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The process of wealth accumulation with regard to the path dependence theory

Stefan Kranzinger*

Abstract

This paper analyses the process of wealth accumulation with regard to the path dependence theory. Based on the theoretical foundations of Robert King Merton, Vilfredo Pareto and Pierre Bourdieu, mechanisms of wealth accumulation are analyzed. These mechanisms, which are understood as direct and indirect network effects, are formalized using the statistical computing software R. A base model without any mechanisms of wealth accumulation is developed, which makes it possible to include the analyzed mechanisms step by step and observe their effects on the process of wealth accumulation and social inequality. Piketty's findings from his work Capital in the 21st Century are included in the formalized models of wealth accumulation, in particular the relationship between the rate of return on capital and the growth rate of the economy.

Keywords: social inequality, wealth accumulation, wealth transmission, path dependence

Eine Analyse des Prozesses der Vermögensakkumulation anhand des Konzeptes der Pfadtheorie

Zusammenfassung

Dieses Paper beschäftigt sich mit einer Analyse des Prozesses der Vermögensakkumulation anhand des Konzeptes der Pfadabhängigkeit. Basierend auf den theoretischen Fundamenten von Robert King Merton, Vilfredo Pareto und Pierre Bourdieu werden verschiedene Mechanismen der Vermögensakkumulation identifiziert. Hierbei werden diese Mechanismen als direkte und indirekte Netzwerkeffekte verstanden, um als Analyseinstrument eines pfadabhängigen Verlaufes verwendet werden zu können. Zur Untermuerung der herausgearbeiteten direkten und indirekten Netzwerkeffekte werden diese im Verlauf dieses Papers mithilfe der Statistik-Software R formalisiert und grafisch veranschaulicht. Hierbei wird zuerst ein Basismodell entworfen, welches im Verlauf der Arbeit durch direkte und indirekte Netzwerkeffekte erweitert wird. Durch die Simulation direkter und indirekter Netzwerkeffekte soll der Einfluss von Netzwerkeffekten auf den Prozess der Vermögensakkumulation besser verstanden werden. Zudem wird noch auf Erkenntnisse aus Pikettys Werk Capital in the 21th century eingegangen, im Speziellen auf die Relation zwischen Kapitalrendite und Wirtschaftswachstum, welche in das entwickelte Modell eingebaut werden.

Schlagwörter: Soziale Ungleichheit, Vermögensakkumulation, Vermögenstransmission, Pfadabhängigkeit

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1. Introduction

The topic of this paper is wealth accumulation and wealth inequality. It tries to answer the question of which mechanisms produce wealth inequality and how they influence wealth accumulation. Therefore, this paper analyzes the process of wealth accumulation with regard to the path dependence theory, which is used to show the development of social inequality in a theoretical way. To describe the phenomenon of resistant and manifest social inequality, the paper identifies mechanisms which influence the process of wealth accumulation.

In section 2 the framework of path dependence theory and its mechanisms will be described. Within this paper these mechanisms are understood as direct and indirect network effects, which can be used as analytical instruments of a path dependent development. It will be shown that the analyzed network effects benefit a small elite to accumulate capital, which causes wealth inequality within a society.

Section 3 and 4 will cover the analysis of network effects and their implications on the process of wealth accumulation. In this context, direct network effects explain how monetary profits increase with their amount. It will be shown that due to cumulative advantages, small initial differences in wealth between individuals grow larger over time and lead to a more pronounced concentration of wealth in a small number of individuals.

Indirect network effects explain how two compatible systems, regarding the process of wealth accumulation, produce self-reinforcing advantages that increase wealth (Liebowitz/Margolis 2000). As a theoretical foundation for direct network effects, the paper uses Robert King Merton's concept of the "Matthew-effect" (Merton 1968). Next, Bourdieu's (1983, 2007) capital theory and Pareto's (1965) theory of society will be analyzed to find indirect network effects of the process of wealth accumulation. This literature will provide the foundation to find mechanisms of wealth accumulation that lead to an unequal distribution of wealth among individuals.

Inspired by Piketty's (2014) work *Capital in the 21st Century*, this paper will analyze in section 5 how the created models react when the rate of return on capital surpasses the growth rate of the economy.

However, the core of the paper will be the development of different models which show how the analyzed network effects, both direct and indirect, influence the

process of wealth accumulation. Based on an equation of Meade (1964, 1975), the framework of a base model without any direct or indirect network effects will be developed, simulated and illustrated. The analyzed direct and indirect network effects will be included step by step, to simulate the process of wealth accumulation. This should allow for a better understanding of the creation of social inequality and which mechanisms need to be taken into account when the process of wealth accumulation is discussed in the current debate on social inequality.

2. Path Dependence Theory

The theory of path dependence can be employed as a tool for explaining rigidities and inertia of structural processes. This paper analyzes the process of wealth accumulation as a path dependent process, which is historically determined and leads, under prevailing economic and social conditions, to a rigid distribution of wealth within society. We start the analysis of the process of wealth accumulation by explaining the theoretical framework of the path dependence theory.

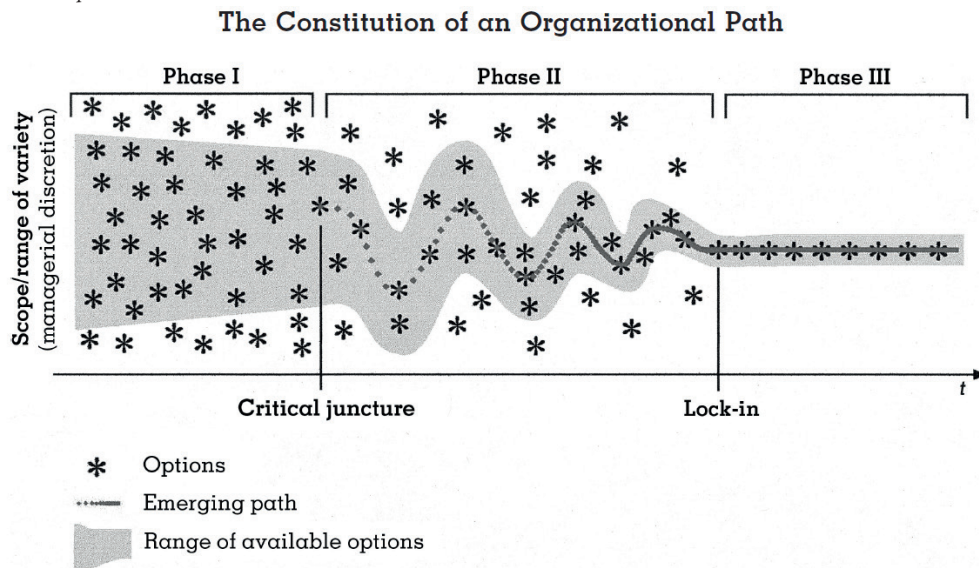
2.1 Framework

The path dependence theory stresses that events in the past influence the present and the future. These events may lead to *lock-ins*, in which technological standards and states of society cannot be changed any more. The process is set off by critical junctures and is then strengthened through direct and indirect network effects (cf. Sydow et al. 2009: 690). This paper postulates that the process of wealth accumulation is influenced by mechanisms that are discussed in the following sections and are interpreted as direct and indirect network effects.

Sydow et al. (2009) subdivide the development of a path dependent process into three phases, which is illustrated in Figure 1. Phase 1, the preformation phase, is characterized by an open situation without significant restrictions in the scope of action. It is built on a historically framed or imprinted contingency, but it does neither assume a determined process nor a completely unrestricted range of outcomes. However, the outcomes are unforeseeable and cannot be anticipated until the process has been formed in Phase 2 (cf. Sydow et al. 2009: 692 f.).

In the case of wealth accumulation, Phase 1 can be thought of as a theoretical situation, in which all

Figure 1: Path dependence



Source: Sydow et al. 2009: 692

individuals in a society possess the same amount of capital. The situation of equal capital endowments is inspired by the time of hunter-gatherer or horticultural populations, which were both relatively egalitarian and had low interest in accumulating economic wealth (cf. Borgerhoff Mulder et al. 2009: 686). Due to a lack of mechanisms of wealth accumulation, which came into force in Phase 2, there are no significant differences in the process of wealth accumulation among individuals. However, the formation of social institutions at the end of Phase 1 will then enable individuals to accumulate economic capital and lay the foundations for social inequality. Basic governmental institutions provide the incentives and constraints regarding economic life (cf. Borgerhoff Mulder et al. 2009: 686) and protect asset ownership, which is a prerequisite for wealth accumulation (cf. Acemoglu/Robinson 2009: 679).

The transition to Phase 2, or formation phase, is marked by the occurrence of a critical juncture, which represents a decision or an action that amounts to a trigger for the development that is to follow. At this point of the process, direct and indirect network effects come into force and cause cumulative and self-reinforcing advantages for individuals with a high amount of wealth (cf. Sydow et al. 2009: 693 f.).

The Neolithic Revolution could be seen as a possible critical juncture (cf. Acemoglu/Robinson 2009: 679). It allowed a division of labor into a production and a social sphere, which led to the emergence of com-

plex social institutions and enabled wealth accumulation. Moreover, the emergence of a banking system, that enabled wealth transmission and supported capital persistency over the long run, can be seen as such a possible critical juncture in the process of wealth accumulation. It laid the foundation for the mechanisms of wealth accumulation – i.e. for direct and indirect network effects – to come into force, causing initial differences in wealth to grow over time.

This development can finally lead to further restrictions in the scope of action and possibly cause a *lock-in*. This development is represented by Phase 3, where only one possible outcome remains, which cannot be changed anymore (cf. Sydow et al. 2009: 694 f.).

In the process of wealth accumulation, Phase 3 would occur if the differences in wealth between the individuals in a society are so large that – due to direct and indirect network effects – an individual does no longer have “managerial discretion”. As a result, rich individuals remain rich and poor individuals remain poor.

2.2 Direct and Indirect Network Effects

Liebowitz and Margolis (1994) define a network effect as a “*circumstance in which the net value of an action [...] is affected by the number of agents taking equivalent actions*” (Liebowitz/Margolis 1994: 135). Page and Lopatka (2000) argue that network effects can be subdivided into direct and indirect network effects.

This distinction refers to the source of benefit in the network.

Direct network effects typically occur in a physical two-way communications network. The utility of a fax machine, for example, directly depends on how many fax machines owners exist in total. The higher the number of fax machine owners, the higher is the individual utility because the number of potential communication partners increases. The same can be said for mobile phones, the internet or languages (cf. Page/Lopatka 2000: 954 f.). This paper will use Robert King Merton's (1968) theory of the Matthew-effect to explain a direct network effect. It will be shown that as a result of the mechanism of interest rates, small initial differences in wealth between individuals increase tremendously over time.

Indirect network effects are found in networks with compatible devices or systems. As a possible example for an indirect network effect, the relationship between hardware and software can be named. To use software, for example a word processing program like Microsoft Word, hardware such as a computer is necessary. If the number of computers increases, there is an incentive for software developers to create new software, which causes the number of software packages to rise. On the other hand, an increase in software circulation causes the hardware to become more valuable for possible consumers, so that the number of sold computers increases as well. Therefore, as the number of computers increases, the number of software packages will increase as well – and vice versa. Page and Lopatka (2000) state that at the extreme, any combination of complementary products can be described as a system in which indirect network effects can occur (cf. Page/Lopatka 2000: 955). This paper will interpret Pierre Bourdieu's *capital-theory* and Vilfredo Pareto's *theory of society* as theoretical foundations that represent indirect network effects.

3. Direct Network Effect: Matthew-Effect

To analyze a direct network effect of wealth accumulation Robert King Merton's (1968) theory of the Matthew-effect will be explained in the next section of this paper. It will be shown that as a result of the mechanisms of interest rates, small initial differences in wealth between individuals increase tremendously over time. Moreover, a formal model, which shows the process of wealth accumulation, will be developed and extended by the analyzed direct and indirect network effects.

3.1 Theory: Matthew-Effect

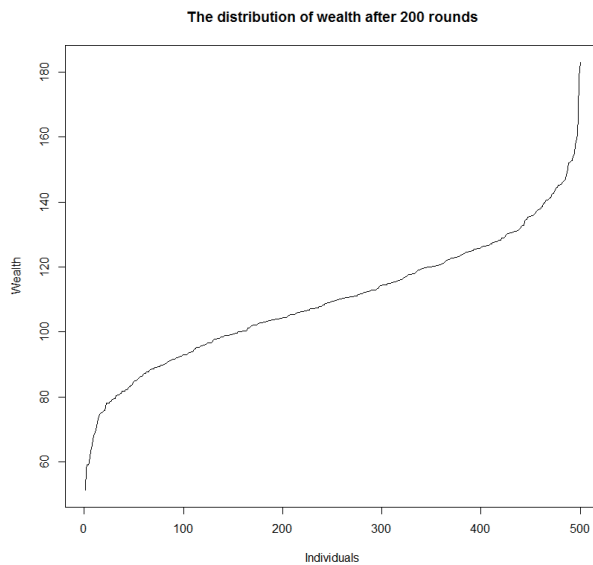
“For to everyone who has, more shall be given, and he will have an abundance; but from the one who does not have, even what he does have shall be taken away” (biblehub, Matthew 25:29).

Inspired by this quote from the gospel of Matthew, Robert King Merton (1968) described the Matthew-effect on the basis of the reward system in science. Merton showed that eminent scientists receive disproportionately large credit for their contributions to science, whereas relatively unknown scientists tend to get disproportionately little credit for comparable contributions (cf. Merton 1968: 1 f.). Therefore, success depends not only on actual performance in the present but on performance in the past. As a result, the Matthew-effect causes initial differences at the beginning of a process to grow larger in the long term (cf. Lutter 2012: 435 f.). Rigney (2010) illustrated this phenomenon by the example of interest rates and shows that the Matthew-effect causes initial differences in wealth to increase over time, which is due to initial advantages in endowment for some individuals (cf. Rigney 2010: 11). Moreover, similarities to direct network effects in the technological sector can be observed: The higher the wealth of an individual, the higher the potential for large wealth gains, as the amount of potential interest rates increases. Therefore, the amount of money has a direct physical effect on the profits it yields and a direct network effect occurs.

In the context of the cumulative advantages of the Matthew-effect, the concept of cumulative causation, which is known as a typical logic of “positive feedback” and emphasizes the circular and cumulative character of processes, should be mentioned (Fujita 2004: 1). This concept highlights the importance of taking self-reinforcing advantages into account when explaining the development of processes. Myrdal (1968) formulated the concept of cumulative causation as follows: “[...] *circular causation will give rise to a cumulative movement only when [...] a change in one of the conditions will ultimately be followed by a feed-back of secondary impulses [...] big enough not only to sustain the primary change, but to push it further*” (Myrdal 1968: 1875). Thus, it can be stated that the concept of cumulative causation is a useful tool to underline the importance of self-reinforcing advantages in process models.

This paper now turns to developing a formal model of direct network effects as introduced above. For this

Figure 2: Model 1 – Basic Model



Source: Own illustration

purpose the statistical computing environment R will be used (R Development Core Team 2014).

3.2 Model 1: Basic Model

The first formal model includes no direct or indirect network effects. It is the reference model for analyzing the mechanisms of wealth accumulation. Model 1 is based on the following assumptions: There are 500 individuals and 200 simulated rounds. Each individual gets a normally distributed earned income with mean 5 € and standard deviation of 1. The normally distributed income for each individual is calculated in round 1; it is paid out each round and stays the same for all 200 rounds. The consumption rate of each individual is 90 % of its earned income. Furthermore, each individual has an initial asset of 10 €. Figure 2 shows that there is no considerable difference between the individuals in the distribution of wealth after 200 rounds. To analyze the effects on the process of wealth accumulation, various indicators have been calculated in Table 1. These indicators will be used to compare the following models with each other by indicating how the developed direct and indirect network effects influence the process of wealth accumulation. The 20/20 (10/10 ratio), which represents the ratio between the highest 20 % (10 %) and the lowest 20 % (10 %) of wealth owners is calculated. The higher this ratio, the larger the extent of social inequality. Table 1 shows a 20/20 (10/10 ratio) of 1.676 (1.938), which means that the top 20 % (10 %) of wealth owner

Table 1: Indicators

Model 1	
20/20 ratio	1.676
10/10 ratio	1.938
Gini coefficient	0.102
Total wealth	54,918 €
Wealth min.	51 €
Wealth max.	183 €

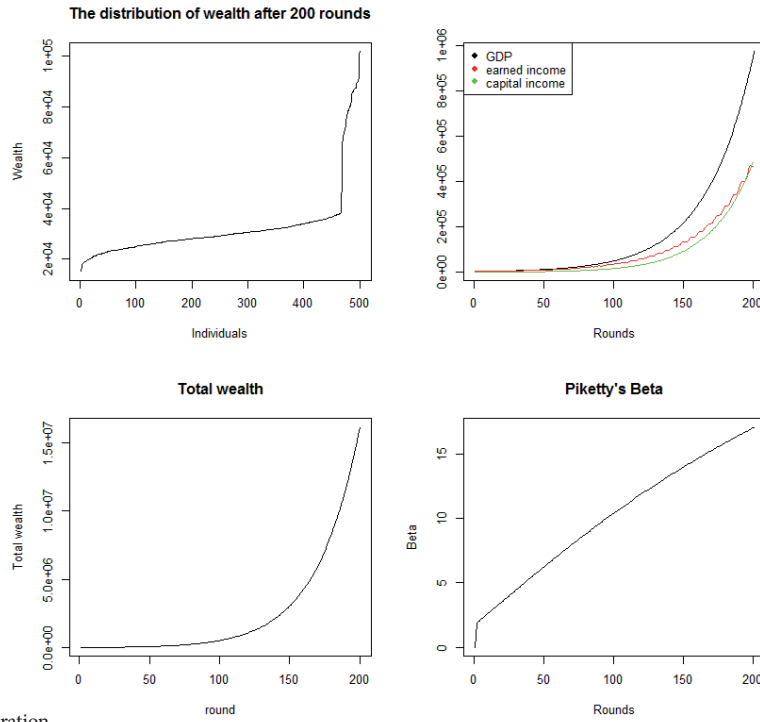
Source: Own calculations

possess 1.676 (1.938) times more economic capital than the lowest 20 % (10 %) of wealth owners. Furthermore, the Gini coefficient is used to show the effects of the analyzed direct and indirect network effects. This coefficient would reach a value of 0 if there is a minimal and a value of 1 if there is a maximal concentration of wealth (cf. Quatember 2008: 60). A value of 0.102, as in Table 1, shows a relatively low concentration of economic capital within the simulated society. Table 1 also includes the minimal and maximal wealth an individual was able to reach after 200 rounds. Moreover, the total wealth of all individuals after 200 rounds is shown. Figure 2 describes the distribution of wealth after 200 rounds among the 500 individuals. The x-axis shows the number of individuals and the y-axis the amount of wealth an individual was able to accumulate. Furthermore, the slope in Figure 2 highlights the relatively equal distribution of wealth in model 1. There is no huge distance between the individuals within the simulated society.

3.3 Model 2: Basic Model with random interest rates and an adjusted savings rate

To include the analyzed direct network effect, Model 1 will be extended by the following assumptions: A normally distributed interest rate with a mean of 3 % and a standard deviation of 0.1/100 is introduced into the model. Additionally, we include an adjusted savings rate: If the wealth of an individual is equal or larger than 1.2 times the average wealth, the consumption rate is set to 75 % of the earned income and if the wealth of an individual is equal to or larger than 1.5 times the average wealth, the consumption rate is set to 65 % of the earned income. Therefore, individuals with high wealth are able to increase their wealth faster than individuals with low wealth because due to interest rates profits increase with the amount of money. Individuals with a high amount of wealth have lower consumption

Figure 3: Model 2 – Matthew-Effect



Source: Own illustration

Table 2: Indicators

	Model 1	Model 2
20/20 ratio	1.676	2.269
10/10 ratio	1.938	3.199
Gini coefficient	0.102	0.171
Total wealth	54,918 €	16,101,785 €
Wealth min.	51 €	15,137 €
Wealth max.	183 €	101,876 €

Source: Own calculations

rates and are therefore able to accumulate wealth faster. Those two assumptions are intended to simulate the self-reinforcing mechanism of the Matthew-effect. The growth rate of GDP is set to 3 % per round. We use an accounting identity to calculate the wealth of an individual as follows:

$$W_t = W_{t-1} + EI_t + r_c * W_{t-1} - C_t + I_t$$

This simple framework allows us to analyze the process of wealth accumulation over time. Variable W_t represents the accumulated wealth in round t , W_{t-1} the accumulated wealth in round $t - 1$, EI_t the earned income in round t , $r_c * W_{t-1}$ the capital income in round t , C_t the consumption in round t and I_t the inheritances in round t . The last variable represents an initial wealth of 10 (cf. Davies/Shorrocks 2000:

610). Another accounting identity is used to calculate the growth rate of earned income. As the interest rate for capital r_c , the growth rate of GDP (g), the sum of earned income $\sum EI_{t-1} * (1+r_e)$ in period t and the sum of capital income $\sum W_{t-1} * r_c$ in period t are given, the growth rate of earned income r_e can be calculated by transforming the following equation:

$$GDP_{t-1} * (1 + g) = \sum EI_{t-1} * (1 + r_e) + \sum W_{t-1} * r_c$$

$$GDP_t - \sum W_{t-1} * r_c = \sum EI_{t-1} * (1 + r_e)$$

$$\frac{GDP_t - \sum W_{t-1} * r_c}{\sum EI_{t-1}} = 1 + r_e$$

$$r_e = \frac{GDP_t - \sum W_{t-1} * r_c}{\sum EI_{t-1}} - 1$$

By taking the new assumptions into account, Model 2 can be simulated; its outcomes are shown in Figure 3. Owing to the consideration of the analyzed direct network effect, the distribution of wealth after 200 rounds has changed remarkably: A small elite of individuals has accumulated significantly more wealth than the rest. The composition of GDP indicates that

the importance of capital income has increased over time. This point is emphasized by the development of Piketty's Beta, which represents the ratio between total wealth and GDP and is an indicator for the importance of capital in the process of wealth accumulation. The higher this indicator, the higher is the importance of capital in the process of wealth accumulation (cf. Piketty 2014: 50 f.). In addition to Piketty's Beta, Figure 3 also shows the development of total wealth according to Model 2.

From the indicators in Table 2 it can be seen that, owing to the implementation of the direct network effect, social inequality has increased. The 20/20 ratio has increased from 1.676 in Model 1 to 2.269 in Model 2; and the 10/10 ratio has risen from 2.269 in Model 1 to 3.199 in Model 2. The Gini coefficient, which has increased from 0.102 in Model 1 to 0.171 in Model 2, highlights the increase in social inequality. This may be interpreted in the sense that the implementation of the direct network effect – modelled as normally distributed interest rate and adjusted savings rate – has led to a more pronounced concentration of wealth in a small number of individuals.

4. Indirect Network Effects

The following section will analyze indirect network effects of the process of wealth accumulation. For this purpose, the *capital theory* of Bourdieu and Pareto's *theory of society* will be analyzed and discussed. The analyzed indirect network effects are implemented in the formal model of wealth accumulation to extend the current model by elements from Bourdieu's and Pareto's theories.

The concept of *cumulative causation* could be used to highlight the importance of an analysis that does not only take its focus on economic factors. It postulates that an analysis of development processes such as wealth accumulation, which focusses solely on economic factors, is irrelevant because historical, institutional, social and cultural factors matter as well (Panico/Rizza 2009: 183). Therefore, the following section will provide an analysis of the process of wealth accumulation, which takes those factors into account.

4.1 Bourdieu

To begin with the discussion of indirect network effects, Bourdieu's *capital theory* will be analyzed in the next section. Therefore, the essential elements of

Bourdieu's theory will be explained, before including the analyzed indirect network effect into the formal model.

4.1.1 Theory: Bourdieu

According to Bourdieu (2007), capital is an immanent regularity of the social world. Its distribution within a society is like a set of constraints, which is inscribed in the very reality of the world and governs its functioning in a durable way. Bourdieu (2007) argues that capital has a potential capacity to produce profits and reproduce itself in identical or expanded form, which causes the distribution of capital to tend to persist. As a result, capital can be interpreted as a force inscribed in the objectivity of things and determines an individual's chances of success (cf. Bourdieu 2007: 83). Thus, in order to understand the structure of the social world, one needs to learn about the structure of the distribution of different types and subtypes of capital.

Bourdieu (2007) states that economic theory reduces the universe of exchanges to mercantile exchanges; other, "non-economic" forms of exchanges are considered to be uninteresting. As a result, economic theory fails to take the complex structure of the real world including all its forms of capital and interactions into account. For Bourdieu (2007), capital presents itself in three fundamental forms: *Economic capital*, which is directly convertible into money and can be institutionalized in the form of property. *Cultural capital*, which can be institutionalized in the form of educational qualifications and *social capital*, which can be institutionalized in the form of titles of nobility. Bourdieu (2007) states that cultural and economic capital are convertible into money (cf. Bourdieu 2007: 83 ff.). However, acquiring an understanding of how economic and social/cultural capital are compatible systems that create cumulative advantages for individuals requires further theoretical and formal analysis, which will be provided in the next subsections.

4.1.2 Cultural Capital

Cultural capital can exist in three forms. The first form is the embodied state, which reflects the form of long-lasting dispositions of the mind and body (cf. Bourdieu 2007: 84). According to Krenz (2008), the accumulation of this form of capital takes time and can only happen through individuals themself-

ves. Moreover, this form of capital represents part of their habitus and therefore influences the character of an individual (cf. Krenz 2008: 7). Second, there is the objectified state, which is represented by cultural goods such as pictures, instruments and books (cf. Bourdieu 2007: 84). Krenz (2008) argues that this form of capital can be transmitted to other persons but cannot be used without the embodied form of cultural capital that enables an individual to benefit from cultural goods (cf. Krenz 2008: 7). Third, the institutionalized state can be expressed in the form of educational qualifications, such as college degrees. According to Bourdieu (2007), economic theory is not capable of understanding the impact of cultural capital on the process of wealth accumulation because it only considers monetary investments and profits, or forms of capital directly convertible into money. For this reason they neglect that the scholastic yield from an educational action depends not only on the cost of study, but also on the cultural capital previously invested by the family (cf. Bourdieu 2007: 84 f.).

Also, Krenz (2008) argues that cultural capital, among other things, becomes visible in the way a person speaks and is dependent on its first form of acquisition. In this context it is necessary to understand that an individual can only accumulate cultural capital in the form of educational qualifications if it gets enough financial support. For example, the acquisition of a college degree requires economic capital. Moreover, opportunity costs need to be taken into account, as the time needed to accumulate cultural capital in the institutionalized state keeps an individual off the job market (cf. Krenz 2008: 7). As educational qualifications can be used on the job market to earn a higher income, it is obvious that economic and cultural capital are two complementary systems that benefit from each other through positive feedback effects. As a consequence, it gets easier for a person to accumulate cultural capital in the embodied, objectified or institutionalized state if it already possesses economic capital – and vice versa.

Bourdieu (1983) mentions that institutional frameworks tend a lot of persistence to cultural capital, which leads to rigid capital structures within a society. This effect is strengthened through conservative policies that cause politics of demobilization and depolitization (cf. Bourdieu 1983: 184). Hence, it can be argued that institutions affect the accumulation of cultural capital, which needs to be taken into account when the distribution of cultural capital is analyzed.

4.1.3 Social Capital

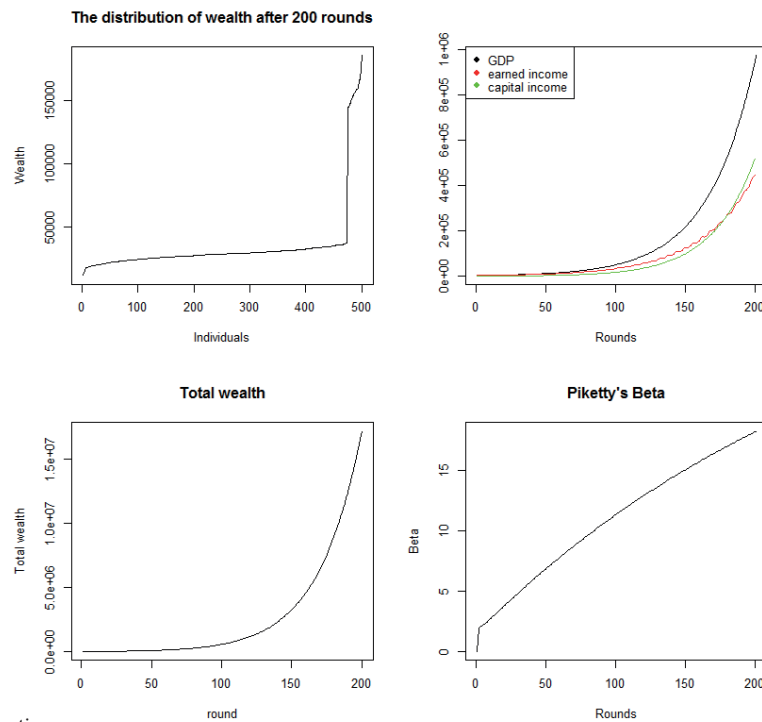
According to Bourdieu (2007), social capital is “*the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationship of mutual acquaintance and recognition-or in other words, to membership in a group*” (Bourdieu 2007: 88). Furthermore, social capital can manifest itself in the membership to a political party, family, class etc. (cf. Bourdieu 1983: 191). Bourdieu (2007) argues that the reproduction of social capital needs time and effort. For an individual, it is more likely to get access to a group of influence that enables the accumulation of social capital if it possesses a high amount of economic capital. Therefore, social capital depends directly or indirectly on economic capital. On the other hand, social capital, which is linked to the membership of a group, creates profits in the form of economic capital for its members (cf. Bourdieu 2007: 88 ff.). As a result, it can be stated that social capital leads to economic capital and vice versa.

Rössel and Bromberger (2009) mention that the distribution of cultural and social capital causes a rigid class structure within a society. This structure will be strengthened, as individuals are able to inherit parts of their cultural and social capital, which leads to an unequal distribution of wealth (cf. Rössel/Bromberger 2009: 495 f.).

The analysis of Bourdieu’s concept of cultural and social capital shows that a high amount of economic capital leads to a high amount of social/cultural capital and vice versa. Individuals with a high amount of economic capital can accumulate cultural capital more easily in the form of the embodied, objectified and institutionalized state, and they have easier access to resources of power, which are linked to the membership of a group. As a result of the previous analysis, it becomes evident that individuals are able to use their cultural and social capital to accumulate more economic capital, which leads to the formation of a rigid social elite. Therefore, an indirect network effect can be observed, because economic and social/cultural capital are complementary and form a compatible system, which causes cumulative and self-reinforcing advantages.

Model 3 will take the impacts of social and cultural capital into account by showing how these two forms of capital can affect the process of wealth accumulation.

Figure 4: Model 3 – Bourdieu



Source: Own illustration

Table 3: Indicators

	<i>Model 1</i>	<i>Model 2</i>	<i>Model 3</i>
20/20 ratio	1.676	2.269	3.161
10/10 ratio	1.938	3.199	5.221
Gini coefficient	0.102	0.171	0.254
Total wealth	54,918 €	16,101,785 €	17,189,237 €
Wealth min.	51 €	15,137 €	11,305 €
Wealth max.	183 €	101,876 €	186,072 €

Source: Own calculations

4.1.4 Model 3: The Simulation of Social and Cultural Capital

To include the analyzed indirect network effect, Model 2 will be extended using the following assumption: If the wealth of an individual is larger than 1.1 times the average wealth, the individual receives an earned income, which is 20 % higher than before.

Figure 4 shows that the distribution of wealth after 200 rounds has changed. Compared to Figure 3, the distribution of wealth indicates that a social elite has developed, which is more elitist than under the assumptions of Model 2. Furthermore, capital income has increased; it surpasses earned income. Table 3 shows that the indicators have changed and social inequality has increased. The 20/20 (10/10) ratio has

increased from 2.269 (3.199) in Model 2 to 3.161 (5.221) in Model 3. The Gini coefficient has increased from 0.171 to 0.254, which indicates that social inequality has increased. The range between the minimum and maximum wealth has widened as well. The minimum wealth decreased from 15,137 € in Model 2 to 11,305 € in Model 3, whereas the maximum wealth increased from 101,876 € in Model 2 to 186,072 € in Model 3. These results show that the implementation of the indirect network effect has an impact on the process of wealth accumulation and that social inequality has increased.

4.2 Pareto's Theory of Society

The second theoretic foundation for the development of an indirect network effect is Vilfredo Pareto's

theory of society, which will be discussed in detail in the next section of this paper. It will be shown how Pareto's theory can be applied into practice, before the analyzed network effect is implemented into the formal model of wealth accumulation.

4.2.1 Theory: Pareto

The second theoretic foundation for the development of an indirect network effect is Vilfredo Pareto's *theory of society*. According to Pareto (1975), a sociologist and economist, the distribution of wealth does not change over time and it is not determined by pure chance, but depends on the distribution of physiological and psychological characteristics of human beings (cf. Pareto 1975: 112 f.). Pareto states that it would be possible to classify human beings on a scale from 0, human beings with low skills, to 10, human beings with high skills. However, this classification is only theoretical; according to Pareto, society needs a marking system in the form of titles, such as "lawyer", that marks the position of individuals and shows their potential political and economic influence. Pareto (1975a, 1975b) also states – similar to Bourdieu (1983, 2007) – that individuals are able to inherit their standing or position in society, which causes a rigid distribution between the lower and upper class. In the context of this classification, Pareto (1975b) argues that there are two main classes within a society: the lower class and the upper class, which is split into a ruling and a non-ruling part (cf. Pareto 1975b: 256 ff.). We can see that Pareto divided the society into different classes that have a different chance to accumulate wealth and power (cf. Riener 1995: 62).

According to Pareto (1975), individuals who have the most political and economic influence also have the most wealth in society, which helps them to reproduce their favorable position (cf. Pareto 1975: 113). However, the social elite is in a persistent struggle with competitors who are trying to enter the upper class. Therefore, Pareto (1975a) argues that the social elite, which has political and economic influence, needs to use social and governmental institutions to defend its position at the top of society. Only the willingness of the social elite to take advantage of the institutions allows it to defend its favorable situation in society, making it possible to remain in power over the long run. As a result, the social elite needs to use political institutions to install legal systems that protect it from its competitors (cf. Pareto 1975a: 132).

Against this background, it can be seen that wealth and political power overlap and form a strong social elite. According to Pareto's conclusions, social elites can use their power to design legal systems, which help them to reproduce the situation of social inequality by securing advantages in the process of wealth accumulation. As a system of two compatible systems, power and wealth, becomes apparent, a second indirect network effect can be observed. It can be said that political power and economic capital cause a positive feedback loop: Political power leads to economic capital and vice versa. Therefore, this paper assumes that the social elite will use its political influence, which overlaps with economic capital, to build a legal system that enables it to reproduce social inequality.

It should be mentioned that Pareto's theory of society has relations to those of Karl Marx (1956, 1867/1959) and Antonio Gramsci (1975), who supported a similar approach to explain how power is reproduced by social elites in society. Studies from Acemoglu/Robinson (2009) and Borgerhoff Mulder et al. (2009) show how the distribution of wealth depends on institutional factors, which are defining legal restrictions on the economic life.

4.2.2 Pareto in Practice: Shadow Banks and Unequal Returns on Capital

To formalize this indirect network effect, which represents the unequal distribution of power in a society, the phenomenon of shadow banks will be added to Model 2. Shadow banks represent legal systems, which are used by the social elite to reproduce social inequality through causing unequal returns on capital. Therefore, this paper assumes that social elites generate legal systems, like the shadow banking system, to increase their return on capital, which strengthens their position in society.

Liebert et al. (2013) argue that social elites have political influence, which they use to prevent interventions by the state that could reduce the phenomenon of shadow banking. In fact, the debate focuses on the self-healing mechanisms of the market, which is a result of the neoliberal paradigm in politics and economics. Therefore, a political discussion cannot take place and it is difficult to tackle the problem of the shadow banking system (cf. Liebert et al. 2013: 5 f.).

According to the European Commission (2012), shadow banks have a strong impact on society and the economy. Shadow banks held about \$ 46 trillion assets

Figure 5: The growth rate of top global wealth, 1987-2013

The growth rate of top global wealth, 1987–2013

	Average real growth rate per year (after deduction of inflation) (%)
The top 1/(100 million) highest wealth holders ^a	6.8
The top 1/(20 million) highest wealth holders ^b	6.4
Average world wealth per adult	2.1
Average world income per adult	1.4
World adult population	1.9
World GDP	3.3

Note: Between 1987 and 2013, the highest global wealth fractiles have grown at 6%–7% per year versus 2.1% for average world wealth and 1.4% for average world income. All growth rates are net of inflation (2.3% per year between 1987 and 2013).

a. About 30 adults out of 3 billion in the 1980s, and 45 adults out of 4.5 billion in 2010.

b. About 150 adults out of 3 billion in the 1980s, and 225 adults out of 4.5 billion in the 2010s.

Sources: See piketty.pse.ens.fr/capital21c

Source: Piketty 2014: 435

in the year 2010, which is about 25-30 % of the global financial system and 50 % of all bank resources (cf. European Commission 2012: 5). According to Liebert et al. (2013), the shadow banking system grew to \$ 67 trillion, which represents about 86 % of world GDP and 90 % of global financial securities in 2012 (cf. Liebert et al. 2013: 15). The latest figures, based on Financial Stability Board data, show that the shadow banking sector has grown to an amount of \$ 75 trillion in 2013, which represents 120 % of global GDP and approximately 56 % of all bank assets (cf. Chartered Financial Analyst Institute 2015: 10). These numbers underline the relevance of the shadow banking system and highlight that it is a global phenomenon.

The argument about unequal returns on capital is supported by Piketty (2014), who showed that the highest wealth holders have a higher average real growth rate of capital than the rest of society. Piketty discusses two reasons for unequal returns on capital. First, he underlines that wealthier individuals obtain higher average returns on capital because they simply have greater means to employ wealth management consultants and financial advisors than less wealthy individuals. Second, Piketty argues that it is easier for investors with substantial reserves to take risks and to be patient than it is for investors without reserves (cf. Piketty 2014: 430 f.).

Figure 5 illustrates the argument about unequal returns on capital. Between 1987 and 2013, the average real growth rate of wealth per adult was 2.1 %, whereas it was 6.8 % for the top 1/(100 million) highest wealth owners (cf. Piketty 2014: 435).

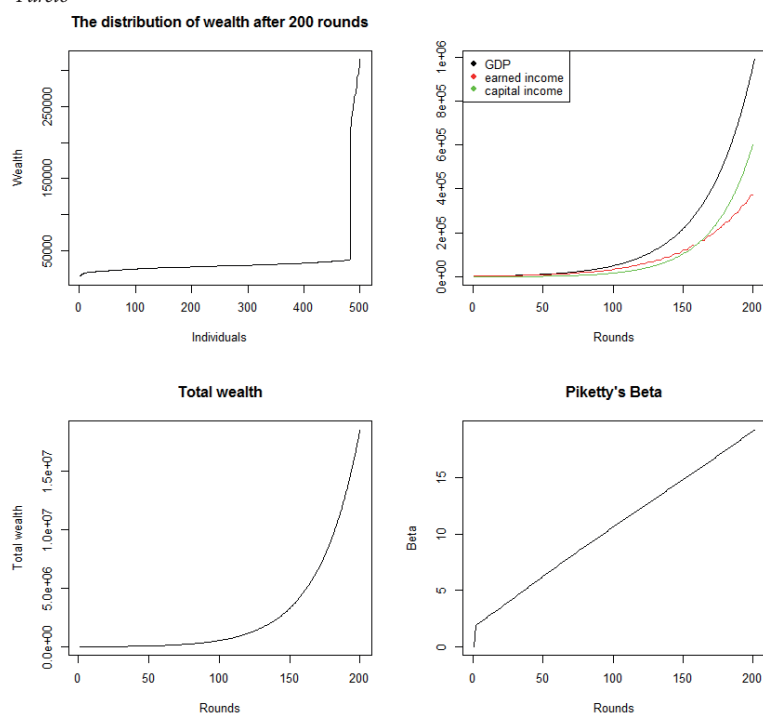
The previous analysis of Pareto's *theory of society* has shown that wealth causes power and that this power can be used to create wealth. Therefore, there exists a compatible system consisting of money and power. Piketty (2014) showed that high-net-worth-individuals have higher returns on capital than the rest of society. According to the findings in this section, these excess returns can be converted into political and economic power that is used by the social elite to skew the distribution of social possibilities. As a result, an indirect network effect can be observed. Money and power can be interpreted as two complementary entities, which cause cumulative and self-reinforcing advantages in the process of wealth accumulation.

4.2.3 Model 4: Simulating Unequal Interest Rates

To include the presence of shadow banks, which allow for higher interest rates for wealthy individuals, the following assumptions are included in Model 2: If the wealth of an individual is larger than 1.5 times the average wealth, the interest rate will increase by 1 percentage point.

Owing to this formalization, the distribution of wealth after 200 rounds has again changed remarkably. Figure 6 shows that a social elite has formed, which is even more elitist than in Model 3. Capital income has surpassed earned income and the composition of GDP has changed dramatically. In addition, Table 4 shows that the 20/20 (10/10) ratio has increased from 2.269 (3.199) in Model 2 to 3.506 (5.924) in Model 4. The

Figure 6: Model 4 – Pareto



Source: Own illustration

Table 4: Indicators

	Model 1	Model 2	Model 3	Model 4
20/20 ratio	1.676	2.269	3.161	3.506
10/10 ratio	1.938	3.199	5.221	5.924
Gini coefficient	0.102	0.171	0.254	0.290
Total wealth	54,918 €	16,101,785 €	17,189,237 €	18,473,695 €
Wealth min.	51 €	15,137 €	11,305 €	14,602 €
Wealth max.	183 €	101,876 €	186,072 €	315,320 €

Source: Own calculations

Gini coefficient has increased from 0.171 in Model 2 to 0.290 in Model 4, which highlights the growth in social inequality. The maximum wealth has increased significantly from 101,876 € in Model 2 to 315,320 € in Model 4. Therefore, it can be argued that the implementation of an indirect network effect has an impact on the process of wealth accumulation, leading to higher social inequality.

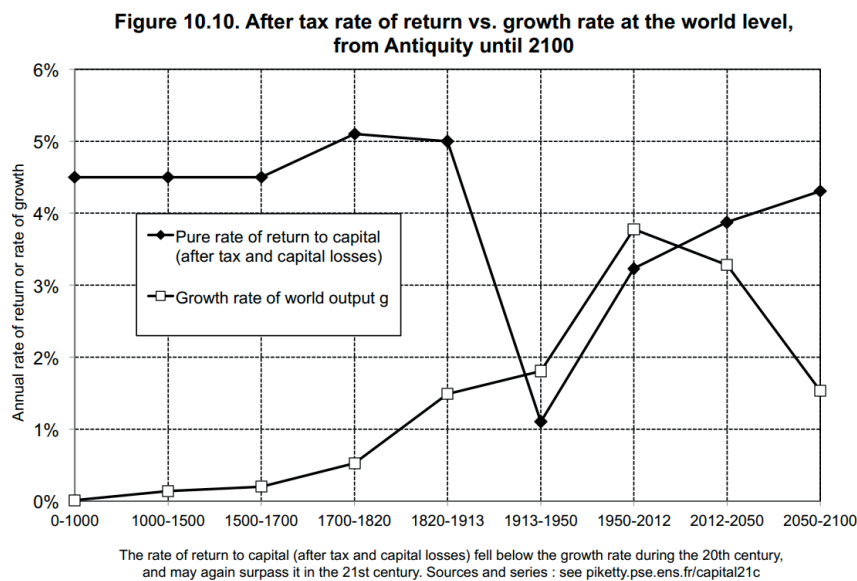
5. Piketty's Analysis: Implications for the Process of Wealth Accumulation

To put the process of wealth accumulation in a broader perspective, the next section discusses Piketty's (2014) work *Capital in the 21st Century* in more detail. Piketty's most important statements for the process of wealth accumulation will be analyzed theoretically and

incorporated into Model 2, in which a random interest rate and an adjusted savings rate were installed, and in Model 4, in which unequal interest rates were simulated.

5.1 Analysis

To understand Piketty's mechanisms in the process of wealth accumulation, we will discuss the main theoretical arguments. In Piketty's analysis, the capital/income ratio $\beta = K/Y$, where K are the capital and asset stocks and Y is the national income, measures the overall importance of capital in society, but says nothing about social inequality within a country. Furthermore, the capital/income ratio (β) is related to the share of income from capital in national income (α), which can be calculated with the formula $\alpha = r * \beta$, where r is the rate of return on capital. If, for example, $\beta = 600\%$ and

Figure 7: The development of the rate of return to capital r and the growth rate of world output g 

Source: Piketty 2014: 356

$r = 5\%$, then $\alpha = r * \beta = 30\%$, which shows that the capital share in national income is 30 percent. Piketty states that this simple framework expresses a transparent relationship between the three most important concepts for analyzing the capitalist system: β , α and r (cf. Piketty 2014: 51 f.).

According to Milanovic (2013), Piketty's (2014) key inequality relationship $r > g$ plays an important role in the production of social inequality. If the rate of return on capital, r , is permanently above the rate of growth of the economy, g , then α increases by definition and β increases as well (cf. Milanovic 2013: 4 f.).

Kapeller (2014) argues that the relationship $r > g$ causes the capital/income ratio (β) to increase. Therefore, the share of capital in national income, α , increases as well, which leads to a redistribution of earned income to capital income. As a result, the role of capital in the process of wealth accumulation increases and the relationship $r > g$ can be interpreted as Piketty's main mechanism for increasing social inequality (cf. Kapeller 2014: 330 f.).

Piketty (2014) illustrates the development of the rate of return on capital, r , and the growth rate of world output, g (Figure 7). It can be seen that the rate of return on capital has been above the growth rate of world output for almost the entire period. Only a combination of favorable circumstances – wartime destruction, progressive tax policies and exceptional growth after World War II – created a historically unique situation where the growth rate of world output was higher than

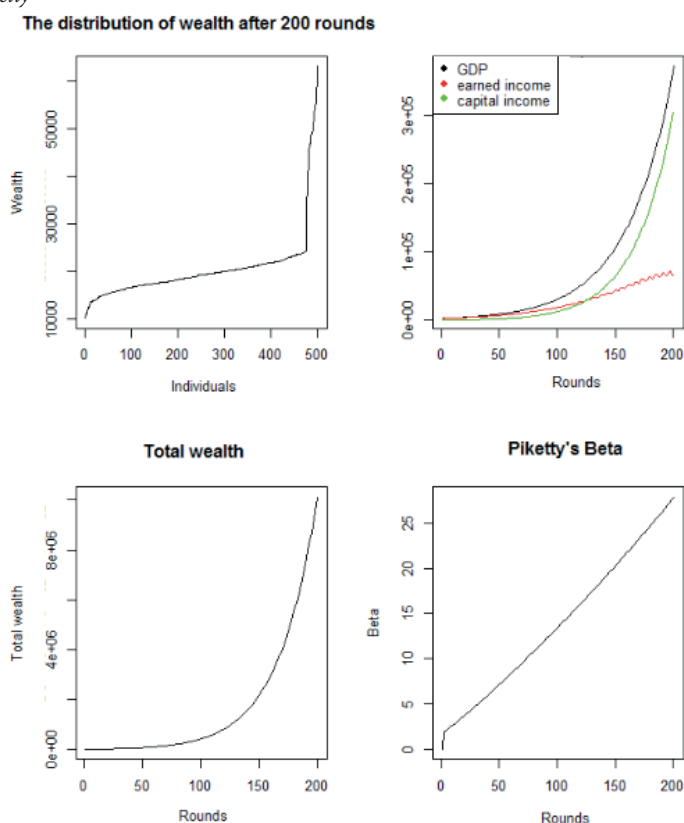
the rate of the return on capital. However, Piketty states that fiscal competition will again cause that the rate of return on capital to surpass the growth rate of world output (cf. Piketty 2014: 356). Therefore, social inequality will increase in the future and the process of wealth accumulation will be heavily affected by the influence of higher rates of return on capital.

5.2 Model 2.1: Basic Model with Formalization of $r > g$

To formalize Piketty's assumption for the development of the rate of return on capital, r , and the growth rate of GDP, g , the models 2 and 4 will be modified by the relationship $r > g$. Therefore, the growth rate of GDP, g , was set to decrease from 3% in Model 2 to 2.5% in Model 2.1. Figure 8 shows the differences to Figure 3 in two respects.

First, the composition of GDP has changed dramatically. In Model 2.1, capital income has gained in importance, compared to earned income. After 100 rounds, the share of capital income starts to take off and it is possible to observe the increasing influence of capital in the process of wealth accumulation. As a result, the importance of labor income is decreasing and high-net-worth individuals can accumulate capital more easily. Second, Figure 8 shows that, compared to Figure 3, Piketty's Beta has increased significantly, which highlights the increased importance of capital in the process of wealth accumulation.

Figure 8: Model 2.1 – Piketty



Source: Own illustration

Table 5: Indicators

	<i>Model 2</i>	<i>Model 2.1</i>
20/20 Ratio	2.269	1.941
10/10 Ratio	3.199	2.564
Gini coefficient	0.171	0.138
Total wealth	16,101,785 €	10,117,305 €
Wealth min.	15,137 €	10,074 €
Wealth max.	101,876 €	63,070 €

Source: Own calculations

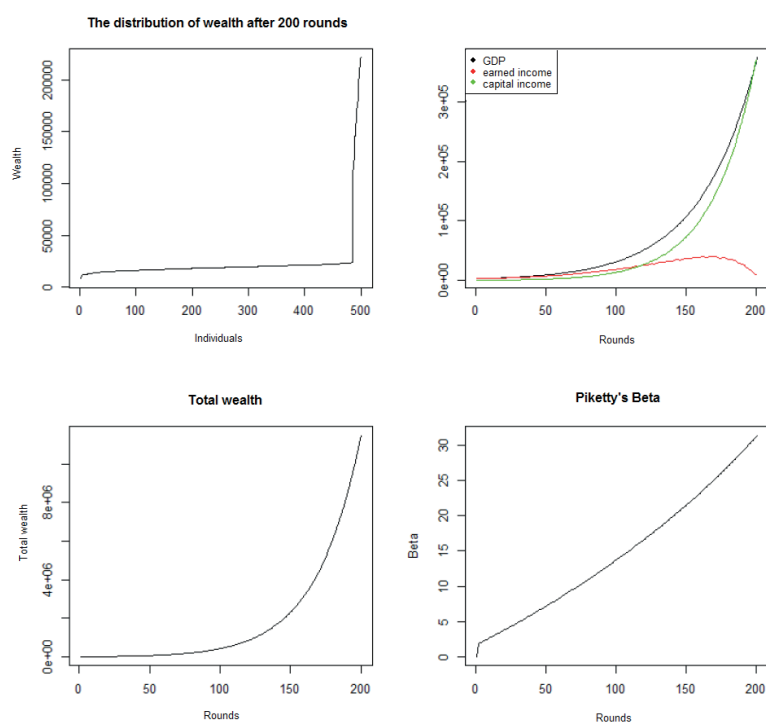
However, the indicators in Table 5 also show that social inequality has decreased. The 20/20 (10/10) ratio has decreased from 2.269 (3.199) to 1.941 (2.564). Moreover, the Gini coefficient has decreased from 0.171 to 0.138. The decrease in social inequality can be explained by the fact that the relation $r > g$ leads to a higher importance of capital in the process of wealth accumulation. However, in round 1 all individuals receive the same initial wealth of 10, whereas in Model 2.1 the growth rate of earned income is not as high as in Model 2, which implies that the differences in wealth are created in later rounds; i.e., the Matthew-effect needs more time to build up. The total, minimum and maximum wealth have decreased as well, which can be

explained by the decrease in the growth rate from 3 % to 2.5 %.

5.3 Model 4.1: The Simulation of Unequal Interest Rates and the Formalization of $r > g$

We have seen that the implementation of the relationship $r > g$ in Model 4 leads to a significant difference in the composition of GDP. After round 100, capital income takes off and surpasses earned income. In round 200, GDP consists of capital income only, as earned income has decreased to a minimum. The decrease in the growth rate caused a decrease in the growth rate of earned income. As a result, the importance of

Figure 9: Model 4.1 – Piketty



Source: Own illustration

Table 6: Indicators

	<i>Model 4</i>	<i>Model 4.1</i>
20/20 ratio	3.506	3.080
10/10 ratio	5.924	5.049
Gini coefficient	0.290	0.257
Total wealth	18,473,695 €	11,473,494 €
Wealth min.	14,602 €	7,984 €
Wealth max.	315,320 €	221,493 €

Source: Own calculations

capital income increased. Figure 9 compared to Figure 4 shows that Piketty's Beta has increased significantly, which highlights the increased importance of capital in the process of wealth accumulation. However, social inequality remained more or less the same, which can be observed by the indicators in Table 6. The implementation of $r > g$ caused a small decrease in the 20/20 (10/10) ratio from 3,506 (5,924) in Model 4 to 3,080 (5,049) in Model 4.1 and a small decrease of the Gini coefficient from 0,290 in Model 4 to 0,257 in Model 4.1.

6. Discussion and Shortcomings

In Austria the Gini coefficient with respect to net-wealth was 0,76 in 2010 (cf. Andreasch et al. 2012: 255). Thus, the Gini coefficients calculated in this paper vary

significantly from those in reality. A possible explanation would be that every individual gets the same amount of initial wealth. Therefore, wealth differences are low at the beginning and the direct and indirect network effects need more time to come into effect. More mechanisms of wealth accumulation should be considered in future research. Two papers from Cagetti and De Nardi (2006) and De Nardi (2015) provide an overview of possible adaptations and extensions.

It is important to understand that, due to the mathematical formalization in the models of wealth accumulation, the socio-scientific theories in this paper were tremendously simplified. It is difficult to quantify the benefits of cultural and social capital on an individual's outcome in the labor market. The increased interest rate due to the amount of economic capital

Table 6: Indicators

	random interest rates	adjusted savings rate	social/ cultural capital	unequal interest rates	Piketty: $r > g$
Model 1 – Basic Model					
Model 2 – Matthew Effect	x	x			
Model 3 – Bourdieu	x	x	x		
Model 4 – Pareto	x	x		x	
Model 2.1 – Piketty	x	x			x
Model 4.1 – Piketty	x	x		x	x

Source: Own calculations

in Model 4 is hard to estimate as well. Also, the limits from which the indirect network effects come into force are difficult to define. However, the formalization in this paper should show how an implementation of Bourdieu's *capital theory* and Pareto's *theory of society* could look like.

Table 7 provides a short overview of the models described in this paper. It shows which extensions were made in each model compared to the basic model, Model 1, which has no direct or indirect network effects included. Throughout the course of this paper, Model 1 has been extended by a random interest rate and an adjusted savings rate in Model 2, which formalized direct network effects. Model 2 represents the base model from which the following extensions were made in Model 3, 4 and 2.1.

7. Conclusions

This paper analyzed the process of wealth accumulation with regard to the path dependence theory. In this regard, three mechanisms of wealth accumulation were identified as either direct or indirect network effects.

Robert King Merton's theory of the Matthew-effect was identified as a direct network effect, showing that, due to cumulative advantages, initial differences at the start of the process of wealth accumulation grow larger over time. It was illustrated that, owing to small interest rate advantages at the beginning, large movements in the distribution of wealth build up, skewing the distribution in favor of a small "elite". The higher the amount of money individuals own, the higher their potential for wealth accumulation, as higher interest rates make it easier to accumulate. Therefore, a direct network effect can be identified.

Bourdieu's *capital theory* has provided us with the insight that social and cultural capital influence the

ability of an individual to accumulate economic capital and that it is necessary to take these two forms of capital into account when the process of wealth accumulation is analyzed. Economic and cultural/social capital are two compatible systems, which are characterized by positive feedback effects: Economic capital leads to cultural/social capital and vice versa, i.e., we observe an indirect network effect.

Next, Pareto's *theory of society* was analyzed to find a second indirect network effect. Pareto assumed that a high amount of economic capital leads to power and vice versa. According to the analysis of Pareto's *theory of society*, social elites have both power and wealth. Moreover, it was argued that social elites build legal systems by influencing the institutions, e.g. in the form of shadow banks, which enables them to earn higher interest rates. As a result, the wealth of the social elite increases faster than the wealth of the rest of society, causing higher social inequality. Additionally, two arguments of Piketty have been used in this paper to underline the assumption of unequal returns on capital: Wealthier individuals have greater means to employ wealth management consultants and financial advisors than less wealthy individuals and it is easier for investors with high reserves to take risks and to be patient compared to investors with no reserves. Therefore, the assumption was made that the higher the wealth of an individual, the higher its return on capital. As a result, power and wealth are compatible and favor each other, i.e. we again observe an indirect network effect.

The Matthew-effect, social/cultural capital and power in the form of unequal returns on capital were formalized and simulated in different models. The implementation of direct and indirect network effects influences the process of wealth accumulation remarkably. Table 4 illustrates that all indicators about the degree of social inequality have increased. Therefore, direct and indirect network effects lead social inequa-

lity to increase over time. Moreover, a social elite will form, which can increase its wealth over time, as the importance of capital income in the process of wealth accumulation increases. As a result, other members of society with less capital income depend more on earned income and have no chance to catch up to the social elite.

Due to the increasing share of capital income compared to earned income, the growth rate of earned income decreases by definition. Individuals who depend more on earned income cannot benefit from the cultural/social capital and higher returns on capital in the way high-net-worth individuals do. The wealth of individuals within the social elite increases more rapidly than the wealth of the rest of society, which enables the formation of a rigid social elite. As a result, the process of wealth accumulation with regard to the assumptions of the developed models, leads to a lock-in, in which poor individuals remain poor and rich individuals remain rich.

Piketty's *Capital in the 21st Century* underlines the importance of the relation between the rate of return on capital, r , and the growth rate of GDP, g . The simulations in this paper have shown that the relation $r > g$ would lead to an increasing importance of capital income in the process of wealth accumulation. Therefore, the growth rate of GDP was reduced from 3 % to 2.5 %, as implemented in models 2 and 4. Due to the decreased growth rate, earned income became less important in the process of wealth accumulation. Moreover, the role of capital income increased, so that wealth can be easier obtained through initial capital endowments as opposed to work.

The main conclusion of the analysis in this paper is that direct and indirect network effects influence the process of wealth accumulation and that they need to be taken into account more seriously in the current debate on social inequality. If social inequality is to be decreased, it is necessary to weaken the effects of social and cultural capital on the process of wealth accumulation. Therefore, direct and indirect network effects need to be regulated by governmental institutions to prevent society from becoming more unequal.

As a possible solution, the accumulation of institutionalized cultural capital could be designed in a more egalitarian way, for instance through policies regarding the educational system. This paper identifies three challenges for Austria. First, the implementation of a comprehensive school. In Austria the splitting in secondary and grammar schools creates different possi-

bilities of accumulating cultural capital, which could be weakened by a comprehensive school system. Second, the expansion of the kindergarten sector, so that all children are able to attend kindergarten independent of family background. Third, the implementation of a full-time day school, which would help to support children from educationally disadvantaged spheres. This measure could decrease the cultural capital gap in society because education would be more decoupled from the cultural capital within families.

Moreover, the effects of power on rates of return on capital need to be decreased. Thus, the shadow banking sector needs to be tackled by supranational institutions to decrease the gap in returns on capital. Furthermore, the differences in wealth could be decreased by implementing a property tax. In addition, banking secrecy could be abolished, which would improve tax compliance. These two measures would weaken the impact of unequal interest rates on the process of wealth accumulation.

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