied, with the fund of labour unchanged. This gives us the marginal productivity, interest, and all those previous units bringing more to their owner constitute the source of **rent of capital**, or, analogically in the case of labour, source of rent of labour. Here, interest finds its place in the static theory, with minimal role of time, which is in opposition to Böhm-Bawerk´s theory, where interest is born only from the differences in present and future value of goods.[1] Clark moreover asserts that the **static forces are truly dominant**, that the good description of static state will give us an important advantage when investigating the rules of economic dynamics.

> „Actual society is dynamic; and, when we study it statically it is with no purpose of ignoring the changes to which it is subject. By a series of static studies we determine the nature of the changes that are actually taking place, as we might ascertain the movements of particles of water in a stream by making a series of cross-sections of it. This series of studies affords a theory of industrial dynamics." (Clark, 1890)

[1] As we said, although interest is justified by different valuation in time, the exact determination of interest rate described by Böhm-Bawerk is static in nature, see chapter 3.2.5)

Capital and capital goods

Capital is discussed more in detail in Clark´s book *The Distribution of Wealth: A Theory of Wages, Interest and Profits*. First look at the title creates the anticipation that the discussion returns to the realm of the theory of distribution, not production, however these two might bear a strong connection through capital.

The utmost importance is laid on the distinction of capital and capital goods. In Clark´s view, **capital** is a permanent fund that consists of material instruments of production. These concrete instruments of production are then called **capital goods**. In themselves, they are perishable, and, with the exception of land, they have to be destroyed to liberate their productive powers.

> „The most distinctive single fact about what we have termed capital is the fact of permanence. It lasts; and it must last, if industry is to be successful. Trench upon it—destroy any of it, and you have suffered a disaster. Destroy all that you have of it, and you must begin empty-handed to earn a living, as best you can, by labor alone. Yet you must destroy *capital-goods* in order not to fail." (Clark 1908, IX. 3)

However, capital is not destroyed with them, the only thing that happens is that we observe a change in forms in which capital is embodied. We can even claim that capital must last in order for the industry to be successful. The consumption of capital can have only detrimental impact on our future prospects, as well as hoarding capital goods as a treasure instead of using them productively. For Clark, it is natural to speak about capital invested in business in money terms, instead of trying to list all the machines and instruments of production we currently hold. It is not some weird abstraction used by economists to avoid possible troubles, it is a fund that has a direct counterpart in the goods it represents, so it is completely legitimate to treat capital in this way. (Clark 1908, IX. 7)

Clark moreover argues that such treatment is common in other branches, that we often use an abstract entity to describe the working of concrete, material things, like in the example with water power.

The easy confusion between capital and capital goods is then seen as the main cause of problems in past economic theory of capital, one of its representatives being the wage fund theory that took capital as a source of wages. (Clark 1908, IX.10) We may only wonder whether it is capital or capital goods that play a role in this theory.

Rent and interest

Another distinction is made between rent and interest. **Rent** is the reward of concrete capital goods, whereas **interest** is earned by capital as a fund of value. (Clark

1908, IX. 12) If interest is not spend but employed productively, it enlarges the existing fund of capital, but it is absurd to imagine that an instrument of production can be enlarged by its own rent. Similarly to capital and capital goods, interest and rent are essentially the same thing, expressed in two different ways – and their distinction needs to exist due to the dual nature of capital.

Clark then comments on some other terms appearing repeatedly in the theory of capital. **Abstinence**, now, is seen as not the only way of capital goods creation. The uniqueness of abstinence resides in the fact that it really creates new capital goods, not just replaces the previous ones.

The unimportance of period of production

With respect to the concept of period of production, this also applies to capital goods and not to pure capital. There is a gap between the employment of labour and the consummation of its fruits, and there is also a time interval during which certain instrument of production is productive, but capital itself is not subjected to any wear and tear, is a source of incessant productive power. (Clark 1908, IX.19) For the description of the function of capital, Clark uses the word **synchronization**: capital synchronizes, not separates, labour and its fruits, which might lead us to think about capital and labour as complements in the process of production. This seems like an unproblematic fact, but what follows from it is so different from the theory of Böhm-Bawerk that one must question the possibility of coexistence of both approaches and their justification.

Without periods of production, waiting or abstinence, everything seems to be „more perfect“, the production of consumer goods is a continuous process, the consumer is not able to perceive any periods in it, the length of production process is somehow irrelevant to him. Even if we admit a substantial waiting time before the first goods ripens, we may discard it as irrelevant once the moment comes. After that we are likely to get an equal amount of the product every following year. (Clark 1908, IX.22) Abstinence thus is important only for the increase of the existing fund of capital, not for its renewal. Its proper place is in the theory of economic dynamics, whereas interest belongs to statics and its explanation can do without abstinence.

Basic explanation of interest

Interest is based simply on the productivity of capital, on the power to create material product. (Clark 1908, IX.28) Introducing the period of production to Clark´s theory is impossible, as the permanent character of capital corresponds to infinite periods, bounded on one side only. If one would conceive period of production as related to capital

goods instead of capital, it would make some sense,[1] but would not bear any relevance to the height of the rate of interest – changes in the production period would not be the cause of changing rate of interest. Measuring capital by the means of these periods is then pointless. In Böhm-Bawerk´s theory, the rate of interest declines with the lengthening of average period, so Clark has to offer a different argument. Again, it is simple to understand: interest falls when the quantity of permanent capital increases.

3.3.2 Types of capital and capital goods

Circulating capital equals money

The distinction between fixed and circulating capital, appearing so often in the past, is now subjected to criticism. Clark again identifies the problem with the ambiguous use of the term capital that used to mean both capital goods and capital. When we mean to distinguish two kinds of concrete capital goods, Clark offers a new way how to do it, one that should be more appropriate for this purpose. In his view, the only part of capital goods that deserves the name circulating is money, the rest usually changes hands no more than once. (Clark 1908, X.2) Since there is no precise dividing line between these two categories, we suggest that the usefulness of working with them is rather doubtful.

Passive vs. active capital goods

What we may try to do is to come up with new categories, better corresponding to reality. Clark suggests passive and active capital goods. This distinction is based on the link between utility and our capital goods. If the goods receive utility, they are only passively modified by it (eg., raw materials), they are counted among **passive capital**. In the other case, goods classified among **active capital** can serve to impose utility on other objects, such as a machine whose work changes the material, but the machines itself remains intact, except for the natural process of wear and tear. In most cases, fixed capital would be included in the active one, and vice versa. (Clark 1908, X.7)

The terms fixed and circulating, however, when applied to capital as a fund, have a good meaning. A part of this fund is made up by capital that must circulate as fast as it can, this being true for **circulating capital** (it can be pictured as future consumption goods still in the process of production). Two additional parts are both **fixed capital**: one of them is of such nature that it never circulates (embodied in land), the other circulates only slowly and it is not desirable for it to circulate any faster (capital in machines, buildings). Generally,

[1] Capital goods are perishable, and we can measure the time for which a particular item is invested in a certain production process. From that, the period of production could be computed.

capital lives by changing its form, it is not the change of owner but the physical transformation of capital that is the most important, that gives it its special features. (Clark 1908, X.7)

With this characterization of capital clearly laid down, Clark easily refutes the thought that capital is constituted by stored-up food to support labourers before the production process they are engaged in is finished. The only food that can be considered capital are the raw materials, such as wheat, that have yet to undergo transformation in order to become real food, ready for consumption. He goes so far as to say that no such store exists, that people are nourished from the continuous stream of ripening goods, which goes to the consumer immediately after its production is completed. In stating that, Clark demonstrate the ability to adopt a dynamic view – looking only at a fixed moment of time, this demonstration would be impossible.

3.4 The first capital controversy: Böhm-Bawerk and Clark

We now get to a point where the variety of opinions and answers to the big open questions in the theory of capital seems to be impending. It can remind us of a vicious circle – most economists being capable to falsify the arguments of their colleagues, but not to come up with a theory that would be immune to criticism. Although the neoclassical and Austrian economics were both born in the great marginal revolution of late 19th century and incorporate the principle of marginal productivity, their approaches to the theory of capital are different in significant aspects. No wonder that the situation gave rise to a great discussion that appears in the literature as the first capital controversy.

3.4.1 Mythology of capital?

Böhm-Bawerk and Clark were both familiar with each other´s contributions to the theory of capital and also admitted the numerous points of agreement. Nevertheless, rather than emphasizing what features were present in both theories, it seemed more urgent at that time to try to discuss the deviations, both in private correspondence and magazine articles. (Cohen 2008, pp. 152)

Contemporary economics might see this debate as a useless effort to find truth between two teories that were both confusing in several points, however, the look into history shows us that the same problems have been recurring in following decades in spite of the continuing development of the theory of capital.

The first capital controversy is centred around Clark´s concept of pure capital, which is denominated by Böhm-Bawerk as a mythology of capital, something too abstract to allow any practical implications. We may ask how it is possible that while both admit the dual nature of capital, one of our economists works mostly with heterogeneous capital goods, and the other puts forward the idea of capital as a fund of value. We will try to identify several points of disaccord.

1.) Time and interest

Clark´s static equilibrium with a constant quantity of capital, as a given fund of productive wealth, makes the explanation of interest independent on time. Böhm-Bawerk, on the other hand, designates the excess value of present over future goods as the source of interest. However, his method of working with capital is still mainly static. The debate about the appropriateness of static approach to study the market of capital will bear a great importance in the future of capital theory too, as no easy solution is available. If we acknowledge the need for a dynamic frame to explain the role of capital in production, we yet have to build such a theory, and the way how to do it without excessive simplification is not obvious.[1]

2.) Productivity

To explain the existence of interest, Clark is basically limited to one possibility only: he has to declare capital to be a productive element, naturally creating surplus value. The fund of capital is capable not only of its replacement, but also to add something to itself, the proportion of these two quantities being the rate of interest. Böhm-Bawerk, on the contrary, excludes capital from the list of the means of production: direct production powers are attributed to nature and labour only, whereas capital brings us additional value only by allowing us to embark on more roundabout processes of production. We might illustrate the difference between these two approaches by the simplified statement that Böhm-Bawerk asserts that time is productive, whereas Clark would say it is capital.

3.) Special features of true capital (permanence, perfect mobility, synchronization)

This constitutes the main evidence that led Böhm-Bawerk to use the word „mythology“ when describing the views of his colleague. (Cohen 2008, pp. 153) Can we bestow upon the fund of capital features that are not present in the particles that give this fund its value? To be specific, this refers to the permanence of pure capital, its perfect mobility, and synchronization over time.

[1](Compare with what Hayek says on methodology, section 4.2.1)

Permanence expresses Clark´s belief that once the capital is created (by abstinence), it is bound to be renewed in an incessant process of transformation of form. This claim of Clark remains unexplained in our opinion. Automatic reinvestment is not guaranteed: the income from capital comes together with the means for its renewal, and the choice of the amount of that fund to be withdrawn for consumption is left to its owner. If he wishes to consume more than just the interest, nothing can stop him.

Perfect mobility is also a fiction, justified only by the complete absence of time in Clark´s analysis. Yes, capital is ultimately able to change forms, but in a limited time horizon, the possibilities for a change might be seriously restricted.

Synchronization eliminates the role of waiting, or abstinence. In a static state, with only well-established production processes in motion, we may be sure that at the same moment, each production process can be found in all its stages, including the stage of goods ready for consumption, that stop being capital goods and are ready to get consumed. Instead of following production processes in their full duration, we "stop the time" and look at what we can see at that one moment, like doing a cross section over many production processes serving to produce the same goods. Clark imagines that no matter what our view is, we get the same picture, with some goods ready for consumption, and thus no waiting necessarily included in our analysis. For the static state, this argument seems to be plausible.

4.) Dynamic effects and time preference

One obvious drawback of Clark´s analysis is that when any dynamic change occurs, its apparatus is unable to explain its consequences. Economic growth or changing technology[1], all these common phenomena of real world economy, find no place in static theory. Clark supposes no path dependency, comparative statics allows us to jump from one equilibrium into another, but does not account for the causes of this move, for the way how it happened. This is rather counterintuitive, but when we choose to work with static theory, we must know about this consequence and have some stronger justification for statics.

Böhm-Bawerk, however, builds his quantitative theory of interest rate in a static frame as well. This is done by the assumption of a given subsistence fund (which, in this

[1]When we understand technology as a collection of production processes that are in operation at a given moment, changing technology will mean an introduction of a new production process or a termination of an existing one (we cease to add new inputs to it).

part of Böhm-Bawerk´s theory, resembles the concept of pure capital, but Clark does not pay much attention to this).

In an article on the first capital controversy, Cohen (2008, pp. 166) asserts that both economist use time preference in a similar way. Clark´s unchanging quantity of capital in equilibrium relies on the hidden assumption that no savings are made, that the existing rate of interest exactly offsets time preference for present enjoyment. On the other hand, fixed subsistence fund in Böhm-Bawerk´s theory also implies that no savings or consumption of capital occur, that the interest rates corresponds to time preference, and the productivity of roundabout methods is not the only determinant of interest rates. We may conclude that Clark and Böhm-Bawerk seem to be similar in more aspects then they are willing to admit.

3.5 Knut Wicksell

For his contribution to the theory of capital, this Swedish economist is often mentioned together with Jevons and Böhm-Bawerk. He refined the Austrian period-of-production theory to arrive at similar results in a more elegant way. Here, we will mention only that part of his work that proved to be the most important in the future development of the theory of capital.

His name appears most often as a part of a fixed expression **Wicksell effect**. This name was first used by Carl G. Uhr in his article *Knut Wicksell: A centennial evaluation* (1951). It designates a phenomenon accompanying capital accumulation, one that prevents us to draw a simple analogy between labour, land and capital. Uhr also gives a very clear summary of Wicksell´s work in the theory of capital, so we will follow his exposition here.

Wicksell´s reformulation of the theory of capital

Wicksell is most praised for his concept of capital structure: a devise that lets us quantify capital in two different ways. First, we can describe capital as a determinate, two dimensional "time structure" of production. Second is quantification in value terms, that resembles the period of production approach. (Uhr 1951, pp. 845)

The **two dimensions of capital structure** are width and height. As a value, capital structure can be represented by multiplying the value of inputs at certain wage/land rate by the time these inputs must remain invested. At stationary conditions, wages and rents are determined by lower marginal productivity of factors employed in current production.

One advantage of long term over short term employment of capital Wicksell finds worth mentioning is that the long term capital needs relatively less replacement input than a corresponding value of short maturity capital.[1]

Effects of net investment

Wicksell depicts the effect of capital accumulation as a process altering expansion in width and in height. At first, capital is likely to expand in width: more capital goods of the same kinds appear, their relative proportions being the same. This is assumed to cause an absolute increase in short term capital which makes long term capital relatively more profitable, and thus expansion in height (i.e. new investment in long maturity goods, possibly shift of investment from short term to long term capital) follows. (Uhr 1951, pp. 847) By the lower replacement cost of long term capital mentioned above, some wage and land is liberated for current production, which may offset the rise of wages accompanying the width expansion, and lead to a second wave of a width expansion. Capital accumulation is thus seen as an alternation of the two kinds of expansion, which stops at a point of equilibrium, where the current net yields of capital goods will bear a compound relation to their time till maturity. (Uhr 1951, pp. 846)

Distributive shares analysis

An inquiry into the division of output between labor and capital in the context of capital accumulation is separated into several cases. We may observe either the impact of net investment (without technological change), of technological change (without net capital formation), or both.

Capital intensity is the factor that needs to be considered. Wicksell claims that while it is low, net investment will not cause a dramatic decline in the rate of interest and the share of capitalist on national dividend is likely to increase both relatively and absolutely. When society becomes capital-intensive, the opposite happens and the labour and land shares are now to be increased. With growing wages, investment becomes more and more profitable in the long term capital goods, which slightly reduces the growth of wages.

Technical improvement is said to always increase national dividend, as it increases the average productivity of factors, usually of both labour and land. It is well possible that the marginal productivity of long term investments will be increased absolutely, which

[1] The assumption of greater productivity of roundabout methods of production is hidden in this fact.

goes against the trend of decreasing interest rate and rising wages that would occur at unchanged state of knowledge. Alternatively, we can call this "labour-saving technology".

Wicksell effects

In discussing the process of capital accumulation, Wicksell stresses a particular phenomenon that makes the possibility of reaching zero interest rate highly unlikely. This is now simply called "the **Wicksell effect**".

This term designates the fact that with capital accumulation, rising wages and rent tend to absorb a part of net savings. This effect is so important that it prevents the society to accumulate such a great quantity of capital that its marginal productivity would drop to zero.

Due to this absorption of savings, Uhr states, social marginal productivity of capital is somewhat lower than corresponding interest rate, Thünen´s law[1] becomes invalid and we cannot draw exact analogy between the case of increasing labour force and capital accumulation.[2] (Uhr 1951, pp. 851)

Unfortunately, realizing the presence of forces such as Wicksell effect brings additional complications to our theory. Wicksell effects have to be considered whenever dealing with changes in capital structure and their impact on income distribution or changes in composition of total output.

Gustaf Åkerman, another Swedish economist whose works share certain important aspects with Wicksell´s, came to a slightly surprising conclusion that Wicksell effect can work in the opposite direction too (Wicksell effect in reverse). A formula was found in which marginal productivity of social capital equals interest rate times factor *h*, which can be lower, but also higher than unity. (Pasinetti 1978)

In later discussions, economists started to distinguish **price Wicksell effect** and **real Wicksell effect**. Real Wicksell effect includes changes in technology, while price Wicksell effect reflects only the changes of wage rate and rate of interest with technique of production unchanged. (Harcourt 1969, pp.398) Both can be applied to show the problems of capital valuation. In Cambridge capital controversy, a link has been made between Wicksell effects and reswitching (see chapter 5.4.3).

[1] Law of diminishing marginal productivity, discussed in chapter 3.2.2.

[2] Interest rate is given by the quantity of real capital, which is lowered by the amount of absorbed net savings, this increases the interest rate over the social marginal product of capital, which reflects the increment of output with capital accumulation.

3.6 The contribution of Jevons/Böhm-Bawerk/Clark/Wicksell: summary

After the marginal revolution, differential calculus became a common tool for interest rate calculation, which was estimated using the marginal product of capital. Although the members of the Austrian school tried to develop their own method, their result was very similar. Wicksell was the first one to offer a serious argument against the marginal productivity theory applied to capital.

Hence, interest theory remains static in its nature. However, from Jevons, we learnt that it might be useful to consider time as one of the variables in the theory of capital, and the Austrian school tried to expand this idea. Böhm-Bawerk attempted to measure capital using the average period of production, which should substitute the quantity of capital in our calculations. The next chapter will try to explain why this cannot work. Another justification of positive interest is given in the form of three causes why present goods have higher value than future ones. The moral aspect of interest is no longer a problem deserving much attention.

As an alternative to Austrian vision of the economy, there stands the neoclassical theory, which treats capital as a homogeneous fund with permanency, perfect mobility and synchronization as its main features. These features determine the character of their whole exposition.

Despite the seemingly different approach to capital of Austrians and neoclassics, they still share some important features. This is highlighted by the fact that Böhm-Bawerk in the part of his *Positive theory of capital* devoted to quantitative determination of the rate of interest begins to treat capital as a homogeneous subsistence fund – he does not manage to maintain the original concept of capital as a collection of heterogeneous goods. Moreover, both versions of the theory of interest contain the hidden assumption of time preference whose definite relation with the rate of interest ensures that the economy stays in equilibrium.

Wicksell not only rephrased the Austrian theory, but also added important considerations on the effects accompanying the accumulation of capital. The general acknowledgement for his suggestions came only later – we will discuss the implications of his ideas in Chapter 5.

4 Further development in the theory of capital

Although the first capital controversy did not solve much in terms of bringing the two distinct approaches closer to each other, it managed to state clearly the questions that stood as a challenge for future capital theorists.

Hence, we may observe continuing development of capital theory along two different paths: one in the tradition of Austrian school, a school that was not assimilated into neoclassical economics, as some dare to say, but lived to see its "golden age" in 1930´s with such a great names as Mises and Hayek. Second, neoclassical economics pursued the examination of capital seen as a permanent fund of value whose marginal productivity determines the interest rate.

We will move a few decades ahead in time to describe what the situation in capital theory was in 1930´s. Economists active at that time have lived through Great Depression to see how huge an impact such a crises can have. A possible source of explanation might lie in the theory of capital. However, the Hayek/Knight/Kaldor capital controversy, second of the three great capital controversies of history, showed that the theory itself is still plagued by so many problems and ambiguities, that it is hardly able to provide any universally recognized solution to current economic-policy questions.

Before we enter the fierce discussion, we recall a work of a less well-known Austrian economist, Richard von Strigl. His work will show us the possible reasons why a theory of capital is important and what exactly should be studied.

4.1 Third generation Austrians: Richard von Strigl

Richard von Strigl was a member of a generation deeply touched by the Great Depression. In his writings, he follows the tradition of the Austrian school. That leads him to take the productivity of roundabout methods as a starting point – first explaining how these work and only after that trying to define capital. However, he mentions also the wage fund theory as an additional source of his ideas. Part of his effort should aim at a possible explanation of the Depression from the view of capital-based macroeconomics.

In search for the proper length of production process

In his theory, the available **subsistence fund** serves as a limit to the length of a roundabout production process. Knowing the size of our fund, we should be able to determine the correct length of production processes that will be undertaken. As longer processes are more productive, we seek to find the maximum length we can afford without

encountering the need to interrupt the process in the future. Increasing roundaboutness is seen as the only way how to get a greater product.

> "From a purely economic standpoint, what one commonly calls improved production must almost always be understood as lengthening roundabout methods of production – except when it is exclusively attributable to progress of the division of labour or technological knowledge." (Strigl 2000, pp. 5)

Strigl uses great simplification to explain the basic idea, and then tries to remove some limiting assumptions. Imagining only one production process running at a time, the theory is highly unrealistic and in direct opposition to the continuous flow of product described by Clark. So the next step is to add more production processes of the same length, only at different phases of maturity. At the moment of completion of one of these processes, we can determine the length of a new process to be started in such a way: we take the funds liberated by the completion of one process and add the value of "incomplete subsistence funds" in the form of running production processes. The total constitutes our current and future subsistence fund. Considering the use of this fund, if the roundabout processes are to continue on the same scale, we have to use it productively, to invest it in a new process so that the fund can reproduce itself. The issue of **reproduction of capital** thus returns: Strigl opposes Clark in the same way as Böhm-Bawerk did: automatic reproduction is not guaranteed.

At this stage, it is easy to relax further assumptions. Especially, we can think about a great number of production processes running at one time, what makes the subsistence fund created at the completion of one of these only a small fraction of the total value incorporated in goods that are being created in the other processes. Although the quantities are very different, the role of the subsistence funds stays the same, and so the study of a simplified version of the theory remains useful.

Utilization of a subsistence fund for reproduction

Strigl explicitly lists the several possible uses of a subsistence fund. (Strigl 2000, pp. 18) On the most general level, subsistence fund must serve for the reproduction of the original factors of production consumed in the process. **Consumption goods**, being the only source of a subsistence fund, thus seem to fulfil the function of capital: to support roundabout methods of production. The subsistence fund must support not only the producers of final goods, but also those engaged in earlier stages of the process or in the processes that do not end with a production of consumption goods, but help other processes by creating machines or other durable capital. The presence of intermediary

goods in our processes does not call for a new theory to be introduced: it just leads to a further lengthening of the process, and demands a **renewal fund** to be created for the reproduction of the investment. This renewal fund is obtained as a part of the increased subsistence fund, going to those employed in the durable goods creation processes. With this, the principle of a reproduction in economy should be clearly stated.

Three kinds of capital

Based on the description of roundabout processes and the conditions for their renewal, three kinds of capital are distinguished[1].

1.) **Free capital** – the subsistence fund, the supply of consumer goods

2.) **Intermediate products**

3.) **Fixed capital**

The difference between 2) and 3) lies in the fact that the goods constituting fixed capital are durable, they can be used repeatedly in several production processes. Together (2+3), they can be denoted as **capital goods**. Capital goods (which must be produced with the help of free capital) not capital as a whole, are considered to be a factor of production (besides the two original factors, land and labour). Roundabout method of production is characterized by the employment of all three kinds of capital. (Strigl 2000, pp. 28) Consumption goods, on the other hand, are never capital, they only assume its function when used reproductively. This gives the foundation to the subjective nature of capital.

In Strigl´s treatment, capital is thus composed by two very different parts: capital goods, these objects that facilitate production in roundabout processes, and free capital, the prerequisite of such processes. In this context, the only way to create new capital is to use free capital. To me, it seems questionable whether the use of the term capital for both free capital and capital goods can be justified. It is probably only a matter of terminology, but the strict separation of capital and capital goods made by Clark might be easier to grasp and work with to avoid any confusion.

Free capital transformed into capital goods

The problem of **capital mobility** and the ease of reinvestment is related to the transformation of free capital into capital goods. Originally, free capital can be employed in any process, but once it becomes tied, the range of purposes it can serve dramatically decreases. Strigl presents this as the notion of **liquidity of capital investments**. (Strigl 2000, pp. 31) The **danger of malinvestment** is presented as the violation of the proper

[1] No general definition of capital is made in advance – capital is presented only as a collection of his parts.

ratio of capital goods to capital. Then, the lack of free capital to support existing investments results in troubles to finish already started processes. The extra free capital needed can only be obtained by finishing some production processes, but not all the plans may be carried out, and this imbalance and **immobilization of capital** creates serious problems.[1] Here, more soundly than in previous works, a warning is pronounced: overestimating our production possibilities and the supply of free capital that will be at our disposal can cause severe problems.

Capital market

In their decisions about capital investments, entrepreneurs use the information about prices on capital market. They seek to obtain the greatest revenue possible by determining the most profitable length of roundabout process of production. By **availability of capital**, Strigl understands the possibility of beginning roundabout processes of productions. What happens on the capital market, then, is an exchange of present goods (capital) for future goods (product obtained with the employment of capital in roundabout processes). (Strigl 2000, pp. 53) The entrepreneur gets a subsistence fund of a sufficient size to support him during the whole process of production. Upon its completion, he is able to pay interest for capital he has borrowed due to increased productivity of processes in which labour is supported by more capital then before, and thus can be employed for a longer time.

Profitability of roundabout methods

A more roundabout method will be chosen only if it is expected to bring profit. However, with more roundabout processes in the economy, two tendencies decrease their profitability: rising wages and falling product prices. The universal law of decreasing marginal productivity and diminishing returns applies to capital as well. Smoothly functioning capital market will yield only one price for the goods it offers, capital. This price is the **interest rate**. Interest rate influences both the selection of production processes to be started and the length of those chosen. (Strigl 2000, pp. 59)

When we move from a simple one entrepreneur case towards situations closer to reality, we find there are more entrepreneurs that strive after profits. Some of them specialize at the production of capital goods, whose prices have now to be determined. Prices in general reflect the demand for the respective goods, and, in equilibrium,

[1]Later, we will see that it is the interest rate that coordinates the length of production process with the supply of capital.

correspond to cost expenditures during production, the same principle working for durable capital goods (interest being part of the costs) as well as for intermediate products.

In accordance with previous works, supply of capital can be increased only by **savings**, that is investing our income instead of consuming it. (Strigl 2000, pp. 61) The fact that capital is tied up in production processes, sometimes for a great length of time, is seen as its important feature – economic fluctuations can then cause serious gains or losses:

> "During fluctuations in the economy, the fact that capital is tied up in lenghthy roundabout methods of production can result in significant gains and losses in capital goods." (Strigl 2000, pp. 63)

The **explanation of wages** reminds the famous wage fund theory. Capitalist can pay no more to his labourers than what he can draw from his subsistence fund at the beginning of a production process. (Strigl 2000, pp. 68) This rule holds for the whole economy: a self-regulating mechanism makes wages correspond to the chosen length of roundabout processes, so that existing wage fund is just sufficient to pay wages.

Key process: transformation of capital structure

To conclude the discussion, Strigl stresses the **principle of marginal productivity**. The structure of capital invested in an economy has a tendency to follow this principle – and only the length of time during which capital is tied in specific investments prevents the economy from staying in the equilibrium (alternatively, we can call the cause of this the **irreversibility of time**), where prices of factors reflect their marginal productivity and all capital brings the greatest income possible. (Strigl 2000, pp. 84) The adjustment in real economy – the **transformation of capital structure** – can be very slow and deserves a great attention. The maximum affordable length of capital investment with given technology is that key thing that has to be studied, that is of vital importance for the understanding of capitalist production.

If we decide to work with the assumption of a static state, then we are bound to stay far from reality: String emphasizes the need to consider changing structure of the economy and the need to work with time factor in the theory of capital. (Strigl 2000, pp. 89) In fact, study of the structure of production and the employment of capital can be seen as equivalent: and hence the great importance attributed to capital theory in Strigl´s eyes.

4.2 Fridrich A. von Hayek

In this chapter, we will provide a summary of Hayek´s critique of existing capital theories. This will be followed by the survey of his debate with Knight. Only after that, we try to describe the positive theory of capital he offers.

In the introduction to his *The Pure Theory of Capital*, Hayek directly admits that the theory of capital he is going to build will be rather distinct from all those past attempts. At the same time, he mentions Jevons, Böhm-Bawerk and Wicksell as those economists on whose work he will elaborate: he appreciates their effort to include time factor in the theory of capital and strives to correct the failures and inaccuracies they committed in the course of their work. Hayek praises especially Wicksell for not overemphasizing subjective psychological factors and time preference relative to productivity – which should constitute the foundation of his theory.

Hayek´s main hypothesis asserts that no capital theory can be a theory of a stationary equilibrium. (Hayek 2009, pp. 4) The fundamental reason is this: in a stationary equilibrium, many problems belonging to the theory of capital disappear. Those that are still present might be solved maybe more easily than without our simplifying static assumptions, however, the solutions thus provided are without any practical applications to real world situations.

4.2.1 Stationary-state theory of capital

The aim of past theories of capital

Moreover, Hayek claims that in the past, the theory of capital was subordinate to the theory of interest, and the main purpose of investigations was to determine the interest rate. Putting it in a direct relation to the quantity of capital seemed to be the easiest solution – although this is feasible only with a defined meaning of the expression **quantity of capital**, which presents a problem in itself. To avoid the difficult issue how to measure capital as a collection of heterogeneous goods, capital was assumed to take a form of a homogeneous substance[1].

Hayek is convinced that this move is justifiable only in the static frame. Unfortunately, the theory of capital built there loses any real explanatory power.

Two forms of capital

When we leave static equilibrium and look at the situation outside it, we are forced to discuss capital in two forms, one of them representing demand, the other supply: demand for capital is now given by the existing structure of production whereas free or disposable capital constitutes the supply. (Hayek 2009, pp.9) The interaction between the

[1] To measure the quantity of capital as heterogeneous goods, we need first to choose some measure of value. The problem is that the relative prices of various capital goods in these value-units may change, and one collection of the same capital goods can be valued differently depending on the ruling conditions in the economy.

two forms of capital is the key phenomenon that has to be studied. The new aim of the theory is seen in the study of the **material structure of production**, in the investigation into qualitative changes in its structure induced by changing conditions in an economy that finds itself outside equilibrium.

> "The main problems are to explain what types of instruments will be produced under given conditions, and what will be the consequences of producing particular instruments." (Hayek 2009, pp.15)

The theory of static equilibrium did not permit any such study, it makes no sense to build on its findings with this new goal in mind – the only chance is to construct a new apparatus for economy outside stationary state and then apply it to the theory of capital.

Methodology: static vs. dynamic theory

The notion of dynamics needs specification. Hayek describes a theory of **economic dynamics** as the theory that attempts to explain economic processes in time – in contrast to the theory of **general equilibrium**, a situation when the plans of economic subjects are consistent with each other, meaning that all can be carried out without interruption. **Stationary state**, an extreme equilibrium where the plans do not result in any change of economic variables, is only a special case of general equilibrium and static theory in the traditional meaning confines itself to this stationary state. However, economists are not restricted to choose one of the two opposing approaches – dynamics as outlined above and statics. There exists an intermediate way: to work with **economics outside the unchanging conditions of stationary state**, but not necessarily outside equilibrium. This is what Hayek intends to do. (Hayek 2009, pp.18) In terms of terminology, this approach has sometimes been matched with the title of dynamics, although it stands more in the middle. Hayek uses the term general equilibrium.

Regarding the question whether the analysis should be in real or monetary terms, Hayek chooses the first option. It is mainly for the sake of simplicity: we are already entering a new field, and additional complications should be evaded. An interesting argument says that we are not restricted to building theories describing our reality (where money, of course, has its place). (Hayek 2009, pp. 22) Purely **fictitious theories** may underline some aspects of capital that would otherwise remain unnoticed. This does not apply only to the decision not to work with money, but also to the whole method of general equilibrium – such a state, we may argue, might not exist at all. Once we presuppose its existence, excluding money from our theory is not a major problem: the main reason for

holding money known from reality disappears when people do expect their plans to realize, so there is no need for money derived from uncertainty about the future.

4.2.2 On the way to new capital theory

Requirements for a new capital theory

To sum up his views, Hayek tries to postulate in several points what conditions a satisfactory theory of capital has to meet. First, it has to be a general, not partial theory, because only then it will be able to explain the interrelations between industrial branches. Next, it must not restrict itself to study a stationary state, but try to explain the structure of production under given conditions, to be able to say how existing equipment influences the future, how a man is capable to cope with the consequences of his inaccurate predictions made in the past. Interest is then explained as a by-product of such observations, being an important result, but not a goal in itself.

When Hayek speaks about the Anglo-American capital theory, he only remarks that it neglects some aspects that are important in the Austrian theory, and that will be important for him also. He saves his critique for a later date.

Definition of capital

Hayek draws up the distinction between **permanent and non-permanent economic resources** as the fundamental proposition which will enable us to define capital.

Here, permanent character is mostly a matter of degree: relative to an individual, many things may be considered permanent whose durability is not infinite, but exceeds our lifespan. Irreversibility of time gives an extra importance to the distinction above: asymmetry between present and future demonstrates itself in the fact that present services can be postponed whereas future services are unattainable in the present.

Capital is defined as:

> "....the *aggregate of* those *non-permanent resources* which can be used only in this indirect manner to contribute to the *permanent* maintenance of the income at a particular level." (Hayek 2009, pp. 54)

The mechanism of its work has to be carefully explained: how is it possible that non-permanent assets are able to invoke a permanent increase in productivity? There has to be an indirect effect, which works towards increasing productivity of methods using the

same amount of permanent assets, now supported by capital. (Hayek 2009, pp. 53) In Hayek´s words, this is the peculiar problem connected to capital.[1]

An interesting comment relates the non-permanency of capital to the very reason for existence of the term capital. Under the problems of capital, we attempt to solve the question of **division of income** between **pure yield** of an asset (interest) and the part that must go to its **replacement**. Permanent resources, however, do create only a yield: they cannot be destroyed in the process, so no need for funds for their replacement – this problem is irrelevant to them.

Greater productivity of time consuming methods

The function of capital is inherently related to time. The additional income it provides lets us extend the period for which other, permanent resources will be invested before they earn income. (Hayek 2009, pp. 59) Extra capital means extra provision for consumption, so we can postpone the moment when currently started production processes will be completed. Then, the famous argument of increased productivity of longer processes is used to explain the benefit capital brings to industry.

One good reason why we should believe in its usefulness is that in any economy, there will at all times be some **unused potential resources**. Once these become involved in the production process (assisted by capital) the total product of an economy will rise. It is not necessary to require all possible extensions of production process to be more productive, but there should always exist some way how to increase productivity by lengthening an appropriate production process. Second reason stresses the relation between longer production processes and the **division of labour**. A man is more productive when performing specialized, narrow tasks. These might be completely unlike those performed in processes of shorter duration. Another chance for increased productivity is the fact that the **goods** created in longer processes are often **more efficient in satisfying the same needs**. Many, many possibilities exist - it is important to remove from our thoughts all unnecessary rigid assumptions: most resources have several distinct uses and the changes induced by extra capital available may include a switch from one usage to the other, if it becomes more profitable. A complementarity of productive resources creates strong

[1] In correspondence with the indefinite character of permanence, what is capital depends on a particular context. However, this does not change the question posed above – even if we count goods with a long, say hundred years durability, among capital, their durability is still limited and the explanation of permanent increase in productivity is not found automatically.

interrelations in the system. Further complication might lie in the possibility of some free resources becoming scarce as the amount of investment grows.

We may conclude this discussion with the statement that the increased productivity is given by **technical improvements**. When using this statement, however, certain caution must be paid to the term technical improvements. Its meaning includes no change in knowledge: due to new capital, we are able to use extended methods that were not available before.

4.2.3 New terminology

Period of investment

A few terms are defined on the way towards the concept of a period of investment, modification of Böhm-Bawerk´s period of production. Input designates the flow of services of permanent resources at a given moment. Output means the flow of final services. Investment occurs when we apply a unit of input in a process of production. In reality, input and output can be connected in various ways, but our abstract theory has to abstain from such possibilities and consider the simplest case: one unit of input generating one unit of output. We are interested in the time between the investment of a given input and the acquirement of corresponding output – briefly, the **period of investment**. (Hayek 2009, pp. 77) With this instrument, we are capable to discuss the effect of a change in the technique of production.

Here, we should recall the slightly different notion of **period of production**. This older concept works like an aggregate of periods of investments of all inputs involved in a production of certain output. The problem with the period of production, the reason that leads to an abandonment of such a concept, is this: with a change in production technique, investment periods of various units are not bound to change in the same degree and even direction. The process of production is seen as a series of operations that have to be conducted to obtain a final product. Then, an ultimate change in the length of the process is given by the changes in the investments periods of individual inputs, but the reasonability of examination of such an aggregate without proper attention devoted to investment periods is questionable[1].

[1] To understand the change, one should examine the factors whose investment period has been extended and whose has been shortened, but the knowledge of the development of the production period does not provide such information.

Vertical division of labour and stages of production

To employ capital productively, it must be used in such a way that the new production method is able to employ more original production factors, more powers of nature. This usually comes together with a division of production into several successive stages that can be done by different firms, each of them making a part of one extensive process of production. What is important for the theory is not the technical division of labour between subjects, but the character of goods resulting from each part of the process. Stages are of interest in connection to the **remoteness of capital goods from final product**, as a more subtle subdivision then the basic level distinction between consumer and capital goods. (Hayek 2009, pp. 74)

Measuring the length of a process of production or even comparing the length of two production processes is a precarious task. A previously suggested instrument of the average period of production has to be discarded as misleading. Hayek highlights the importance of investments period over the length of the whole process. Knowing the change in individual investment periods of units of outputs, we have at our disposal much better tool to describe the changes in the method of production than any aggregate average period might provide.

Durability of capital goods

The word **durable** assumes two different meanings. It can be attached to goods that can be used more than once, repeatedly, to create a certain number of products. Or, it might point at the fact that certain goods will last for a definite amount of time, e.g. a building with expected durability of 100 years. Usually, both elements come together, only in different proportions, in the majority of durable goods.

This ambiguity has a twofold impact on the theory of capital. First, related to the section above, it makes measuring the period of investment somewhat more difficult.[1] Then, growing quantity of capital sometimes manifests oneself in "more durable goods" being used. (Hayek 2009, pp. 82) This expression offers two possible interpretations: more = greater number of goods of the same durability as before OR goods that will last for a longer time than those used before. In both cases, the new goods whose existence was permitted by the increased supply of capital are more efficient in production. When speaking about more goods of the same durability, we may assume that the new equipment is more costly and more **labour-saving** (same output is now created using less labour-

[1] Output obtained with the help of durable goods is a stream of services over a period of time.

force). This is based on the fact that with given supply of capital, only the most productive available methods of production will be used.

Capital in the role of a subsistence fund

What Hayek dislikes about the notion of subsistence fund is the image it evokes. **Subsistence fund** corresponds more to a set of final goods labourers will consume while employed in a particular lengthy production process. Without this subsistence fund, roundabout methods of production would be impossible. However, consumption goods stand outside our definition of capital.

We might explain the following puzzle as follows: capital truly enables to extend production processes by providing certain income that will support labourers for their whole duration, but it is not the same as those material objects, food or clothes, that labourers need to keep their living standard. It is sufficient to know that capital can be turned into these means of subsistence, thus providing the necessary subsistence fund. (Hayek 2009, pp. 85)

A definition common in the past, describing capital as produced means of production is found to be almost identical in a stationary state with our non-permanent resources. Before we reach such an equilibrium, another feature of capital is important: not that it was produced, but the need for its reproduction. Once this happens, the moment when a new capital goods replaces the old one, its "history" becomes unimportant: the fact that it was produced is not a part of a necessary knowledge its owner must have, as opposed to the need for its reproduction, which must not be forgotten.[1] (Hayek 2009, pp. 88)

Capital and investment

The explanation of ways how existing capital determines current investment will stand in the centre of Hayek´s exposition of a theory of capital. Here also, we face a **duality of the problem of capital**. (Hayek 2009, pp. 90)

1.) First task seeks to answer how capital determines the possible time interval we can wait for the complete product. In this sense, capital enables us to invest. As this is a common feature of all capital, Hayek claims that this might be the reason why many economists treat capital as a homogeneous fund, abstaining from its special productive powers and focusing on its role of a subsistence fund.

[1] Different question might arise: what are the permanent goods Hayek speaks about, i. e. are there really such resources that need not be reproduced or cultivated. Land might not a good example as without care, it can be exhausted and its productivity diminishes a lot. Hayek´s answer would probably return to his remark about the subjective nature of permanency.

2.) Second task focuses on a question why the extra waiting leads to a greater productivity. Here, we have to be concerned with differences among various capital goods, and the value fund approach offers no help now. Hayek is thus very sceptical to any usage of such an abstract, in his words mystical, conception.

4.3 Second capital controversy: Hayek/Knight/Kaldor

About thirty years since the first controversy have passed without offering any universally acceptable solution to the problems of capital, as formulated in the discussion between Böhm-Bawerk and Clark. In fact, the development proceeded mostly along two independent lines. Another large-scale debate was inevitable: and its main figures, this time, became three economists. Hayek, who emphasized the importance of time factor, Knight, who hold opinions similar to Clark, and Kaldor, who later enriched the debate with some new arguments. The centre of the debate was again the controversial concept of permanent capital. Many journal articles appeared devoted to this problem, both during 1930, when the three economists actively seek to convince the rest about their truth, and later – trying to summarize the complex development of the debate.

The main points of our discussion will focus again on the production period on one side, and the concept of permanent capital on the other.

4.3.1 Hayek´s position

In his article *The mythology of capital*, Hayek identifies one reason why such a dispute was born in the misleading concepts of his predecessor, Böhm-Bawerk. Allegedly, the obvious confusion his period of production brings to the theory of capital is the key problem. Then, a skilful economist, this being Knight himself, is able to discern the failures, to focus mainly on these erroneous concepts. Based on them, he comes to a conclusion that time factor is utterly dispensable, and the theory without it can work towards the same goals. But this is a conclusion Hayek cannot accept. He blames Knight from building a theory that not only is not able to provide answers to the problems of capital (as these are inseparably connected with time), but also the statements it advertises as solutions to some problems are wrong or inapplicable. We include a short extract to illustrate the nature of Hayek´s article.

> The basic mistake – if the substitution of a meaningless statement for the solution of a problem can be called a mistake – is the idea of capital as a fund which maintains itself automatically, and that, in

consequence, once an amount of capital has been brought into existence the necessity of reproducing it presents no economic problem. (Hayek 1936, pp. 201)

On the number of ways how to employ capital

Hayek finds the hypothesis that there are (infinitely) **many ways how to employ new capital**, not just the lengthening of some investment period, to be the main argument of his colleague.[1] At the same time, he asserts that no convincing evidence for this statement is provided, as Knight takes it to be rather obvious and does not bother much to prove it.

Hayek´s detailed investigation of Knight´s draft of three possible ways how such a thing as employment of new capital can occur without lengthening a period of investment of some factor is conducted to show that all three suggestions fail as an illustration of the hypothesis. In each of them, there is hidden an extension of some period of investment, either of labour or of other unit of input. Knight´s neglect of these facts is justifiable only on the grounds of him working with the aggregate average period of production, ignoring Hayek´s new revised concept of a period of investment.

Knight´s example from agriculture

Knight writes that under the assumption of a constant population, additional capital can enable us to grow more plants of the same kind as before, thus the length of the cycle remains unchanged.

How can this additional capital let us grow more plants, using constant labour? Hayek lists three possibilities, all of them shown to contradict Knight´s thesis.

1.) New instruments will be made by the people formerly working in agriculture to facilitate the agricultural production.

This includes increase in the period of investment of labour making those instruments.

2.) New instruments will be used that were made by people redirected from different branches.

3.) Additional capital will employ more people to grow plants.

Given that 2 and 3 is made possible only by the appearance of additional capital, the people changing their occupation must be employed in longer processes than before, thus again we find a unit whose investment period is lengthened. (Hayek 1936, pp. 212)

[1] In the previous chapter (4.2.2), we recall Hayek´s arguments telling us why the lengthening of the investment period means more profitable production.

Perpetual fund and the quantity of capital

Hayek translates Knight´s statement "capital is permanent" as "the quantity of capital stays constant".[1] If we admit that at least a part of capital goods is perishable, the proposition above implies the existence of some automatic mechanism working towards a renewal of capital goods so that the quantity of capital remains at the same level.

If there is such a mechanism, its proponents should be able to find it and describe the process of **automatic capital replacement**. However, no such explanation appears in Knight´s work and, moreover, we cannot even decide whether the hypothesis holds – whether the quantity of capital remains unchanged. This is because of the vagueness of such a notion. How can we say that two capital goods are equivalent? Here, we are not talking about some homogeneous substance, but about real objects. The most important thing to realize is that these objects do not offer only one kind of services, they can be used in various production processes to serve different purposes. At given conditions, only the most profitable use will be chosen. For the calculation of the quantity of capital, however, the multitude of possible uses is crucial. It prevents us to match each object with one unique income stream that would determine the value. (Hayek 1936, pp. 221) As Hayek says, the **quantity of capital is not a single-dimension magnitude**, simply corresponding to time – only the unfortunate treatment of Böhm-Bawerk may let us think so.

Capital and time

Hayek affirms that Böhm-Bawerk, after all, did not manage to detach himself from the traditional view of capital as a homogeneous fund – his subsistence fund shares important features with it, and this prevents us to proceed with our study in the right direction. The subsistence fund depicted in his works is an artificial concept: no stock of capital goods is equal to a single fixed quantity of consumers´ goods, thus it cannot be represented by a unique **waiting time**, a period for which it can sustain the population. (Hayek 1936, pp. 219)

In Hayek´s view, the situation is much more complicated. The process of capital replacement deserves a great attention, its explanation lies in the core of the theory of capital, and it is impossible to achieve this goal without working with time. Even then, the quantity of capital will not be associated a definite meaning, and this expression should be banished from capital theory altogether. Our analysis has to be based on the fact that existing capital goods is consistent with a great number of future income streams of

[1] Unless we want to increase it and act accordingly, which does not happen in the stationary state, and thus lies outside the scope of investigation.

different magnitude and time structure. The search for the best investment possible at a given time has to consider all the alternatives, single valued variable of "quantity of capital", even if there was a way how to construct it, would not convey sufficient information for the theory of production.

An attempt to **substitute time for capital** in the role of a factor of production cannot bring any results either. The character of time is not equal to that of capital: speaking about **supply of time** that is to be used in production seems to be absurd.[1] (Hayek 1936, pp. 222) Time is important, but using time instead of capital does not solve anything: only chance is to seek understanding of ways how capital and time cooperate to bring the highest profit possible.

Perfect foresight

Another assumption used in Knight´s works that is judged absurd by Hayek is **perfect foresight**. It is shown that having such a factor in our theory makes it rather obscure since with perfect foresight, the majority of problems of capital would never occur. (Hayek 1936, pp. 226) The only possible remnant is the question of the original investment of capital, if there is such a thing. Once this plan is made, our assumption guarantees that nothing will go wrong. No problems of capital replacement, redirecting it to other uses, or overinvestment resulting in lack of consumers´ goods would come.

In addition, if capital acquires all its qualities (permanent, perfectly mobile factor) only with this assumption, the chance for any practical applicability of such a concept seems to decline even more.

Concluding remarks – theory full of paradoxes

Even without any sophisticated theory constructed to discredit Knight´s approach, one is able to see several controversies implied directly by his statements. An appreciation of the need for dynamic theory, directly expressed or implicitly included in his treatment of issues such as the mobility of capital, makes us wonder why Knight puts so much effort into building stationary state theory and what he hopes to achieve. Knowing the limitations of such an approach and still wanting to develop it is a behaviour not everybody can understand.

Unfortunately, it seems that Knight in his critique focuses more on the work of Böhm-Bawerk than Hayek, and thus part of his critique aims at facts and concepts

[1] Also, time has different value for different people, and it is impossible to arbitrarily choose a person whose valuation of time will be the universally employed measure.

generally dismissed as wrong. The debate is thus, mostly in the beginnings, concerned more with past than present.

4.3.2 Frank H. Knight´s position

It is time to let Knight speak to defend his theory. The summary of Knight´s opinions is to be found in many sources.[1] The problem one has to face when attempting to give a short introduction to his views is that he has to decide how to deal with a gradual development of Knight´s opinions. This is demonstrated for example in the numerous models of interest rate determination, each new varying in certain aspects from the previous one. However, all is based on the underlying features of Knight´s capital, which we will describe in the following passage.

Capital and its properties

Inspiration by the treatment of I. Fisher is apparent in Knight´s approach to capital. He often mentions the domain of **accounting** as if it could provide evidence for the validity of his theory.

The procedure of bookkeeping transforms physical capital items into value to be able to keep records about them: and Knight creates an analogy between the work of accountant and his own effort, which uses **pure capital** as a basic element. (Knight 1934, pp. 258)

In an article from 1916, Knight defines capital as "claim or title to a certain amount of wealth, not involving the ownership of any particular piece or kind of property". (Cohen 1998) This suggests that this amount is predetermined, that capital represents some definite quantity. Knight himself speaks about **capital as value**. In accordance with Fisher, capital may be seen as a **discounted future income stream**. A capital owner is free to use the whole income for consumption without diminishing his capital (that is, the prospect of future income).

This leads us to probably the most discussed feature of Knight´s capital: its **perpetual character**. Despite his acknowledgement of the fact that capital goods have limited durability, that they wear out with time, he maintains that capital, as a whole, is permanent and cannot be destroyed in a single act of consumption.

> "Indeed, it makes no difference to the general theory of capital, ... , if the owner decides to disinvest and consume his capital." (Knight 1934, pp. 265)

[1] e.g. Cohen (1998): *Frank Knight´s Position on Capital and Interest.*
For a list of his articles on capital theory and some of his models, see *"What is Truth" in Capital Theory?* (web source), available at https://www.msu.edu/~emmettr/capital/Theme3.html

Reading Knight, one feels that the income which we may decide to consume is only a part of a yield of capital that remains after the deduction of necessary expenses for its maintenance. What we may cause by the consummation of capital is only restricting the possibility of its growth and a minor change of ownership.

Moreover, Knight identifies maintenance of capital with its **replacement**. It does not matter whether the successor of a concrete capital item that ceased to exist is of the same kind: as a part of the whole fund, all capital becomes undistinguishable. Replacement is reduced to a mere technical detail: it happens in reality, but the theory may neglect it without any risks. (Knight 1934, pp. 264)

Simple interest rate determination

Theory of capital in its pure form is taken to be a substance of a theory of interest. One of the basic assumptions of Knight´s capital theory is the all-time opportunity for investment. With the appearance of additional capital in the economy, the most profitable investment possibility will be found and the capital thus included into the permanent, income generating fund. **Profit-maximizing behaviour** of entrepreneurs will choose the concrete project and thus specify the income stream representing our capital.

In equilibrium, a discounted value of the particular income stream will equal its cost of production. The simple equation of cost expended and the expected income lets us compute the equilibrium interest rate, as a **rate of return on capital**.

A question might be posed how Knight avoids the danger of circularity, that is the explanation of the interest rate using the quantity of capital, which itself is a function of interest rate. Knight attempts to achieve this goal by determining the interest rate using the additional income generated by one-time investment, and thus exclude capital from its determination. Whether he succeeds is not so clear: he still writes about "interest rate as a perpetual income that is a fraction of total capital" and "capital goods measured by the perpetual income they yield" which I found a bit confusing. (Knight 1934)

Critique of wage fund/length of the cycle theories

According to Knight, there are many ways how investment can be profitable, and a great failure of the rival theory is that it chooses only two of them, claiming those are the only ones. (Knight 1934, pp. 268) Knight identifies these two as increasing the durability of capital goods and increasing the period of construction (roundaboutness of production).[1]

[1] The attempts made for their justification are included in the passage on Hayek´s role in the capital controversy.

Knight correctly suspects the period of production of being a senseless concept. However, his explanation asserts that all production periods are infinite, or, similarly, there is only one production period spanning the whole life of human civilization. Two arguments are given as evidence: first, Knight claims that if we choose one bound (the original moment of investment of productive factors or the moment of finishing our product) we are unable to find the second border of the process. Then, a famous statement, used already by Clark, affirms that **production and consumption are simultaneous**. (Knight 1934, pp. 275) From this perspective, a length of a production process, if it can assume any meaning at all, is irrelevant for the theory as well as for the consumer, who comes to the market with the intention of buying a particular item and does not care about the time needed to complete its production.

The **origin of capital** is said to correspond more to the term **abstinence** than waiting. This again tries to remove the time factor from our theory: instead of saving our income to invest it for a certain amount of time, described by the word "waiting", we invest in anticipation of a permanent income stream generated by our investment, our action is bounded on one side only: once the investment is made, it permanently increases the fund of capital and there is no need to decide whether to renew the investment, once it matures, or whether to consume its fruits with a consequence of permanent drop in our income.

The importance which Böhm-Bawerk accords to time preference is dismissed by reversing the causality between **time preference** and interest rate. Knight says that time preference is born only as a consequence of a positive interest rate, in the light of which more expensive present goods seems to be preferable to cheaper future goods. (Cohen 1998)

Interest rate models

All interest rate models that Knight tried to develop are built in the frame of static equilibrium theory. This stands in contrast to his claim that investment and savings find their place in the dynamic theory only, when we allow economic conditions to change. Another paradox, highlighted by Hayek, is the contrast between his speculating about unforeseen changes, which contradict so many assumptions of his theory, and working with these assumptions in spite of knowing the limitations.

In *Capital, time and the interest rate* the market for capital is seen through the demand and supply curves, which should give us the value of these two variables at a

particular moment of time. As we will see, this can be done for present moment (depicted P in Fig. 5), but to show other possible combinations of demand and supply is difficult.

In one paragraph, supply of capital is presented as the amount of new perpetual income over a period of time, and demand is assumed to be the net savings brought to market over a period of time. (Knight 1934, pp. 282) Elasticity of demand is considered to be practically infinite.

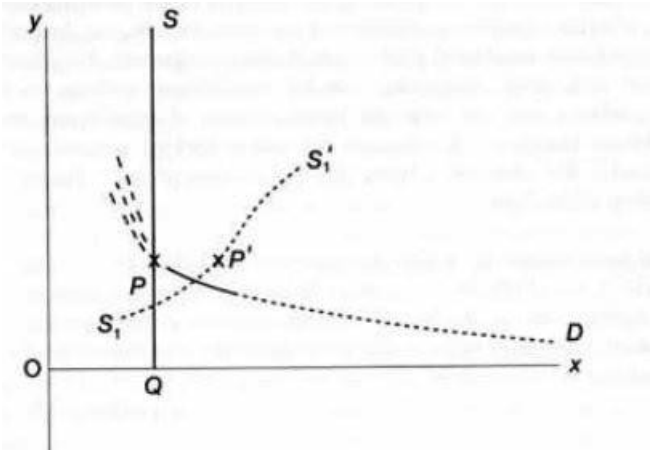

Fig. 5 Equilibrium demand and supply (Cohen 1998)

This picture first appeared in Knight´s 1936 article. Quantity of capital is measured along the x-axis, y-axis depicts the interest rate. Supply of capital at any moment of time is assumed to be given, represented by the vertical curve (although Knight says that the curve is reduced to a point, as any change in the interest rate means also a (simultaneous) change in the quantity of capital). (Cohen 1998) Concerning the demand curve, its part on the left of supply curve does not have to be considered when we exclude the possibility of disinvestment. Only a small part close to P (equilibrium point) is of interest, as huge changes in the quantity of capital are improbable. The tendency for decreasing rate of interest with increasing amount of investment is clearly visible.

The problems appear when Knight tries to explain the effect of **accumulation of capital** in the framework of this static equilibrium model. Knight is forced to reject any definite conclusion about the effects of accumulation of capital in time (represented by shifting supply curve to the right), since any addition to the supply of capital changes conditions in the society, movement of demand curve is independent and has an opposite effect, and the ultimate result for the rate of interest is indeterminable ("everything depends on the race between accumulation and improvement"). (Cohen 1998, pp. 156).

To illustrate the development of Knigh´s ideas, we will briefly describe his late Crusonia plant model. This model captures the working of a very simple economy with

only one commodity and its real applicability is not obvious, but it nicely illustrates the main features of Knight´s theory of interest.

Crusonia plant

Knight introduces his exposition by arguing that even a look at "Crusoe economy" may provide precious knowledge on fundamental economic categories. To investigate the rate of return on investment, Knight chooses to work in a simple economy, called Crusonia. Instead of a single individual, we consider a population that behaves like a single unit. (Knight 1944, pp. 29) This community has a **sole productive resource**, which grows at a constant rate, and which serves to satisfy the population wants. We may picture this as **Crusonia plant** that grows indefinitely without any need of care or cultivation. The plant represents capital to our society.

Apparently, no diminishing returns are present in this world: capital can be perceived as a perpetual sustainable rate of consumption (given stable growth rate of our plant). Each addition to it, by reducing our present consumption, will bring a return corresponding to this growth rate. The only decision left to the planner of our economy is the level of consumption, or the level of saving and investment.[1] Knight remarks that nothing like a period of production can be found in our theory. However, "in abstract essentials the situation pictured is identical with the reality of economic life". (Knight 1944, pp. 31) The **rate of return**, in any situation, is put in a relation to the cost of increasing the perpetual income a little, and thus being determined by technical conditions only.

Diminishing returns and the factor of knowledge

After considering the imaginary economy, we have to make a step towards the analysis of real world. Knight tries to answer this question: "Will accumulation necessarily cause diminishing returns? " Here, Knight introduces **knowledge** as an important factor which should stand in opposition to natural **tendency for diminishing returns** (explained by limited supply of some productive agents). Knowledge in his work includes technological change and its most important attribute is unpredictability – inventions come unexpectedly and this makes their incorporation into rigorous analysis extremely difficult.

The purpose of investment is to increase the quantity of capital goods (by definition, "a class of productive agents subject to free augmentation by investment"). It can be assumed, Knight assures us, that **investment at given conditions** leads to a

[1] This comes to the same thing, as two sides of our decision.

decrease in the rate of return.[1] However, due to the claim that each investment is partly an **investment into knowledge**, that is no ultimate result. And the very nature of knowledge prevents any mechanical approaches to reach satisfactory conclusions.

> „This limited knowledge", Knight says, „which directs the quest for new knowledge, and the quest itself, are the ultimate mysteries of „free" activity, of conduct". (Knight 1944, pp. 40)

This aspect of Knight´s work may remind us of J. Schumpeter, who based his thoughts on the central role of an „entrepreneur", somebody who brings innovations into market. In this view, each investment is an adventure with unknown result – something Knight might agree with. His theory states also states that we may never know the yield of an investment until it matures. It is impossible to extract the cost of expenditure for knowledge from other costs, as well as to predict the yield of such an investment.

At this point, it seems quite reasonable to turn to empirical observations, which show a fairly constant rate of return over time. From this fact, we may derive that without increasing knowledge, there would be a great likelihood of diminishing returns. Concerning the possibility of zero interest rate, our chances of arriving at any clear results are also limited. Knight conceives of a highly hypothetical conditions speaking about a society in which nothing new and worth preserving can be created. However, we may never exclude the possibility of increased knowledge: knowing what innovations will come would mean practically to make these innovations, which is absurd. Our analysis is limited by present knowledge and this must not be forgotten.

Knight´s contribution to the debate - summary

The study of Knight is made difficult due to the number of resources in which his views are scattered. Concerning the permanent character of capital, the debate seems to offer strong arguments against it. On the other hand, the situation in the interest theory cannot be easily resolved since Knight himself has so many versions of his interest theory. The Crusonia model which presents one of the simplest situations possible seems to offer the clearest propositions. In contrast to the changing nature of Knight´s interest theories, his analysis of the role of knowledge seems to be consistent enough and his conclusion about the importance of knowledge in offsetting diminishing returns interesting.

[1] This rate is still, as in Crusonia model, determined purely by technical conditions, although the measuring is complicated by the variability of production agents.

4.3.3 Kaldor enters the debate

Shift of the debate

In 1937, Kaldor published an article trying to summarize the recent Hayek/Knight debate. Rather than inclining towards one side, he stands somewhere in the middle. He disagrees with important propositions of both Knight and Hayek. Cohen (2005) claims that with Kaldor, the centre of the debate shifts from the concept of period of production towards **productivity functions** and the search for and explanation of diminishing returns to capital. The resulting discussion can be presented as having two separate branches, one between Kaldor and Knight and the other between Kaldor and Hayek. The first branch contains three main questions, on which the opinions of its participants differ (Cohen 2005):

1.) The nature of capital: Is it a distinct factor of production? Is capital permanent or non-permanent?

2.) Can we measure capital and if yes, how?

3.) How can we explain the return to equilibrium after a disturbance? What is the impact of accumulation of capital on interest rate?[1]

Along with this, we may follow Kaldor in his considerations on the meaning of Hayek´s investment period. His conclusions speaking about this concept are fairly negative, but different from Knight´s complete rejection. His debate with Hayek then proceeds on some issues related more to the trade cycle.

It is assumed that his contributions resulted in a general abandonment of the theory of capital: its development did not mark any bigger success in several decades to follow.

Capital as a factor of production

To be able to treat capital as a factor of production is in a way the most desired property we would like to have since it permits us to make use of analogies with labour as another factor of production and wage as its reward.

However, Knight´s answer erases this possible advantage by introducing **capital as "everything"**, or at least admitting the possibility to do so. To this, Kaldor has a simple objection: if everything is capital and accumulation increases the quantity of all resources (there is no fixed factor whose quantity could not be increased by any means), how can we arrive at diminishing returns to additional investment. (Kaldor 1937, pp. 218) Knight´s

[1] Kaldor blames Knight of having no explanation of the return-to-equilibrium process and claims that we need some convergence stories. To see how they might look like, we would have to understand Kaldor´s models of simplifyied economies, but we will not address this question here.

effort to return the possibility of diminishing returns to his theory leads him to select knowledge as the potential fixed factor, which stayed mostly out of consideration by that time (Cohen 2005, pp. 10).

On the other hand, Kaldor claims that it is only thanks to the roundaboutness that the Austrians may treat capital as a factor of production, measured as the waiting time, as period of investment. The condition that must hold so that we can afford to **reduce the production function to two variables**, capital and labour (plus land), is such: any services of fixed factors must be regarded as homogeneous. Then, we can take the relative scarcity of their services with changes in the amount of other services as constant. This is not guaranteed in any heterogeneous goods model. (Kaldor 1937, pp. 232)

Original, permanent and non-producible factors as a fiction

One of the main theses of Knight, pronouncing all capital to be permanent, has already been introduced. Kaldor identifies this point of disaccord with Austrians and adds his own contribution: siding with Knight that no distinction can be made between permanent and non-permanent. (Kaldor 1937, pp. 204). However, given our perspective, both can be consistent: to say that all capital is permanent (it can be maintained if we wish to) or that all is non-permanent (without maintenance, it will be destroyed). **Permanency** as the ability to yield useful services without cooperation with other resources is a property that cannot be ascribed to any resource – nobody would say that land is of any use if it is not properly cultivated.

Knight, however, rejects another distinction: the one between **original and produced resources**. Kaldor agrees that in a way how it is used by the Austrians, this distinction is untenable: production does not occur only in a single mode of cooperation of original and secondary, produced factors.

Finally, there still remains one distinction that is well in place, in Kaldor´s view. The fact that the quantity of some resources cannot be augmented, or can be augmented only with severe restrictions, helps to explain **decreasing marginal productivity** with capital accumulation – a generally acknowledged hypothesis Knight is unable to support. The incapability to provide satisfactory "stories" to explain processes going on in real economy is a big reproach aimed against Knight´s theory.

Rate of interest vs. net return (house model)

In an attempt to reconstruct Knight´s thoughts, Kaldor builds a simple house model to illustrate in which sense capital can be perceived as permanent – showing that it repays to renew the investment continually and that, in addition, the most desired investment

structure has houses in all stages of their life existing at one moment of time – it is advantageous to hold the amount of investment constant, which could not be achieved if we build our house and let it deteriorate, waiting to build a new house that will supplant the old one once it is ruined completely. In Kaldor´s words,

> "investing in 30 houses, one of which falls due for replacement and is planned to be replaced every year ad infinitum, is the same thing as investing in a house which lasts forever, while a certain sum has to be paid out every year to keep it in repair". (Kaldor 1937, pp. 212).

In this model, we are allowed to speak about the optimum degree of durability, since with houses as the only commodity, it assumes an unambiguous meaning. Kaldor´s analysis shows that the optimum durability of houses in this model maximizes the rate of return on investment. This, in turn, will give us the greatest net yield at the real rate of return, that is, when the amortization quotas accumulated (at a given rate of interest) are reinvested to "repeat" the original investment. This gives a possible reason why to support Knight´s permanent capital.

The roundaboutness in this model can be understood only as a ratio of initial construction costs to regular maintenance cost – with the law saying that we can always increase the former to reduce the later. However, Knight claims that this concept is insignificant, as it fails to measure the quantity of capital properly. If we work with Knight´s assumption of continuous maintenance, rate of return becomes independent on the rate of interest.[1] When the interest rate falls houses whose rate of return was lower than the former interest rate, but is higher than the new one will become profitable. However, we do not know whether these houses are also more durable – on these grounds Knight criticizes the Austrians. (Kaldor 1937, pp. 215)

The problem with this model taken as an evidence for Knight arises when we discard our homogeneous-commodity assumptions. The model will no longer work as an evidence.

Do we need investment period?

Concerning the second question from our list, that on measurement of capital, Kaldor affirms that "investment period is immeasurable, rather than irrelevant". (Kaldor 1937, pp. 233) This opposes Knight´s simple rejection of such a concept and prompts us to look for a more appropriate expression for the "quantity of capital". Kaldor still believes

[1] Continuous maintenance is guaranteed at any rate of interest. For detailed explanation see Kaldor (1937), house model on pages 208-215.

there must be an index with an inverse relation to interest rate that could serve as a measure of capital, but he does not show what this index is.

The major objection against the investment period is the natural question of its practical meaning: it is utterly impossible to isolate certain units of input and units of output that could be described as one investment – economy is a network of complicated relationships where no production processes occur in isolation, as would be needed to speak about investment periods of particular factors.

However, nobody has found a working index yet. The natural requirement that a measure of a factor of production should not vary with its price does not seem to hold in Knight´s case: Kaldor blames him of having a measure subjected to price changes. For Hayek´s investment period, the non-homogeneousness of fixed factors (mentioned above) together with the non-homogeneousness of consumption goods, is a great inconvenience that we can hardly overcome.

Kaldor´s results

The problem with Kaldor´s contribution is that it does not offer any clear way out of the problems. It presents several reasonable arguments that support the critique of both original actors in the debate, but does not indicate any new possibility for the theory of capital. The two new models (house model, machine and slaves model) he builds are meant only to illustrate the statements concerning very simple economies – the conclusions withdrawn from them do not hold in more general cases. This might help us to understand why capital theory development proceeded at a sluggish pace, and followed the pattern known from the past: its results were more in the shape of critique of some central methodological concepts than as an apparatus that would really help us with the investigation of capital and its role in economy.

Speaking of capital as a "periodic investment and disinvestment" (Cohen 2006) is close to the Austrian tradition, where the fact that capital becomes tied in investment is important for the study of capital structure. And it can also point out the fact that Knight favours the concept of investment against the quantity of capital as having a greater explanatory power.

4.4 Hayek and his theory of investment

Trying to adhere to all the conditions he designated as conditions any working theory of capital has to satisfy, (see chapter 4.2.2) Hayek is forced to go much deeper into the investigation of the mechanisms operating in the process of production than his

predecessors. We should realize that his work investigates capital structure and its changes – he tries to deal with capital directly, not to avoid the complicated issues by explaining the need to build the theory of interest, not capital. This leads to numerous difficulties: the work proceeds by using simplifying assumptions to obtain at least some clear statements, which however do not have to hold when we discard these assumptions. Then, in many cases, all we are able to do is to state a general trend, the exact formulation being too complicated.

In this section, we will present some of his instruments and models related to investment and capital structure. The purpose of such exposition is that it should demonstrate a possible way of development of capital theory and let us compare Hayek with his predecessors.

4.4.1 Structure of production and its graphical representation

Input and output function

The basic tools for analysis are two related curves: **input curve** and **output curve**. They can both be depicted in a single chart, see fig. 6 below. However, it is crucial to understand the difference between them. The vertical axis measures time, horizontal units of input or output. The output curve expresses the quantity of output produced at a certain time from a moment input. Due to higher productivity of roundabout methods, it must always lie above the input curve, which represents the quantity of input (invested at one date) which matures at a certain time. Hayek explains:

> "If we speak in terms of units of output, the share of the total product for which we have to wait a comparatively long time will clearly be larger than the share of total input for whose product we have to wait an equally long time." (Hayek 2009, pp. 106)

The horizontal distance between these two curves shows the **interest** accumulated during the process of production.

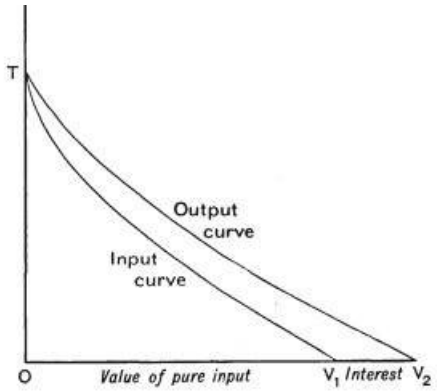

Fig. 6 Input and output curve (Hayek 2009)

The rate of interest, as a ratio at which output of a given time exceeds input employed in producing it, is clearly seen to be increasing over time.

Under stationary conditions, it is simple to show the correspondence between Hayek´s theory and the results of American economists Clark and Knight, mainly the simultaneousness of production and consumption. What Clark (Clark 1908) pictured as a matrix of quantities of output and intermediate goods created in successive production processes, Hayek illustrates in a simple chart. The fundamental difference lies in the fact that whereas for Clark, this situation explains the whole problem of capital, Hayek includes it only as the most simple case we may encounter, that is, when input is continuously invested in the same production processes of **point input-point output** kind (Hayek 2009, pp. 114).

1907 --	A	A′	A″	A‴
1908 --	A	A′	A″	A‴
1909 --	A	A′	A″	A‴
1910 --	A	A′	A″	A‴

Fig. 7 Four stages of production (Clark 1908)

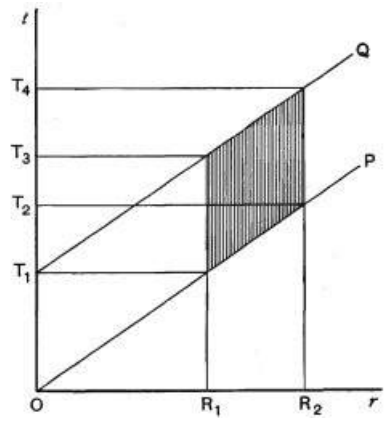

Fig. 8 Constant period of investment (Hayek 2009)

The similarity of Clark´s matrix and Hayek´s graph can be explained thus: each production process (a diagonal line in a matrix/a vertical line between OP and T_1Q curves) is an identical copy of any production process started at a different time, and thus, at a certain moment, we find that all stages of a single production process exist simultaneously (represented by a line in Clark´s matrix and a part of horizontal line between the lines OP and T_1Q in Hayek´s chart).

Structure of production using different investment periods

As soon as we drop the assumption of uniform investment period, it becomes impossible to use such a simple picture, and an extra dimension has to be added to our chart, which should depict the **continuous input/point output case**. Here, the input function finds its practical usage. The diagram seems a lot more complicated, so we shall take some time now to explain it properly.

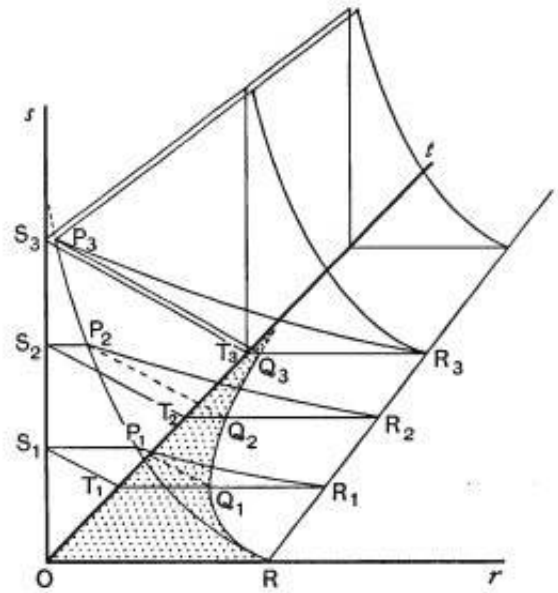

Fig. 9 Continuous input – point output case (Hayek 2009)

The base plane refers to final goods, the curve RQ_3 being **input curve** defined above. Third dimension is introduced to include **intermediate goods** in our considerations: the curve RP_3 depicts the stages to which currently existing intermediate goods belong: the closer to the base plane, the closer to maturity. To show how intermediate goods contribute to the production of final output, we sketch a plane that connects points of the perpendicular plane with corresponding points in the base plane, illustrating when the intermediate goods of a certain stage will mature into given output. For instance, the intermediate goods found on the line S_2P_2 will mature at time T_2 and only the share T_2Q_2 of

the final product at that time will be due to their application (the majority of that product is created thanks to input applied later).

Three variations on input curve

A special attention is drawn to another form of input curve that can be found in the same diagram: the curve R_3P_3. It corresponds to the continuous process of applying input over time to produce output of one future date.

It is intriguing how variable usage such a simple tool can have. Three phenomena can be illustrated using this curve – all of them appear in the three dimensional diagram above. (Hayek 2009, pp. 121)

1.) The original input curve (base plane)

2.) Stock of intermediate goods at a moment of time (perpendicular plane)

3.) Inverted form (leaning plane) – shows best the distribution of input over time

Another important thing to realize is that **input function** can be expressed either **in value terms, or in physical quantities**. When we try to describe single investment that uses different inputs, the only possibility is in value terms. However, this approach has an obvious disadvantage: changes of relative values of parts of input will change the input function as well. What we can do, is to try to do without aggregation and use input function for a single factor only.

Case of durable goods

In the preceding paragraphs, we discussed somewhat simplified version of the continuous production process – continuous input/point output case. Speaking about durable goods, it is best to start from the opposite extreme and consider the **point input/continuous output** case. This means that we take the time needed to produce durable goods to be zero – they only release their services during an interval of time.[1]

The situation can be again represented by a three dimensional diagram. The plane that used to depict intermediate goods here shows different stages of durable goods, that is, for how long they will stay productive. (Hayek 2009, pp. 130) Analogically to the previous case, the diagram can be seen as showing the relation between services provided at a certain point in time (horizontal line in the base plane) and the moments of time when input was invested to produce these services (here, we use the inverted input curve again).

[1] This case would be more easily represented by the output function – we know the time when each service matures, but not due to which part of input this output was created. However, Hayek wants to use input curve again.

In reality, the production of durable goods always takes some time.[1] There is however no fixed point in time from which we might easily describe the whole process (e.g. the moment when all output matures), which is the source of difficulties.

4.4.2 The most profitable investment

Quantity of capital and productivity of investment

Hayek´s refusal of simple concepts of uniform period of production, or, what he believes is the same thing, quantity of capital, makes him search for a more sophisticated explanation of the productivity of investment. Here, input and output functions prove to be a useful tool – as with their help we are able to express the increase in value over time. This increase is naturally different for different inputs, and thus aggregating over time in the production processes employing heterogeneous inputs in senseless (when conducted in value terms, it presupposes constant relative values of different kinds of input, but these cannot be calculated without the interest rate – in consequence, the aggregate cannot be used in interest rate determination).

The **complex investment structure** has to substitute the concept of **supply of capital**, which is, for the same reasons as apply to the quantity of capital or waiting, no single definite magnitude. If we still wish to use this term, we have to picture the whole structure of alternative income streams obtainable from given input to be the supply of capital.

Our task – to employ capital in a most productive way - is transformed to the task of finding the most appropriate income stream we are able to obtain with given means.

Choosing the most profitable income stream

Two main factors are considered: the productivity of investment and time preference. For simplicity, Hayek´s theory first ignores the existence of markets and price system – it is basically a model of a society with a single social planner, whose goal is to produce the greatest income stream. However, we still distinguish a great number of specific cases. We will try to give only a basic picture of how Hayek proceeds with his explanation.

1.) The productivity of investment

Although we work with the assumption of constant income stream, since constant composition of this stream is not required, we move **outside equilibrium conditions** – this

[1] Jevons illustrated this by drawing a triangle composed of two parts: first for the period when the good is in the process of production, second for the period when it yields services.

is one possible way how to perform general equilibrium analysis we discussed in the part on methodology (chapter 4.2.1).

The most direct way to estimate the productivity of investment is in the imaginary case, when it is possible to continuously vary the amount of individual input used in production, without necessarily altering the other inputs. Hayek´s results are expressed by a theorem that works with the rate of increase of a product due to additional investment of given factor. The basic rule says that the greatest income will be derived from such a situation when the **rate of increase of the product** with the extension of investment period of each input for the same time interval will be the same. [1](Hayek 2009, pp. 165).

Rates of increase of investments for different time periods, as well as rate of increase of investments maturing at different moments, does not have to follow the same rule. Another complication is brought about by changing relative values of different commodities.

Comparison of rates of increase over time with changing relative values is done by measuring the **own rate of interest** for each commodity, e.g. the rate of increase in terms of this commodity, and comparing these data with the relative values of commodities at the two dates. No single rate of interest can be constructed to determine the productivity of investment in a simple manner. (Hayek 2009, pp. 167).

Compound interest is taken to be the basic rate of interest and enters our considerations when dealing with investments for different periods of time. In stationary conditions, rate of increase of investment for longer period has to correspond to the product of the rates for shorter periods whose total length equals the long period (law of compound interest). On the other hand, by decreasing the length of periods infinitely, we come to the **instantaneous rate of interest.**

The ultimate relation between the rate of increase of a product and rate of interest is expressed thus: the rate of increase – as an absolute quantity over time – becomes the rate of interest when expressed as a percentage of the total magnitude. (Hayek 2009, pp. 178) We can depict compound interest curve together with productivity curves of different investment in a simple chart and if they exactly touch each other, we are in equilibrium.[2]

[1] These inputs are increased separetely, not all at once – thus the ratio of inputs is always changed a little and we seek the situation when product increases the same no matter which of the inputs was increased.
[2] This again has some simplifying assumptions in the background: without them, productivity curve becomes indeterminate, and cannot be included in our picture. See Hayek (2009), pp. 188.

To sum up, the core of the theory is again marginalism: the ratio between the marginal increase of a product and the size of the product must be the same for all inputs invested. (Hayek 2009, pp. 191)

2.) Time preference

The productivity of investment alone cannot explain the choice of investment made by different individuals. An investment with the same parameters (volume, length, productivity) may be valued differently due to **subjective preferences** and our current (financial) situation.

To account for tastes of individuals and to be able to speak about a change in an individual´s preferences over time, we need to know the whole **indifference map**. Its graphical representation has to reduce the variety of commodities into one, using a well-known concept of composite commodity, or choose to work with one commodity only. By plotting the indifference curves of an individual together with **transformation curves** (that reflect the technical possibilities of transformation of present into future income), we will immediately see the most preferable combination of present consumption and future income for our individual. (Hayek 2009, pp. 226) It is highly likely that unless we found ourselves in complete stationary conditions, with each decision, our situation will be altered a bit and the next decision will occur under new conditions.

We may naturally ask about the probability that the process of saving will continue indefinitely. Another question that seems really important is which factor has greater share in determining the resulting rate of interest: technical or psychological, productivity of investment or time preference. Hayek again identifies many different cases, but all lead to a similar result: the **productivity of investment is the main factor**, and in extreme cases, the role of time preference can be reduced to a choice of the date when stationary conditions will be reached. This stationary state is well consistent with a positive rate of interest: only it must be equal to the constant productivity of investment (slope of transformation curve). (Hayek 2009, pp. 228)

Time preference, Hayek proceeds to say, determines only the rate of interest in final equilibrium – for the process of savings to stop at positive interest rate, our positive time preference must put present enjoyment over enhanced future possibilities. There will be a few more words on savings shortly.

4.4.3 Market system and entrepreneurs

Abandoning the assumption of a society with a social planner, we need to discuss how the individual plans can all be carried out. This is where market system comes into play.

Rate of return on investment in a market system

When we include more individuals into our discussion, we are forced to contemplate the variety of plans and their consistency. Fortunately, there is the great coordinating mechanism of market system with **prices** that shift to **harmonize the plans** of different individuals so that they can all be carried out.

Concerning the changes to the theory of capital, it might be good to start with a maybe obvious statement: the maintenance of capital is not a goal in itself. Capital has to be investigated only in relation to the purposes it serves. The key magnitude for an individual is his **income**, not the quantity of capital he owns.

What we are dealing with is a **process of continuous change**: the existing equipment is linked to both past and future. The study of investment structure has to be based on distinguishing individual capital items in their variety, and find those that are believed to provide the greatest output. Price relationships between consumer and capital goods, not rate of interest on money loans or anything else, will set the **rate of return on investment**, which thus can be deduced without using the aggregate quantity of capital. (Hayek 2009, pp. 266)

Dynamic society and unforeseen changes

This topic lacks in most past works on capital, although it is inevitable that such a situation occurs in the real world: each capitalist has to be prepared to deal with changes he did not expect. These changes can be both favourable and unfavourable: and we call their result **windfall profits/losses**. Only part of this magnitude, called **capital gains**, is income in the proper sense. (Hayek 2009, pp. 308) This kind of profit was explicitly excluded from the studies of economists who insisted on building the theory of capital in a static frame. What will happen when an unexpected profit is earned is not evident. We may try to assume that the entrepreneur will re-evaluate the sustainable level of income and try to keep it. Or, alternatively, an improvement in outside situation might incite a desire to save more to further increase his prospects for the future.

A model example of unexpected change is found in **inventions** that make other method of production profitable. Each invention is likely to cause both capital gains and

capital losses. The case of capital losses deserves more attention: Hayek uses several simple equations to demonstrate when it becomes unprofitable to keep the old, now superseded, equipment, in operation. With all likelihood, this will not be the moment of first introduction of the respective invention into production, but later. On the other hand, if the operating and replacement cost of the old equipment exceeds the same cost for the new one, it does not pay off to pay for its maintenance – the old equipment will work for the time corresponding to its leftover durability. By that time, enough new equipment must be accumulated to enable to keep the level of production constant.

An interesting question to be asked is how we can know whether the new **invention** is really **capital-saving**. It is shown that it is far from being automatically guaranteed: only in the most favourable cases the new equipment will be paid from the costs that would go to the maintenance of the old one. More often, and especially when the old equipment is completely specific[1], some capital will have to be withdrawn from other industry to enable the introduction of new production technique. The new equipment will often cause only a decrease of the amount of capital needed in that one branch of production, but not in the whole economy.

In the past, economists often argued about the connection between human labour and capital, as if the income of a society would have to be divided between these two factors, implying that the wage of labour and interest of capital bear an indirect relation. Hayek briefly touches this question here to stress that the conclusion of previous discussion – that inventions are likely to increase the scarcity[2], and thus the returns on capital – does not mean that the income of labourers must be reduced. Mostly, invention should be realized only when it helps to **increase the aggregate output**. The key fact here for further considerations is that the value of capital cannot be taken as constant. Even the information about an increased remuneration for (newly invested) capital does not let us to deduce anything about the resulting movement of wages. (Hayek 2009, pp. 321)

Mobility of capital

In the world of unforeseen changes, mobility of capital is vitally important as an "insurance" against great losses. Before giving a definition of mobility, it might be useful to think about the reasons for using such a concept. We need to shift capital from one

[1] Meaning that it can serve one purpose only.
[2] Conclusion from the previous paragraph – capital-saving inventions are rather an exemption, as new inventions can usually be introduced only with an extra capital brought into the economy.

branch to other when there is an unexpected demand for it in one industry – in this situation, owing more mobile capital is an advantage.

Since capital typically cannot be moved from one industry to another in its physical form (a range of purposes a machine can serve is limited), "shifting" capital means letting it produce an income stream which then can be used in any industry. Mobility of capital has to be described in two dimensions working with **alternative income streams** a particular capital goods can produce: we are interested in the date when this return might become available and its magnitude (as compared to the return of its original employment).

Mobility of capital as it exists in any society is largely dependent on the **foresight of entrepreneurs**: good foresight may prevent the need for dramatic changes in the structure of capital. Moreover, when it becomes necessary to remove capital from its planned usage, it can be done at a relatively low cost. Capital itself is governed more by the foresight of entrepreneurs than anything else. (Hayek 2009, pp. 331) In the process of continuous change, **path dependence** in the development of capital structure is apparent: the entrepreneurial decision will affect not only present, but also the future, possibly beyond the date to which current plans reach.

In contrast to past theories, Hayek does not attempt any division of capital into two separate categories, being that fixed/circulating capital (with an obvious reference to mobility), free/durable capital or anything else: any such distinction is said to do more harm than good. For example, we may look at the two categories of permanent capital and free capital (that can be employed without waiting). If we discuss capital only in terms of these two components, Hayek claims that all the problems will disappear (Hayek 2009, pp. 330) – in the context of his theory, permanent capital is not capital at all, and free capital is perfectly mobile, and thus any change of capital structure can be done at zero cost.

The fact that mobility of capital is understood as the ease of transformation of the income stream it provides makes it difficult to measure. But it is not necessary to say which capital is the most mobile in general – we only have to know how to choose the capital that can be easily transformed for the demanded usage when the need for a change of capital structure occurs.

Savings as the cause of accumulation

Hayek considers only one aspect of the accumulation of capital, although its common meaning connects two processes: accumulation in "height" or time dimension (**deepening**), which is the growing relative share of capital to other factors of production, and which will be discussed here, and accumulation in "width" or labour dimension

(**widening**), when we observe simultaneous increase of all factors of production. Only the deepening has the effects known to accompany the accumulation of capital, that is: decreasing interest rate and extension of the process of production (by lengthening investment period of individual inputs).

What is the connection between accumulation and savings, a link made so often in the past? Here, Hayek again questions the meaning of terms we are used to work with, in particular, **savings** and **investment**. He raises objections against the explanation of increasing quantity of capital by savings and investment as the only factors, as there are additional causes. (Hayek 2009, pp. 335). The problem with the concept of savings as defined in the past is such: to be able to say what net savings are, we need to have the expression quantity of capital.

Since the distinction between **net and maintained savings**, and correspondingly investment, has its importance, we should try to support it with something else than problematic "quantity of capital". Hayek suggests a new method of comparison, working directly with income streams. The two magnitudes we should contrast are the demand for consumers´ goods and the supply of consumers´ goods at corresponding moment. **Savings** is only an instance of a general case when demand exceeds supply. It is well possible that new investment will be made in spite of "decreasing total quantity of capital". The rule for correspondence of "savings" and "investment" can still be expressed, at the cost of dealing with alternative income streams and expectations.

Disproportions between "savings" and "investment"

This disproportion is of highly asymmetrical nature. Underconsumption may not have any negative results at all: the newly chosen (longer) production methods are likely to be more profitable than the old ones, thus compensating any loss incurred from having more goods in stock. More problems are linked to the case when consumers demand more goods that entrepreneurs are willing to produce given the relative costs. The fact of **irreversibility of time**, which Hayek mentioned at the beginning of his work as a main cause of problems, shows its importance here – the possibility to **accelerate the production** of final goods to satisfy the demand exists, but only at the cost of disorganizing the whole production structure, accompanied by extensive losses. Not only is the excess consumers´ demand prone to cause troubles, it is also more likely to occur than its opposite. Consumption of capital can be induced for example by regulatory power of the state that forces the capitalist to use part of his income aimed for reproduction of

capital for other purposes. Also, **redistribution of income** usually occurs in the direction from capitalists to consumers, and thus tends to increase demand for consumers´ goods.

Importance of Hayek´s work

In this chapter, we recalled only a fraction of Hayek´s ideas, omitting his theory of interest in monetary economy or his famous work on trade cycles. However, it should be clear now how a non-neoclassical capital theory built in the Austrian tradition may look like.

Hayek´s work presents a remarkable attempt to construct a theory of capital without simplifications that obscured it in the past. The key difference from neoclassical treatment of capital is the importance of time, expressed already in the definition of capital which is produced and non-permanent. Time needed for production of capital goods must not be neglected. Time appears also as the lifetime of capital goods, their durability. All these properties of production can be expressed in the shape of input and output curve. Investment is a process directed by time, whose irreversibility makes the decision about future investment more difficult. The entrepreneur needs good intuition and maybe even luck to choose the best investment possibility.

The drawback of such approach is obvious: when studying the capital structure of the economy, we have to treat capital as a collection of heterogeneous items, to consider the features of each capital good. The theory becomes really complex and the detailed description of mechanisms that would be applicable to real-life situations must sometimes be left over to a less general work. The breakthrough of Hayek´s theory into economic mainstream never occurred.

5 Cambridge capital controversy

In years to follow, capital theory did not enjoy much popularity among economists and not many of them were trying to make some advance in it. However, the state in which it was left after the second wave of controversies could not remain the final result for eternity. Several decades later, the same questions came to be discussed again, this time aiming to reveal problems in other parts of economic theory, threatening to severely undermine the prevailing neoclassical approach.

5.1 General overview

Historical circumstances

Last of the three big capital controversies of 20th century was incited by an article *Production Function and the Theory of Capital* wrote by English economist Joan Robinson and published in 1953. The debate was still in progress during 1960´s and it was never completely resolved – the attention of economists shifted to other, maybe more easily solvable questions. By doing this, economists evaded some very deep issues – issues of importance for the whole economic theory. Some of the problems are of methodological nature and they were included in the discussion only because the questions arising from them are most apparent in the theory of capital.

Instead of a clash of two opposite approaches, Cambridge capital controversy may remind us more of an open debate. One of the major views on the theory of capital is still neoclassical - represented by the American Cambridge, with names like Solow or Samuelson. These economists defend classical parables concerning the relation between rate of profit and other economic variables.[1] (Cohen, Harcourt 2003) These statements were long assumed valid – but now we are forced to cope with evidence against them, and admit that they may not hold in all situations. On the opposite side, we find the English Cambridge. There, several post-keynesian or neo-ricardian economists (Robinson, Kaldor, Sraffa) try to warn us against using simplified models and well established technique like aggregation for describing our world full of heterogeneity.

Gradually, the opposition to neoclassical theory withdrew into the background. Although the arguments against neoclassical method were recognized as reasonable, the consequences their adoption by mainstream economics would bring were maybe too

[1] The most simple formulation says that the rate of profit (real return on capital) is determined by the (diminishing) marginal productivity of capital.

dramatic. Thus, while some economists still exist who try to solve the mysteries of the theory of capital, most of them employ their abilities elsewhere and the textbooks for students only reflect this situation: capital does not deserve much attention and when it does, the exposition is limited to a summary of simple models that capital theory shares with other theories built on the principle of marginal productivity.

We will now look at several of the issues raised during 1950´s and 60´s. Most of them reflect some of the problems already discussed as a part of previous two capital controversies.

1.) Measurement of capital problem

On the basic level, capital is described as a factor of production and appears in the **aggregate production function**. Every time we use this concept, we should also realize that "capital" whose quantities are plotted in our figure is a value, meanwhile it should reflect the physical items we would call capital in reality.

If we restrict our model to one commodity, we may still count capital in physical units and express its price in an unambiguous way (Cohen, Harcourt 2003). However, with more commodities included, the measurement of capital is obscured (time factor is necessary included in our measurement, the quantity of capital now depends on the interest rate, which was meant to be explained by it, but such circular reasoning is inadmissible, Wicksell effects start to operate). The consequence is that the rate of interest cannot be determined only by taking into consideration the exogenous, technical properties of capital. Multiple equilibria are allowed. The phenomena related to this received names "reswitching" and "reversing".

Reswitching expresses the possibility that one production technique (as a particular capital/labour ratio) will be preferred at both high and low interest rates, while other technique will be chosen for interest rates somewhere in the middle. This disproves the Austrian hypothesis of roundaboutness – simply to say that with more capital, more capital-intensive (time consuming, roundabout) technique will be chosen, is wrong.

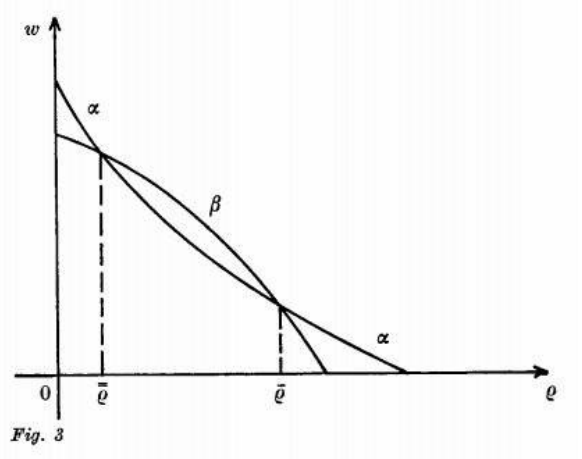

Fig. 10 Reswitching of techniques (Pasinetti 1978)

Capital reversing is a related concept. As implied by reswitching, low capital/labour ratio can be associated with low interest rate, and the demand curve does not have to be downward sloping: the demand for capital might rise with an increase in its price (interest rate).

These discoveries lead to the same question which was asked many times before: whether we need to work with "quantity of capital". Since it shows simple, one-way relationships with other variables only in the simple theoretical models, what is its real explanatory power is not apparent. Moreover, the possibility to determine the interest rate through the quantity of capital should be definitely excluded from considerations.

2.) Equilibrium vs. path dependence

Capital theory is necessarily intertwined with time. Some authors tried to emphasize this when building the theory of capital, some rather to suppress it, to use the analogies between capital and labour or just to avoid pointless complications. However, most of their theories were in the core static theories, and their application to changing conditions was done using **comparative statics** and its results.

It was Joan Robinson who questioned the admissibility of such treatment. She contrasted a movie as a sequence of photos with an economy. By analogy, we should be able to get a notion of economic processes in time by examining a sequence of static pictures of economic situation in following moments. Robinson claims this analogy to be invalid: she believes that every movement has some influence on the final outcome, and thus speaking about long-term equilibrium without knowing the way it was achieved is wrong. Path-dependence has to be taken into account if we ever want to get to some useful results.

There still remains a chance to defend comparative statics: though being an abstraction, it might provide a useful insight. What we have to realize, though, is that it allows us to speak about differences, not about changes.

3.) Simple models vs. reality

Attempts were made to include heterogeneous goods in production function models, however, none met with a success – this was made apparent when its author itself had to state that his model is in fact transformable to one-commodity model that can be build in a much simpler way.

Cambridge capital controversy forced the economists to admit that **we need unreal assumptions** for our models – all clear results in the theory of capital we have emerged from such abstractions, whereas more complex theories were often concluded by stating that "nothing universally valid can be said". This implies a question of what applications to reality do these theories offer. This is probably what should be investigated: how big an error do we commit using our assumptions and whether the conclusions are in accord with empirical observations. **Ideology** is the word that appears here: we come to a point where only exact, mathematical science, will not allow us to do a further step, and something else has to be engaged to proceed to any conclusions.

5.2 Joan Robinson: production function and equilibrium

Her famous 1953 article identifies some serious problems of neoclassical theory, thus showing the limitations of an investigation conducted in its frame. The attention is drawn to the production function, which determines output as a function of capital and labour.

The quantity of capital

Robinson prompts us to ask in which units this capital is measured: when we leave the short period, key decision has to be made. There are basically two options: either we look into the past and measure the **cost of production of capital**, or we estimate its **future earning power** and use this as our quantity.

Both suggested ways of measuring capital are problematic. First, calculating the value of future output stream assumes known interest rate, whereas production function was meant as a tool to determine this interest rate. The other way round is obscured by a well known characteristic of a process of production: cooperation between factors employed in production of a piece of capital goods. Consequently, we cannot add up the

cost of labour time employed in a particular production, because the impossibility of separation of such a set.

The nature of equilibrium

In equilibrium, the choice of technique of measurement of capital is irrelevant: past costs equal the value of capital measured as a purchasing power and its productivity as well. Any unexpected event, unfortunately, destroys this balance. Money is not a universal measure either. The gap of time between the expenditure of money capital and receiving money profits is often quite long and unexpected events may cause the value of money to change. Although we might postulate that no such events occur, doing that surely means adopting another unreal assumption.

Robinson offers an intriguing insight on the nature of equilibrium, suggesting the failure of neoclassical economics and their method of analysis:

> "it is impossible for a system to get into a position of equilibrium, for the very nature of equilibrium is that the system is already in it, and has been in it for a certain length of past time." (Robinson 1953, pp. 85)

The irreversibility of time stands out again[1] and, for the theory of capital, it removes from the concept of quantity of capital any meaning (except the collection of physical objects) when an unpredicted change happens.

Long-term equilibrium under assumptions

To be able to build a theory including long-term equilibrium, the possibility of which Robinson doubted in a general case, she begins with a set of assumptions on homogeneity of labour and land, stable composition of output etc. All these are assumptions that are obviously not valid in reality.

For Robinson, the stock of capital at any moment is simply the amount of capital accumulated up to that point and that this stock can expand without violating the conditions of equilibrium ruling at any given moment. She assumes that conditions of long-term equilibrium will prevail and claims that in given setting the quantity of capital is not problematic. That is because everyone perceives capital as a value, the quantity of capital being determined by its cost of production – sum of wage and profit. (Robinson 1953, pp. 88)

Techniques representing state of knowledge

Robinson attempts to grasp the **state of knowledge** by describing the range of techniques that could be used in production. Given rate of interest, we may express the cost

[1] In a remark of Robinson, it "makes the distance from today to yesterday infinite". (Robinson 1953, pp. 85)

of equipment used in any process and then, by comparing these costs, eliminate inferior techniques – those using more equipment to produce lower output. Technique A is more mechanized than B if it has a higher factor (capital/labour) ratio. At a given rate of interest, there is a **hierarchy of techniques** ordered by their rate of output with a given amount of current labour. At other interest rate, some of them might fall out of the list as unprofitable, but no pair of techniques can reverse its position. Wage rate then determines the choice of technique from the list: we may say that technique is a function of wage rate.

Production function

Graphic representation enables Robinson to show the rate of output at given real capital per man employed. However, the picture is now rather bizarre. Four production techniques (A, B, C, D) are depicted in fig. 11, with A having the highest rate of output. We further assume constant labour force that must be employed.

For each interest rate, a special **productivity** curve must be drawn – four are included in our picture. They represent the increase of output with more real capital available. The thick line is the **factor ratio curve**: output rate at given factor ratio – it does not assume a constant rate of interest, but shows how it must change to allow for a shift to more advanced production technique with a constant amount of workers. (Decrease of interest rate lowers the amount of real capital (wage rate grows) and can make transition to more capital-intensive technique possible).

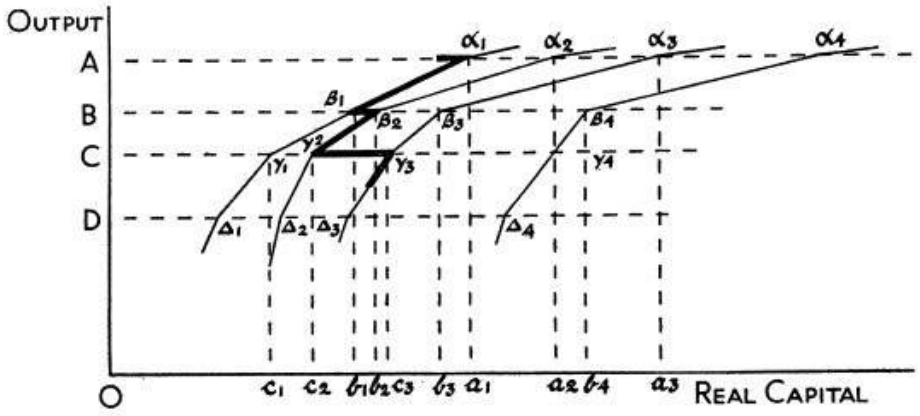

Fig. 11 Production function (Robinson 1953)

Analysis of labour/capital ratio

Distributive shares in equilibrium are given by three factors: wages, rate of interest and degree of mechanisation. Robinson distinguishes three effects present in cooperation of these powers. First, already discussed **Wicksell effect**, shows how wage rate affects the quantity of capital accumulated (higher wages absorb part of the extra accumulated

capital). The opposite, **interest effect**, lowers the cost of a given amount of physical capital at higher wage rate. **Ricardo effect** explains the transition to more mechanised techniques at higher wage rate. The cooperation of these effects determines the direction and magnitude of changes in factor ratio with changing conditions (wage rate).

Discussion of capital accumulation still entails one serious problem: how to deal with expectations about the movement of the rate of profit. Postulating expectations on its gradual decrease makes the analysis too complicated. In the end, Robinson concludes:

> "Thus the assumptions of equilibrium become entangled in self-contradictions if they are applied to the problem of accumulation going on through time with a changing factor ratio." (Robinson 1953, pp. 100)

She adds that this comparison of equilibrium positions will not let us analyse changes in factor ratio, the neoclassical approach can deal with differences, not changes, and the production function remains to be of little use.

Effect of inventions

The analysis of successive equilibrium positions has been already concluded as not bringing any results without even considering the effect of changes in our knowledge, simply called inventions. To be able to discuss them, we are forced to accept the assumption of constant rate of inventions and only then can separate those favourable, neutral and unfavourable to capital. All that can be said, then, is that unless they are highly unfavourable, they lead to an increase in capital-intensity of production and increase in the rate of profit of given amount of capital.

In the end, we can sum up the discussion only with a general, not surprising statement, that technical improvements tend to increase the rate of profit and that capital accumulation does the opposite. Robinson found support for her hypothesis the the aggregate production function is not a useful tool in explaining movements between equilibria.

5.3 Paul Samuelson: surrogate production function

We have to let the American Cambridge speak too. Choosing Paul Samuelson, we will recall his attempt to save neoclassical parables by construing a surrogate production function, ***as if* production function** which should approximate real-world behaviour. Samuelson expresses his idea in a nice way:

> "Indeed if we invent the right fairy tale, we can come as close as we like to duplicating the true blue-print reality in its complexity." (Samuelson 1962, pp. 201)

Samuelson realizes the need to consider heterogeneous, physical capital goods and not some aggregate capital like e.g. Clark did. However, based on two completely different models, he manages to show that sometimes it suffices to study the simple world, since its laws will hold in the more complex one too. An important tool for his analysis is the **factor price frontier** showing the relationship between wage rate and rate of interest. All we can say in general about the frontier is that it needs to be non-increasing.

1. Heterogeneous capital goods model

We assume the existence of n different capital goods, each able to combine its powers with labour to produce final output or to reproduce itself, but no other capital goods – there is no substitutability between them. We may picture each capital goods as a technology with its own, uniquely determined factor-price frontier. Samuelson shows that in this case, this curve must be a straight line. Combining the n factor price frontiers into one picture and taking the outer envelope, we arrive at the global factor price frontier for our economy.

Samuelson asserts that knowing at which point of the factor-price frontier we are, we are able to calculate the relative shares of labour and capital income, using Marshallian **elasticity of the curve**. (Samuelson 1962)

2. Jelly capital model

We now have a two-factor, labour and homogeneous capital jelly model. These two factors can produce only homogeneous final output or new jelly capital, substitutable on one-one basis. The **production function** in this model has the desired properties concerning marginal productivity, we may say that rate of profit is given by the marginal product of capital. Drawing the factor price frontier for this model, Samuelson observes its resemblance to the frontier of the first model – this is what allows us to generalize and use the results from jelly world in a heterogeneous goods model. For instance, in jelly world, it is easy to show that the elasticity of the frontier equals the relative share of factors income.

Jelly is pronounced to be the **surrogate capital**, whose quantity we can easily calculate by multiplying labour by the slope of factor price frontier at the point we find ourselves in. This volume we enter into the **surrogate production function**, and thus determine the level of output. (Samuelson 1962)

Samuelson stresses the fact that that his surrogate model is not universally applicable. We will return to it in a discussion on reswitching, showing what is the key assumption that makes reswitching in jelly model impossible. (chapter 5.4.3)

5.4 Interesting thoughts on Cambridge capital controversy

Besides Robinson and Samuelson, there were many other active participants of the debate. The issues discussed as a part of Cambridge capital controversy revolve more around growth than before. This makes the analysis and also the tools it has to use more advanced. We cannot discuss these issues here in detail, however, we would like to mention some of them to show where the development in the theory of capital leads.

5.4.1 Wicksell effect related to the measurement of capital

Pasinetti traces back the roots of the debate on reswitching all the way to Wicksell. (Pasinetti 1978) Although Wicksell pointed at the important difference between theory of capital and labour, in following decades, economists held to the original assumption of marginal productivity equal to the rate of interest and only with the arrival of Cambridge capital controversy started to question this law.

A common practice was to split up increase in capital stock into a) increase in physical capital, b) capital revaluation. Negative Wicksell effect was translated into the possibility of capital devaluation instead of revaluation. Attempts were made to eliminate Wicksell effect from capital theory, rather than to incorporate it in new models. Some of these will be presented in the next paragraph.

Alternative methods of measuring capital

1.) Trevor Swan and **meccano sets**

Swan describes capital as "meccano sets", homogeneous physical units that can be costlessly and at any time transformed into desired shape to satisfy the needs of an economy. In his theory, relative prices of products never change. He proves that under these conditions, physical changes are separable from price changes. Wicksell effects are said to be merely "inventory revaluation". What the theory does, however, is an elimination of the problems of capital by defining an artificial situation in which, by assumptions, these problems cannot occur.

2.) David Champernowne´s **chain index**

Champernowne starts by ordering techniques of production in a similar way as Joan Robinson does. However, he proceeds by ignoring all the points at which one technique is strictly preferred to others, and builds an analysis based solely on the data from **points of switch from one technique** to other.

In this way, Champernowne manages to eliminate changes due to changes in rate of wages or profit, to which Wicksell effect relates. His index is a physical measure of capital which confirms the marginal productivity theory.

Reswitching causing paradoxes

Reswitching implies the possibility of choice of one technique at two different rates of interest. This breaks the simple hierarchy of techniques needed for the creation of chain index. One technique appears twice in this index, and thus receives two **different physical measures**, which is paradoxical. The idea of a chain index as a physical measure of capital leads to a contradiction, as one set of equipment cannot obviously change physically at two rates of interest. Physical measurement of heterogeneous capital seems to be impossible, and all attempts to evade Wicksell effects by doing so doomed to failure.

5.4.2 Simple laws of profit and interest on unsteady grounds

Traditional view abandoned?

The development of capital theory showed that to see accumulation of capital as a process that entails decreasing marginal productivity of capital and a decreasing rate of profit is too simplified. Not only the Wicksell effect makes it impossible to identify marginal productivity of capital with the rate of interest, we cannot even be sure what happens to the total quantity of capital with diminishing rate of profit. It is well possible that both capital and output will fall with decreasing profits.

Pasinetti asks, then, if we could substitute the quantity of capital, which seems not to be determined exogenously, for other exogenous variable. He suggests **the rate of profit**, which thus becomes completely unrelated to capital. In view of the history of theory of capital, this proposal might be difficult to admit... (Pasinetti 1978, pp. 188)

Ex ante production function and vintage models

A chance for the production function is to pronounce it valid only **ex ante**: at any given moment, production function lets us choose the best option for current investment, the best technique. When the conditions change, the choice already made does not seem to be the best one, but the possibilities for substitution and switch from one technique to another are limited. The meaning of **embodied technical progress** is such: it does not affect all factors alike, as opposed to other, disembodied models, where technical progress is included only as a function of time. Harcourt (1969) states that the embodiment

hypothesis erases the malleability[1] of capital assumption. Only then, we are able to speak about heterogeneous capital goods. Existing capital structure is represented as a set of **vintages of capital**, the results of investments that were made at respective time at given expected relative prices and demand conditions. We speak about "fossils" now, as the conditions may be well unlike the original ones. The advantage of this approach is that it opens the possibility to speak about capital accumulation without dealing with quantification of capital stock. (Harcourt 1969, pp. 377)

The assumptions of vintage models like perfect competition, static expectations and perfect foresight were prone to criticism. However, the assumptions employed are very convenient and models working with technical progress seem preferable to others, explaining the growth of output by more unorthodox ways (for example, as a result of growth in the quantity, not quality, of inputs).

Solow stresses the importance of rate of return

The high level of difficulty present in analysing the role of capital in an economy is recognized by most of its protagonists. We may cite Solow, who, although building on the neoclassical tradition, argues that reducing capitalist production to a single factor is naive, and there is no way one could conclude his work by construing a proper definition of capital and pronouncing interest to be its marginal product. (Harcourt 1969, pp. 381)

Solow is one of those who claim that the core of capital theory should be the rate of return, or interest rate, and not capital itself. Allegedly, this makes the investigation much easier than if one has to deal with time, capital and its marginal product. His result is then the **correspondence of rate of interest and rate of return on investment**. Although we may reach such a result without working with quantity of capital, the inference can still be attacked. Joan Robinson identifies the problem in the fact that some theories work with the assumption of full employment of resources and others do not.

Sollow agrees, but proceeds to build his model, which he enriches by incorporating technical progress and showing its impact on the rate of return on investment. In an attempt to apply his aggregate production function to US economy, he receives some empirical estimates of the rate of return, but does not avoid speaking about capital, and thus does not satisfy the goals set in the beginning. (Harcourt 1969, pp. 386)

[1] Malleability of capital – its capacity to be costlessly transformed into the desired shape.

5.4.3 Reswitching and its consequences

More on reswitching

In face of evidence from various sources, economists from American Cambridge had to admit the impossibility to vindicate neoclassical parables (concerning the relation of rate of profit to other economic variables). For example Samuelson in his article "*Summing Up"* shows a simple situation in which reswitching occurs and then investigates the consequences – what natural laws we have to discard.

Samuelson shows how a reswitching of techniques can occur in a simple Austrian model with uniform labour applied at different stages.

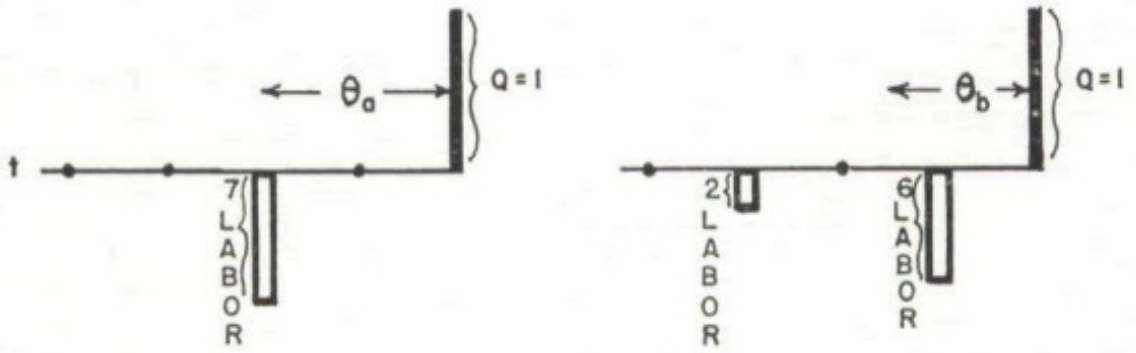

Fig. 12 Reswitching in simple Austrian model (Samuelson 1966)

An illustration may be found in Fig. 12. To decide which of the two techniques depicted is more roundabout is not trivial, we cannot rely on a simple arithmetic measure of average period of production. Instead, we may try to use common sense to decide which of the two techniques will be chosen at different rates of interest. First, the left technique uses less labour in total than the right one, hence it will be preferred at zero (and low) interest rate. At very high interest rate, the two units of labour expended three periods in the past will be too expensive, the left technique will win again. However, there is an interval of interest rates in the middle for which the right production technique will be selected. Such a simple example suffices to show the possibility of reswitching.

The only relation which remains unchanged by reswitching is the one described by the factor price frontier (Fig 13). The trade-off between wage rate and the rate of profit is still present, with no exceptions. Samuelson explains this by the **competitive forces** found in an economy, guaranteeing that prices will be at their minimum and thus real wages the highest possible at given interest rate.

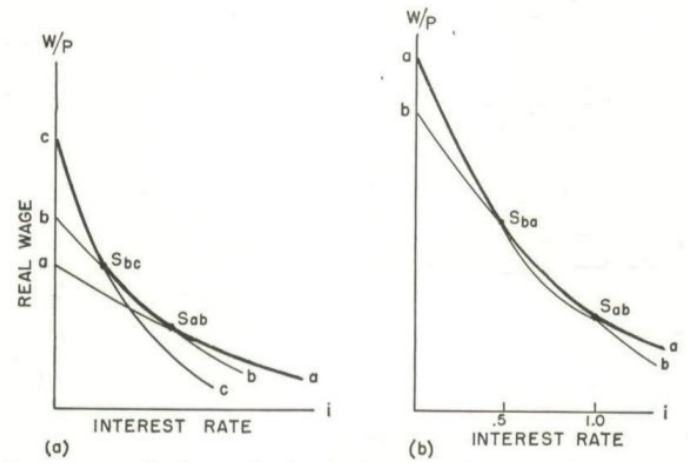

Fig. 13 Factor price frontier (Samuelson 1966)

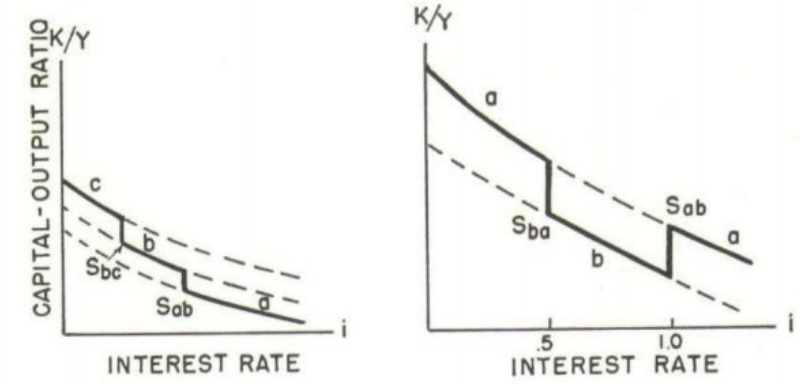

Fig. 14 Alternative capital-output ratio (Samuelson 1966)

In the next picture (Fig 14), the situation is different. What somebody not familiar with the Cambridge debate might expect, is shown in the left part of the picture. Falling interest rate induces us to use more capital-intensive techniques, thus increasing the **capital-output ratio**. Reswitching makes real the other possibility: at interest rate equal to 1, we observe a drop in capital-output ratio with a decrease in the interest rate. Samuelson uses the word "perverse" when he comments this behaviour, but cannot reject it as only imaginary, never occurring in reality.

Similar picture might be sketched for the relation of interest rate and steady state consumption. Here also, an unprecedented drop in the level of consumption with a fall in the interest rate is made possible by the consideration of reswitching.

Jelly world vs. reality

If we would like to exclude the possibility of reswitching, we would have to construct a model with linear *w-r* relationship (wage rate – rate of interest). Then, simple laws of geometry imply two straight lines will meet at no more than one point, which means that reswitching cannot occur. This is what Samuelson did in his jelly capital model. Each price jelly/labour ratio will give us a point on the factor price frontier, showing the w-

r ratio. The elasticity at each point of the frontier measures the distribution of income, something that is not valid in the general case. Also, we are free to use two different expressions for **capital per head** (k). (Harcourt 1969, pp. 392) First, from definition, k = (y – w)/r (where y = output per head). This holds for the reswitching case as well, however, it does not have to equal the second expression k = - dw/dr (when r = dy/dk). As has been already shown, the simple marginal productivity rule cannot be used.

The reswitching is generally considered a possibility whenever we work with **heterogeneous goods or a lapse of time**. The time-consuming process can actually be reduced to an instantaneous process using fictitious heterogeneous goods. (Harcourt 1969, pp. 394) No attempts to explain heterogeneous goods world by using universal homogeneous commodity have met with success.

5.5 Future of the theory of capital

At this point, we have to stop and leave interested readers to lead further investigation for themselves. A lot has been written about Cambridge capital controversy: what we hoped to achieve by our short exposition was only to introduce the issues around which the debate revolved.

The continuity with earlier capital controversies should be clear now. However, not many of the original questions[1] received a satisfactory solution. By its refusal of simple neoclassical parables and the concept of aggregate production function, Cambridge controversy made the study of capital for future generations difficult and maybe unattractive. That is why we may here voices nowadays calling for complete abandonment of such studies, in favour of hopefully less problematic approaches to economic theory. Garrison (2002) in the first part of his *Time and Money* identifies these approaches as labour-based and money-based macroeconomics.

On the other hand, some consider the theory of capital a very useful tool for economic policy, imagining that the study of capital structure and investment could provide advices helping to prevent serious economic crises. The proponents of such view usually claim that more attention should be paid to the danger of capital consumption and that we should always realize that each transformation of capital structure needs time.

[1] Some of them tackled these issues: measurement of capital, productivity of capital, relation between capital and interest or finding the best way of incorporating time factor into the theory of capital.

Then, we can accommodate our behaviour so as the need for large scale and immediate transformation of capital structure does not arise.[1]

Modern Austrian economics, represented for example by Roger W. Garrison, follows the tradition of E. Böhm-Bawerk and others in emphasizing the time aspect and the importance of capital for economic theory.

> A careful assessment of the more conventional treatment of these Austrian concerns reveals that capital-based distinctions play a critical role even in theories that do not openly admit of capital considerations. The fact that such considerations are only implicit or severely understated has the effect of trivializing issues that would otherwise take on a significance of the first order. (Garrison 1991, pp. 304)

This may remind us some of the arguments in favour of time-incorporating capital theory we heard in the course of our work. Let us take it as a last illustration of the fact that what we discussed in this work is not only an interesting chapter from history of economics: the subject of capital is still up-to-date.

[1] Such opinion can be found in Murphy (2008). He shows the consequences of capital consumption in his model of simple, Crusoe-like economy.

6 Conclusion

We covered almost two hundred years of the history of the theory of capital. In an attempt to select the most interesting and important contributions to the theory of capital, we examined the work of A. Smith, E. Böhm-Bawerk, F. A. von Hayek or J. Robinson. We realize that the extent of our work does not permit to analyze all contributions to this theory. Limiting ourselves to the economic schools or approaches included in this work, we could have mentioned for instance Irving Fisher or Fridrich von Wieser. Other famous names were omitted for not fully complying with the frame of our work: Karl Marx or John Maynard Keynes. In spite of that, we believe that the variety of opinions on capital presented here is more than sufficient to help the reader understand the specific nature of the theory of capital, to enrich the picture he had so far and to bring him closer towards the great works of economics.

We began in the era of classic political economy. Looking for a definition of capital, we found two strikingly different forms, pointing at the dual nature of capital: capital may be treated as a collection of objects (Smith) or as a single value (Say). At that period, economics focused mostly on the role of capital in distribution and its contribution towards economic development.

After the marginalist revolution, the fact of dual nature of capital became even more apparent. Inspired by the wage fund theory of Jevons, Austrian economic school chose to incorporate time factor in their explanation of interest, which stems from the differences in value of present and future goods. Their theory makes frequent use of new terms such roundaboutness and average period of production. Capital in production is defined basically as intermediate goods, but the concept of a subsistence fund of free capital shifts our attention back to value-capital.

American neoclassical economists, in our work represented by J. B. Clark, were found to endow capital with different features: permanency and perfect mobility. Strong distinction between capital and capital goods is made. Their purely static interest theory with interest as the price for capital, the reward for its productivity, does not let us explain some phenomena common in the real world such profit due to unexpected changes in economic conditions or economic growth.

Moving a few decades ahead, we tried to explain what led to the dismissal of Böhm-Bawerk´s period of production and describe the numerous points of disaccord, mainly over the meaning of period of production and the nature of capital (including

permanency), discussed in the second capital controversy between Hayek, Knight and Kaldor. Detailed description of Hayek´s positive theory was included to show the complications Austrian-style theory of capital has to face when it insists on incorporating time into its models. The theory branches into several cases and the continuous input-continuous output case, which corresponds to most of the production processes in our world, is too complex to yield any simple and universally valid laws.

To conclude our work, we briefly summarized the debate known as Cambridge capital controversy. We focused on capital reswitching and reversing and the arguments against the simple production function. We saw that according to J. Robinson the relation of marginal profit and other economic variables cannot be summarized in a set of simple equations.

If we were to continue in our examinations, we would probably find that capital theory did not enjoy much interest in the second half of the 20th century, when the Cambridge debate was over. When there was an effort to remedy this situation, the results were not universally accepted, meaning that the questions dealt with in past capital controversies still remain open.

We hope that the goal of this work, to give a transparent summary of the development of capital theory, was at least partly met. The author of this work became familiar with many original classic economics works, an experience which we value a lot. This work should demonstrate that economics is not just an exact science expressible in mathematical language, and that this fact should not be seen as a disadvantage, but as its beauty. The debate on capital is full of nice arguments and their disprovals, and also of simple imaginary models illustrating some basic features, but never being a true description of reality. We believe this work manages to capture the nature of capital theory in an authentic and understandable way.

Bibliography

ARNOLD, Roger A. (2008): *Economics* (9th edition). South-Western College Pub.

BARRO, Robert J. (1997): *Macroeconomics* (5th edition). The MIT Press.

BLAUG, Mark (1992): *Economic Theory in Retrospect* (4th edition). New York, Cambridge University Press.

BLAUG, Mark (1992): *The methodology of economics: or how economists explain* (2nd edition). New York, Cambridge University Press.

BÖHM-BAWERK, Eugen v. (1890): *Capital and Interest: A Critical History of Economical Theory***.** London: Macmillan and Co. William A. Smart, trans. Available from http://www.econlib.org/library/BohmBawerk/bbCI7.html.

BÖHM-BAWERK, Eugen v. (1891): *The Positive Theory of Capital*. London: Macmillan and Co. William A. Smart, trans. Available from http://www.econlib.org/library/BohmBawerk/bbPTC.html.

CATALAN, Jonathan M. Finegold (2010): *A Primer on Austrian Economics.* Mises Daily.

CLARK, John Bates (1890): *Distribution as Determined by a Law of Rent.* History of Economic Thought Articles, McMaster University Archive for the History of Economic Thought, vol. 5.

CLARK, John Bates (1908): *The Distribution of Wealth: A Theory of Wages, Interest and Profits.* New York: The Macmillan Company. Available from http://www.econlib.org/library/Clark/clkDW.html

COHEN, Avi J. (1998): *Frank Knight´s Position on Capital and Interest.* in M. Rutherford (ed.) *The Economic Mind in America: Essays in the History of American Economics.* Perspectives on the History of Economic Thought. London: Routledge.

COHEN, Avi J. (2003): *The Hayek/Knight Capital Controversy: The Irrelevance of Roundaboutness, or Purging Processes in Time*? History of Political Economy, Fall 2003, 35(3), 469-490.

COHEN, Avi J. (2006): *The Kaldor/Knight Controversy: Is Capital A Distinct and Quantifiable Factor of Production?* European Journal of the History of Economic Thought*, (March 2006), 13(1), 141-161.*

COHEN, Avi J. (2008): *The Mythology of Capital or of Static Equilibrium?,* The Böhm-Bawerk/Clark Controversy, J*ournal of the History of Economic Thought*, (June 2008), 30(2), 151-71.

COHEN, Avi J., HARCOURT, G. C. (2003): *Whatever Happened to the Cambridge Capital Controversies*? Journal of Economic Perspectives, Winter 2003, 17(1), 199-214.

DEEPASHREE & Vanita Agarval (2006): *Macroeconomics*. Tata McGraw-Hill Education.

DOLAN, Edwin G., ed. (1976): *The Foundations of Modern Austrian Economics*. Kansas City: Sheed and Ward, Inc.

FISCHER, Irving (1906): *The nature of capital and income.* New York, The Macmillian Co.

FISCHER, Irving (1930). *The Theory of Interest.* New York, The Macmillan Co. Available online at http://www.econlib.org/library/YPDBooks/Fisher/fshToI.html.

GAREGNANI, Piero (2008): *Capital in Neoclassical theory. Some notes.*

GARRISON, Roger W. (1991): *Austrian Capital Theory and The Future of Macroeconomics.* In: Richard M. Ebeling, ed. (1991) Austrian Economics: Perspectives on the Past and Prospects for the Future, Hillsdale, MI: Hilsdale College Press, 1991, 303-324

GARRISON, Roger W. (2002): *Time and Money: The Macroeconomics of Capital Structure.* Routledge, London and New York. Taylor and Francis e-Library.

HARCOURT, G. C. (1969): *Some Cambridge Controversies in the Theory of Capital.* Journal of Economic Literature, vol. 7(2), June, pp. 369-405.

HAYEK, Fridrich A. v. (1936): *The mythology of capital*. The Quaterly Journal of Economics, Vol. 50, No. 2. (Feb. 1936), 199-228

HAYEK, Fridrich A. v. (2009): *The Pure Theory of Capital*. Auburn, Alabama, The Ludwig von Mises Institute.

HICKS, John R. (1974): *Capital Controversies: Ancient and Modern.* The American Economic Review. Vol. 64, No. 2, May 1974, pp. 307-316.

JEVONS, Stanley W. (1957): *The Theory of Political Economy* (5th edition). London: Macmillan and Co.

KALDOR, Nicholas (1937): *Annual survey of economic theory: the recent controversy on the theory of capital.* Econometrica. Vol. 5, No. 3 (Jul., 1937), pp. 201-233.

KNIGHT, Frank H. (1934): *Capital, time and the interest rate*. Economica, n.s., 1:257–86.

KNIGHT, Frank H. (1944): *Diminishing returns from investment.* The Journal of Political Economy, vol 52, No. 1, pp. 26-47.

LACHMANN, Ludwig M. (1978): *Capital and Its Structure* (2nd edition), Kansas City: Sheed Andrews and McMeel, Inc.

MACHLUP, Fritz (1935): *Professor Knight and the "Period of Production*". The Journal of Political Economy, Volume 43, Number 5, October 1935, 577-624.

MANKIW, Gregory N. (2008): *Principles of economics*. Fifth edition. Cengage Learning.

MILL, John Stuart (1909): *Principles of Political Economy with some of their Applications to Social Philosophy*. (7th edition). William J. Ashley, ed. Library of Economics and Liberty. Available online at: http://www.econlib.org/library/Mill/mlP4.html

MURPHY, Robert P. (2008): *The importance of capital theory.* Mises Daily. October 20, 2008

PASINETTI, Luigi L. (1978): *Wicksell effects and reswitchings of technique in capital theory.* The Scandinavian Journal of Economics. Vol. 80, No. 2, The Arne Ryde Symposium on the Theoretical Contributions of Knut Wicksell, pp. 181-189

RICARDO, David (1821): *On principles of Political Economy and Taxation* (3rd edition). London: John Murray. Available online at http://www.econlib.org/library/Ricardo/ricP.html.

ROBINSON, Joan (1953): *The Production Function and the Theory of Capital.* The Review of Economic Studies, Vol. 21, No. 2, pp. 81-106.

SAMUELSON, Paul A. (1962): *Parable and Realism in Capital Theory: The Surrogate Production Function.* The Review of Economic Studies, Vol. 29, No. 3 (Jun., 1962), pp. 193-206.

SAY, Jean-Babtiste (1855): *A Treatise on Political Economy.* C. R. Prinsep, trans. and Clement C. Biddle., ed.. Library of Economics and Liberty. Available online at http://www.econlib.org/library/Say/sayT3.html

SCREPANTI, E., ZAMAGNI, S. (2005): *An Outline of the History of Economic Thought* (2nd edition). Oxford University Press, New York.

SENIOR, Nassau W. (1854): *Political Economy* (3rd edition). London: Richard Griffin and Co. Library of Economics and Liberty. Available online at: http://www.econlib.org/library/Senior/snP.html

SMITH, Adam (1904): *An Inquiry into the Nature and Causes of the Wealth of Nations.* 5th edition. London: Methuen & Co., Ltd. Available online at: http://www.econlib.org/library/Smith/smWN.html.

SRAFFA, Piero (1963): *Production of commodities by means of commodities: prelude to a critique of economic theory* (1st edition). London, Cambridge University Press

STRIGL, Richard v. (2000): *Capital& Production.* Auburn, Alabama, Ludwig von Mises Institute. Trasl. by Margaret Rudelich Hoppe and Hans-Hermann Hoppe.

UHR, Carl. G. (1951): *Knut Wicksell: A Centennial Evaluation.* The American Economic Review, vol. XLI, December 1951, number five, pp. 829-860.

WICKSELL, Knut (1934): *The lectures on political economy* Vol. 1. London: George Routledge & Sons.

WICKSELL, Knut (1970): *Value, Capital and Rent.* London, George Allen & Unwin Ltd.

Collective of authors (2005): *Where is the wealth of nations? Measuring capital for the 21st century.* World Bank Publications.

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Akademický rok 2009/2010

TEZE BAKALÁŘSKÉ PRÁCE

Student:	Natálie Tejkalová
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Garant studijního programu Vám dle zákona č. 111/1998 Sb. o vysokých školách a Studijního a zkušebního řádu UK v Praze určuje následující bakalářskou práci

Předpokládaný název BP:

Theory of capital in past economic thought

Charakteristika tématu, současný stav poznání, případné zvláštní metody zpracování tématu:

Capital presents one of the key concepts in economic theory. As one of the three basic factors of production, it appears in the production function. In modern growth theories, capital is sometimes perceived as the only source of economic growth. This raises the question why and how capital contributes to wealth creation. Since the beginnings of rigorous economic science, several different approaches to capital were developed.
I will use comparative analysis of the works of main economists who contributed to the theory of capital. I will focus on the basic ideas which relate to capital: its definition, the market for capital, its price and eventually also its dynamics. By showing the development of knowledge on these terms, my thesis will naturally incorporate a summary of clarified issues and of questions that still remain open or are being intensively discussed.

Struktura BP:

Abstrakt
I will start with a short synthesis of the notion of capital in current mainstream economics, explaining the design of the capital market and mechanisms ensuring its equilibrium.

With this background, my search will bring me into the past, starting with a summary of the findings of famous classical school economists, namely A. Smith, D. Ricardo and J. S. Mill. A similarly short look at the thoughts of K. Marx will follow.
The gist of the work will consist of a detailed analysis of the works of the economists belonging to the Austrian School. Here, numerous authors try to offer their own contributions to the theory of capital, a matter vitally important for the understanding of economic theory as a whole. A point that I would like to highlight as a striking difference in contrast to previous models is the roundaboutness of capital, which forces us to take the time factor into account.
Seeing capital through works of Eugen Böhm-Bawerk and others, I will be looking for their opinions on basic features of capital, including price and its role in creating suitable conditions for growth.
A description of the development of the theory of capital in Keynesian and neoclassical theory will succeed, as an indication of the way of thinking about capital adopted later.
To conclude, I would like to make a short comparison with current mainstream economic theories, to summarize the differences depicted earlier in the thesis. My goal is to be able to offer a complex view on capital, to discuss whether the opinions of Austrian School are compatible with current mainstream and if so, how they might enrich the basic notion of capital.

Osnova
I. Introduction
I.1. Basic definition of capital
I.2. Features used to describe capital
I.3. Capital market and its equilibrium
I.4. The role of capital in different parts of current economic theory
II. Main part
II.1. First notions of theory of capital
II.1.1. Adam Smith
II.1.2. John Stuart Mill
II.2. Karl Marx and his elaboration on the topic
II.3. Austrian Economic School
II.3.1. Foundations of their theory of capital
II.3.2. Different attitudes towards capital in later works
II.4. Measuring capital
II.5. The price of capital
II.6. Time aspect of capital
II.7. The theory of capital in Keynesian economics
II.8. Capital in neoclassical synthesis
III. Conclusion
III.1. Comparison of static vs. dynamic approach to capital
III.2. Contribution of Austrian theory of capital to modern macroeconomics
III.2. Understanding capital – key aspects of definition

Seznam základních pramenů a odborné literatury:

Böhm-Bawerk, Eugen. Capital and Interest. Macmillian and Co, 1890.
Böhm-Bawerk, Eugen. The positive theory of capital. G.E.Stechert&Co, New York. 1930.
Dolan, Edwin G.,ed.: The foundations of Austrian Macroeconomics. Kansan City: Sheed and Ward, Inc., 1976.
Garrison, Roger W. :Austrian Capital Theory and The Future of Macroeconomics

Hayek, Fridrich A. v.: The mythology of capital. The quarterly Journal of Economics, Vol. 50, No. 2, 1936.
Hayek,Fridrich A.: The Pure Theory of Capital
Jevons: The Theory of Political Economy
Keynes, John M.: The General Theory of Employment, Interest and Money
Lachmann, Ludwig M.: Capital and Its Structure
Machlup, Fritz: Professor Knight and the „Period of Production“. The Journal of Political Economy, 1935.
Marx: Capital: A Critique of Political Economy, Vol. I. The Process of capitalist production.
Mill, John Stuart: Principles of Political Economy with some of their Applications to Social Philosophy
Mises, Ludwig von: Human Action: A Treatise on Economics
Smith, Adam: An Inquiry into the Nature and Causes of the Wealth of Nations
Strigl: Capital& Production
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Termín odevzdání:	

Podpisy konzultanta a studenta:

V Praze dne