Competition between Firms in Economic Evolution: Its Characteristics and Differences to the Biological Sphere

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12 January 2016

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Its Characteristics and Differences to the Biological Sphere

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Abstract

This paper investigates the characteristics of competition among firms from an evolutionary perspective. It develops a coherent approach to economic competition that incorporates two kinds of evolutionary concepts currently used and emerging at the intersection of social sciences, including economics, and biology: *Darwinian thinking* as well as the *naturalistic approach*. Inspired by evolutionary theory, the intersection commonly captures concepts that make metaphorical use of Darwinian ideas – these concepts draw on an analogy construction to the biological sphere. As a result in this paper, different characteristics of economic competition may be analogically described by different forms of biological selection, e.g., genetic group selection. However, selection processes do not only act on genes, but also on culture. By considering the *naturalistic approach*, differences to the biological sphere are revealed. The crux of this paper is the deduction that competition between firms is a form of cultural group selection in economic evolution.

Keywords: Competition – Evolutionary Theory – Selection Processes – Continuity Hypothesis

JEL Codes: D49, B52

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1. Introduction

Competition among firms is a crucial phenomenon that has been investigated by many economists for several decades (e.g., Rosen, 1974; Caves and Porter, 1977; Katz and Shapiro, 1985; Teece, 1992; Fehr and Schmidt, 1999; Edmond et al., 2015). Indeed, competition matters when it comes to industrial structures and industrial development (e.g., Douglas and Miller III, 1974; Flam and Helpman, 1987; Aghion et al., 1997; Raco, 1999; Weir, 1999; Aghion et al., 2015). There are many avenues to analyze the role of competition: for instance, by means of its economic outcomes, its market structures, and its characteristics. The relationship between competition and its concrete economic outcomes, such as unemployment, growth, and income has been already extensively analyzed (e.g., Gabszewicz and Thisse, 1979; Benassy, 1987; Blecker, 1989; Dixon, 1990; Hauner and Peiris, 2008). Apart from the economic outcomes, different market structures have been also well described as to the amount of competitors, namely monopoly, duopoly, oligopoly, and polypoly (e.g., Smith, 1962; Dixit and Stiglitz, 1977; Krugman, 1979; Singh and Vives, 1984; Herk, 1993; Stenbacka, 1994; Nocco et al., 2014). In comparison to that, only few contributions, however, scrutinize the characteristics of competition.

This paper addresses that research gap by proposing an approach to the economic evolution of the characteristics of competition between firms. Competition among firms is a dynamic phenomenon. So, it is appropriate to take on an evolutionary perspective. The contribution arising from this approach is twofold. (i) various characteristics of competition, explained by various forms of selection, are presented. As a result, using analogy constructions to the biological sphere – *Darwinian thinking*, economic competition may be characterized by genetic group selection. (ii) in order to expose the differences to the biological sphere, the *naturalistic approach* is considered, where culture additionally plays a major role. The quintessence of this paper is the deduction that competition among firms is a form of cultural group selection.

The aim is to examine the characteristics of competition between firm organizations from an evolutionary perspective. For this purpose, a coherent approach is devised which not only draws on recent findings in that field as set out by Johnson et al. (2013), but also extend these findings by considering further evolutionary concepts. Cordes (2015) illustrates in his state-of-the-art article the most important evolutionary concepts, currently used and still emerging at the intersection of behavioral sciences, social sciences, including economics, and biology (van den

Bergh and Gowdy, 2009; Stoelhorst and Richerson, 2013). Inspired by evolutionary theory, evolutionary concepts can be separated into two types (Cordes, 2015).

First, *Darwinian thinking* is employed more commonly (e.g., Nelson and Winter, 1982; Metcalfe, 1994; Johnson et al., 2013) and based on analogy constructions to the biological sphere induced by Darwinian ideas, embracing "variation-selection-inheritance algorithms" (e.g., Campbell, 1965; Stoelhorst, 2008). Darwinian ideas capture natural selection acting on gene variation: genes with higher probabilities to be inherited spread, others tend to disappear. The probability of inheritance depends on relative reproductive success[1]. Second, besides selection processes that work on genes, there are additionally selection processes that work on culture in social organisms', e.g., humans', evolutionary history. Culture can be understood as knowledge, ideas, or belief (Richerson and Boyd, 2008). Some knowledge may survive, and other ones may die in the course of time. Those selection processes of culture are peculiarly taken into account by the *naturalistic approach*. Moreover, it relates culture to natural selection: since culture appears to occur later as compared to biological mechanism acting on genes, cultural evolution rests upon foundations laid before by natural selection (Cordes, 2015). Together, competition among firms is investigated with two types of evolutionary concepts: *Darwinian thinking* and the *naturalistic approach*.

Table 1: Characteristics of competition between firms in economic evolution.

Competition can be explained by	Levels of selection (Who is selected?)	Dimensions of selection (What is selected?)	Type of evolutionary concept	Economic actors are characterized by
Individual selection	Individuals	Genes	Darwinian thinking	Selfishness
Naïve group selection	Groups	Genes	Darwinian thinking	Altruism
Genetic group selection	Both	Genes	Darwinian thinking	Both
Cultural group selection	Both	Culture	Naturalistic approach	Both
Gene-culture coevolution	Both	Both	Naturalistic approach	Both

Evolutionary concepts are necessary, in order to explain dynamic phenomena, e.g., competition among firms. Some firms are more successful than others. Successful firms may persist and less successful may disappear when time goes by. To explain differences in firm success, it is appropriate, considering competition between firms to be characterized by behavioral differences of economic actors. Two types of behavior are distinguished: selfishness

[1] Relative reproductive success depends on longevity, fecundity, and copying-fidelity (Dawkins, 2006).

and altruism. Other forms like opportunism, cooperation, or pro-sociality are not discussed in detail. The former can be associated with selfishness and the latter two with altruism, for simplicity. Table 1 shows how the characteristics of competition can be explained, who exactly is selected, what is selected precisely, which type of evolutionary concept the explanations may be assigned to, and what type(s) of economic actors' behavior might spread according to the underlying explanation.

The present paper is organized as follows. Section 2 displays competition among firms as an analogy construction to the biological sphere, i.e., *Darwinian thinking*. Section 3 reveals differences to the biological sphere by incorporating the *naturalistic approach*. Section 4 concludes.

2. Darwinian thinking

Competition is a dynamic process and the foundation for economic evolution. Therefore, we compare competition among firms with selection processes, working on organisms, in biology, inspired by evolutionary theory. Applying Darwinian principles of variation, selection and inheritance is inevitable, in order to explain the evolving systems in both human societies and nature (Hodgson and Knudsen, 2006). First, we focus on individual selection. Second, *naïve* group selection is shown. The first and second point result into third, genetic group selection.

2.1 Individual selection

Characteristics of competition among firms can be explained with the help of individual selection. It is focused on selection processes only taking place at the level of individuals (e.g., Winter, 1971; Ferguson, 2008; Johnson et al., 2013). Evolutionary concepts capturing individual selection to market competition among firm organizations are not new and also used by other scholars. "Individuals" struggle for "profits" and "[T]the suggested approach embodies the principles of biological evolution and natural selection by interpreting the economic system as an adoptive mechanism which chooses among exploratory actions generated by the adaptive pursuit

of [“]success[”]” (Alchian, 1950). Moreover, the notion of “creative destruction” implying firms that know how to innovate have a competitive advantage and displace other ones who cannot keep pace with the harsh innovative change (Schumpeter, 1961; 2008). Beyond that, other influential authors like Friedman (1954; 1970) also utilize the Darwinian “survival of the fittest” argument regarding firms and competitive equilibrium. He, in addition, criticizes the regulations from outside the market by government aid. “Given the assumptions of perfect competition and profit maximization, inefficient firms will be driven out of business […] and any intervention into the natural order of perfectly competitive markets will allow inefficient firms to survive rather than suffering the consequences of their inefficiency” is Friedman’s position, described by Gowdy et al. (2013). In short, individual selection is the simplest and most intuitive explanation to be given for the purpose of examining dynamic economic phenomena between firms. Some firms are more and more successful in the long run, others are less successful. The entity, selection is acting on, is the firm. Each firm can be viewed, analogously to organisms competing for reproductive success, as one individual racing with other firms for economic success. In accord with Section 1, competition among firms, explained by individual selection, is an analogy construction to the biological sphere. The application of individual selection to economic competition is *Darwinian thinking*.

Now, we face more precisely what individual selection is. Evolutionary theory inside the domain of biology provides insights as to the development of certain traits, e.g., behavior (selfishness versus altruism)[2]. These traits are codified in genes and embodied by organisms or individuals. Within a given pool of different individuals there are different traits. Some individuals are selfish, others not. This genetic variation within a population of individuals is an accidental occurrence in the short term due to mutation, recombination, and other processes which induce different traits. Natural selection, then, favors traits with higher probabilities to be inherited and neglects those with reproductive disadvantage. The probability of trait inheritance depends upon a lot of factors.[3] In a stylized example, selfishness leads to optimal strategies regarding fights with conspecifics or predators. Moreover, it might lead to achieving a huge amount of food, at least as much as possible. Selfishness, therefore, gives rise to higher probabilities to survive and it might be inherited with higher rates by the next generation.

[2] Just to give some out of a bundle of other examples: shape of teeth (sharp versus blunt) and hair color (light versus dark). As explained in the last section, it is appropriate to solely focus on behavior (selfishness versus altruism).
[3] See also Section 1, footnote, for some determinants of reproductive success.

Altruistic individuals, however, sacrifice their life when it comes to merciless fights with conspecifics and predators, and renounce some food for the benefit of other individuals. Altruism, therefore, leads on to lower probabilities to survive and it might be inherited with lower rates by the next generation. As a result, in the long term, selfish individuals may persist and altruistic ones may disappear. A highly simplified Darwinian variation-selection-inheritance algorithm involving individual selection has been shown, in order to analyze competition among firms next.

We apply individual selection to competition between firms, that is, market competition is a metaphor of the biological sphere.[4] At the beginning of and in the short run during the market evolution, we presumably have different traits embodied by different firms. Some firms are selfish, others are altruistic. The variation may occur by accidence for above-mentioned reasons. In the course of time, however, via individual selection some traits may be more favored than others and persist. The persistence or inheritance of traits depends upon firm success. Selfish firms aggressively fight with other firms, for market share, revenues, and growth (human, financial, and physical capital), increasing the chance of success. Altruistic firms, by contrast, renounce to aggressively fight for market share, etc., resulting into a decrease of firm success. So, in the long term, selfish firms become the winner of the race in market evolution according to the theory of individual selection, while altruistic firms tend to disappear. Since this is a race for firm success, rather than a struggle of survival, we realize competition among firms is an analogy construction to the biological sphere.

The ruthless Darwinian logic involving individual selection to describe competition among firms, struggling for success, is similar to the behavioral notions stemming from neoclassical traditional economics. Following both theories, selfish actors will persist in the long run. In accordance with Johnson et al. (2013), that is why a lot of other scholars "tend to conclude […] (1) economic actors are self-interested, (2) self-interest contributes to the public good (Adam Smith's "invisible hand"), and (3) the combination of these two assumptions will lead to market optimization. In short, Darwinian selection among firms appears to perfectly bolster neoclassical economics." This view, based on individual selection or neoclassical economics, is fairly stylized and just a first proxy to characterize competition among firms in market evolution (Gowdy et al.,

[4] See also for a discussion Cordes et al. (2008), Witt and Schwesinger (2013), or Nelson and Winter (1982).

2013). However, in the real world, we do not solely have selfish economic actors, but also non-selfish economic actors. It is, thus, inevitable to consider other evolutionary forces which might explain the emergence of other traits, i.e., altruism.

2.2 Naïve group selection

Other characteristics of competition among firms can be explained with another evolutionary force, naïve group selection. Here, we do not focus on selection processes taking place at the level of individuals, rather solely at the level of groups (e.g., Wynne-Edwards, 1962; Wilson and Sober, 1994; van den Bergh and Gowdy, 2009; Johnson et al., 2013). This kind of selection is also called simple group selection. Naïve group selection, like individual selection, is also a straightforward and intuitive explanation given for the purpose of examining dynamic economic phenomena between firms. Some firms are more successful in the long run, others are less. The entity, selection acts on, is the firm. However, unlike in the case of individual selection, each firm is viewed, analogously to social organisms living in groups of individuals competing for reproductive success, as one group of individuals racing with other firms for economic success. Contrary to Section 2.1 treating firms as individuals, whereby competition success is characterized by selfishness, Section 2.2 more realistically treats firms as a group of individuals, whereby altruism predominantly spread in the course of time. Competition among firms, explained by naïve group selection, is also an analogy construction to the biological sphere based on the metaphorical use of Darwinian ideas. The application of naïve group selection to economic competition is *Darwinian thinking* for this reason.

What is naïve group selection? Again, evolutionary theory provides insights as to the development of certain traits, e.g., behavior (altruism versus selfishness). These traits are codified in genes and embodied by individuals. Furthermore, in social species, e.g., humans, there are individuals who live in groups. A given pool of different groups consists of different traits embodied by individuals. Some individuals are altruistic, others are selfish. Some groups have more altruistic members, other groups have less. This genetic variation within a population of different groups is an accidental occurrence in the short term due to mutation, recombination, and other processes which lead on to different traits. In the long term, natural selection favors traits with higher probabilities to be inherited and neglects those with reproductive disadvantage. The

probability of trait inheritance depends upon survival of groups among other factors (see Section 1). Within a group, altruistic individuals help group members, this, in turn, leads to better group survival chances. These members jointly fight against predators or other conspecific groups as well as share food the group members jointly obtained and prepared before, increasing the probability to survive. Selfish individuals, by contrast, do not help each other when it comes to fights or acquiring food, lowering the chance to survive. In the long run, groups with altruistic individuals persist, other groups with selfish individuals may disappear. A highly simplified Darwinian variation-selection-inheritance algorithm consisting of naïve group selection has been shown, in order to analyze the characteristics of competition among firms from another perspective now – the for-the-good-of-all perspective.

We apply naïve group selection to competition between firms. As in the first case, market competition is a metaphor of the biological sphere. At the beginning of market evolution and in the short run during the market evolution, we have different traits embodied by different firm members within different firms. Some colleagues are altruistic, others selfish. Some firms have more altruistic members, others less. These variations may occur by accidence. In the course of time, however, via naïve group selection some traits may be more favored than others and persist. The persistence of traits depends upon the firm success. Within a certain firm, there are a lot of altruistic actors. These actors jointly try to obtain market share, revenues, and capital, increasing the chance to be successful as an organization. Within another firm, there are a lot of selfish actors. This firm is characterized by lazy, opportunistic workers who do not cooperate with colleagues, resulting in worse firm performances. As a consequence, firms with solely altruistic members outcompete all other firms when time goes by, especially those who have a lot of selfish workers are outcompeted. Since this is a race for firm success, rather than a struggle of survival, we realize competition among firms is an analogy construction to the biological sphere, when applying naïve group selection.

A Darwinian logic involving naïve group selection to describe competition among firms, struggling for success, is more realistic than the explanation expounding competition with individual selection. By definition, firms are not individuals, rather firms are groups of individuals. Naïve group selection is an evolutionary force that leads to altruism. It is a good proxy to economic reality. This theory helps us to understand, why some firms with altruistic workers might be more successful than other firms without those. In the real word, however,

economic actors are characterized by both altruism and selfishness. So, we need an explanation which captures two evolutionary forces giving rise to altruism and selfishness.

2.3 Genetic group selection

Further characteristics of competition among firms can be explained by means of genetic group selection. This approach does not focus on selection processes merely taking place either at the level of groups or at the level of individuals. Rather, selection processes between groups and within groups, i.e., between individuals, are considered at the same time (e.g., Wilson and Sober, 1994; Henrich, 2004; Wilson and Wilson, 2007; van den Bergh and Gowdy, 2009; Johnson et al., 2013). This kind of selection, therefore, is a "multilevel" approach and also called "multilevel selection" or "biological group selection." Genetic group selection is the most appropriate approach that examines dynamic economic phenomena as compared to the two approaches explained before. Some firms are more successful in the long run, others less. The entities, selection is working on, are the firms. Each firm is viewed, analogously to social organisms living in groups competing for reproductive success, as one group of individuals racing with other firms for economic success. But now, we additionally account for the fact that some workers are more successful in the long run, others not. The selection entities are not only firms, but also workers inside the firm. While in the earlier two sections, selection mechanism either lead on to altruism or selfishness, Section 2.3 illustrates genetic group selection leading to both altruism and selfishness, which is more realistic. Competition among firms, explained by genetic group selection, is also an analogy construction to the biological sphere based on the metaphorical use of Darwinian ideas. The application of genetic group selection to economic competition is a third opportunity of *Darwinian thinking*.

Let us have a closer look at this multilevel selection theory. To repeat, evolutionary theory provides insights as to the development of certain traits (e.g., altruism versus selfishness). These traits are codified in genes and embodied by individuals. Furthermore, in social species, there are individuals who live in groups. A given pool of different groups consists of different traits embodied by individuals. Some individuals are altruistic, others are selfish. Some groups have

more altruistic members, others less. Moreover, we assume four[5] different types of groups: some with solely altruistic or solely selfish members, and altruistic groups with few or many selfish members inside. This genetic variation within a population of different groups is an accidental occurrence in the short run. In the long run, natural selection favors traits with higher probabilities to be inherited and neglects those with reproductive disadvantage. The probability of trait inheritance depends upon group survival among other factors. Altruistic groups with few selfish members inside exhibit better survival performances in comparison to the other three group types: on the one hand due to between-group selection (raising the relative group-level success), these groups have a huge amount of altruistic members and a high degree of cooperation, on the other hand due to within-group[6] selection (raising the relative group-level success), there are few selfish members who selfishly prevent and exclude members who do not contribute to the group.[7] Purely altruistic groups may have better group performances (between-group selection raising the relative group-level success), but cannot exist in the long run. Altruistic groups do not exclude by nature potential selfish members who join the altruistic group accidentally and reduce the group performance of the purely altruistic group. These selfish members will exploit their altruistic group mates and stay in the group (within-group selection lowering the relative group-level success). Purely selfish groups will be outcompeted, because these groups have very low group performances. The same holds true for altruistic groups with many selfish members inside. In both cases, those groups have less chances to survive (between-group selection lowering the relative group-level success), but its selfish members received some benefits and exclude members who do not contribute to the group in the course of time (within-group selection raising the relative group-level success). In the long run, altruistic groups with few selfish members inside persist, and the other three group types will be outperformed. In other words: concerning the case with altruistic firms with few selfish members inside, between-group and within-group selection work in the same direction (both selection types lead to raising group performances). Altruistic members force a high degree of group performance, while the few selfish individuals do so by excluding members who do not contribute to the group. In the other three cases the two selection types are working in opposing directions. A Darwinian variation-selection-inheritance algorithm consisting of genetic group selection has been shown, in order to

[5] Again, for the sake of simplicity.
[6] Within-group selection is selection working on individuals inside the group. Within-group or individual selection fosters the spread of selfishness.
[7] This egoistic behavior can be assigned to the term “altruistic punishment” (Henrich, 2004).

analyze the characteristics of competition among firms from a perspective which captures the coexistence of altruism and selfishness.

In the following, we apply genetic group selection to competition between firms. As in the first two cases, market competition is a metaphor of the biological sphere. At the beginning of market evolution and in the short run during the market evolution, we have different traits embodied by different firm members within different firms. Some workers are altruistic, others are selfish. Some firms have more altruistic members, others less. For the sake of simplicity, we distinguish only four types of firms: firms with solely altruistic or selfish members, altruistic firms with few or many selfish ones inside. These variations may occur by accidence. In the course of time, however, via genetic group selection some traits may be more favored than others and inherited. The inheritance of traits depends upon the firm success. Altruistic firms with few selfish members inside exhibit a high degree of firm success. There are a lot of altruistic firm members – altruistic workers – that contribute to firm success (market share, profits, and capital) and, at the same time, there are some few selfish firm members – selfish bosses – who wants the firm members to perform well and prevent selfishness – exclusion of selfish workers (Johnson et al., 2013). In so doing, these few selfish bosses contribute to the success of the firm as well. Purely altruistic firms do have more benefits in the short run, but do not maintain as purely ones in the long run. Selfish members may enter those firms by accidence and exploit their pro-social colleagues via free-riding. Some selfish members will stay in the group, as purely altruistic people do not exclude (selfish) firm members by nature.[8] In doing so, the group performance shrinks. Purely altruistic firms become altruistic firms with few selfish members in the course of time. Purely selfish firms and altruistic ones with many selfish members have low group performances. At the same time, the selfish firm members enjoy little costs and some benefits. Firms with many altruistic and few selfish members will win the race in market evolution according to the theory of genetic group selection (between-firm and within-firm selection forces work in the same direction and contribute to the firm success, see also last paragraph), the other three firm types may be outcompeted (both selection forces work opposingly). Since this is a race of firm success, rather than a struggle of survival, we realize competition among firms is an analogy construction to the biological sphere by applying genetic group selection.

[8] We do not refer to the term "altruistic punishment" (Henrich, 2004). Rather, altruistic agents tolerate opportunism. Just egoistic agents punish opportunistic ones (see also Johnson et al., 2013).

Using Darwinian logic involving genetic group selection to describe competition among firms, struggling for success, is most realistic as compared to the explanations expounding competition with solely naïve group or solely individual selection. There are, indeed, both economic actors in the long run, altruistic and selfish ones. Genetic group selection is an evolutionary force that leads to both altruism and selfishness. This theory helps us to understand, why some firms characterized by both behavior types persist, others characterized by solely one type do not. In the real word, in addition, competition is not only characterized by human behavior, but also by culture, e.g., knowledge. It is, thus, necessary to consider other evolutionary forces which explain the emergence of culture.

3. Naturalistic approach

While *Darwinian thinking* is always necessary to explain complex evolving population systems, it is never sufficient on its own (Hodgson and Knudsen, 2006). That is why the *naturalistic approach* should be taken into account (Cordes, 2015). We earlier analyzed competition among firms by using analogy constructions to the biological sphere. Later, considering the continuity hypothesis as one[9] naturalistic endeavor (Witt, 2003, 2004), differences to the biological sphere can be revealed (Cordes, 2006, 2015). Also, we point out competition among firms is a form of cultural group selection. First, we show what cultural group selection is. Second, it is analyzed, how this kind of selection matters in gene-culture coevolution. The first and second point result into third, the continuity hypothesis, exposing differences to the biological sphere and an interpretation of economic evolution.

3.1 Cultural group selection

To focus on other characteristics of competition among firms, cultural group selection is taken into account. Here, we do not focus on selection processes acting on genes anymore, e.g., human

[9] There are also other naturalistic approaches (see Cordes, 2015). For instance, Hayek (1973) investigates the evolution of institutions.

behavior. Rather, we focus on selection processes acting on culture, e.g., knowledge, ideas, or belief[10] (e.g., Boyd and Richerson, 1988; Henrich, 2004; Richerson and Boyd, 2008; van den Bergh and Gowdy, 2009). This kind of selection, like genetic group selection, is also a multilevel selection approach. Cultural group selection is an appropriate approach to investigate dynamic economic phenomena between and within firms. Some firms are more successful in the long run, others less. What is more, some workers within firms have more success than other workers. The entities, selection is working on, are the firms as well as the firm members. Each firm is viewed, analogously to social organisms living in groups competing for reproductive success, as one group of individuals racing with other firms for economic success. But now, we do not compare competition among firms to the biological sphere or genetics. For instance, natural selection acting on human behavior codified in genes. We compare competition to the cultural sphere. That is, we focus on knowledge and cultural selection processes. Cultural group selection occurs in social organisms' evolutionary history and are captured by the *naturalistic approach*.

What is cultural group selection? Evolutionary concepts provide insights as to the development of culture, e.g., knowledge (A and B). Knowledge is embodied by individuals. Furthermore, in social species, individuals live in groups. Within a given pool of different groups there might be different types of culture embodied by different individuals. Some individuals are aware of knowledge A, others are aware of knowledge B. Furthermore, some groups possess knowledge A, other groups are characterized by knowledge B. So, cultural variation within a population of groups occurs. Cultural group selection favors traits with higher probabilities to be transmitted and neglects those with disadvantage in transmission processes. The probability of knowledge transmission depends upon survival of groups. Knowledge A ("How to construct sharp weapons.") may be beneficial regarding fights with conspecific groups or predators. Moreover, it might lead to achieving a huge amount of food. This gives rise to higher probabilities to survive and knowledge A might be transmitted with higher rates to other individuals. Knowledge B ("How to construct blunt weapons."), however, reduce the chance of group survival. Hence, knowledge A may persist and knowledge B disappear, following selection processes only working between groups. Since cultural group selection is a multilevel selection approach, like genetic group selection, there are also within-group selection processes. Sharp

[10] Another dimension of culture could also be human behavior (Richerson and Boyd, 1984). Human behavior is genetically and culturally selected. Not to confuse things, we mainly take knowledge as example for culture, rather than human behavior.

weapons may lead to lower group-survival chances for individual-selection reasons: harsh combats inside the group reduce group-level performances at the same time due to injured individuals. Similar to genetic group selection, cultural group selection may lead to a stable coexistence of knowledge A and knowledge B by investigating four different types of groups (see last section). This is especially true, if there are between-group and within-group selection processes leading to opposing group-level outcomes (e.g., group success due to between-group selection and group failure due to within-group selection at the same time). Knowledge A and B invoke opposing outcomes in three out of four cases. However, if selection processes act on knowledge C ("How to cook raw food.") and D ("Eat the raw food without cooking."), there are no opposing outcomes. C results into positive group performances for both between-group and within-group selection reasons. D results into negative group performances for both between-group and within-group selection reasons. In four out of four cases, there are no opposing group-level outcomes. So, in the course of time, C may persist, and D tends to disappear. There is no coexistence of C and D in the long run. This multilevel selection approach has been shown, in order to describe the characteristics of competition not comparing to selection processes acting on genes, but to selection processes acting on culture.

Now, we apply cultural group selection to competition between firms. Unlike in the last three sections where market competition is an analogy construction to the biological sphere, market competition is an analogy construction to the cultural sphere instead.[11] At the beginning of and in the short run during the economic evolution, we have different types of culture, e.g. knowledge (A and B), embodied by different firm members within different firms. Some workers are aware of knowledge A ("How to acquire customers."), others are characterized by variant B ("Not knowing, how to acquire customers."). Some firms have more A-workers, others more B-workers. These variations may occur in a population with different types of firms. In the course of time, however, via cultural group selection a certain kind of knowledge may be more favored than others and persist. The persistence of knowledge depends upon the success of the firm. Firms with A-workers know how to acquire customers and are more successful. With more customers, the probability is higher to get more market share, profits, and capital. Firms with B-workers are not aware of getting customers. The firm success might be reduced. In the long run,

[11] Later it is argued that competition among firms is not an analogy construction to the cultural sphere. Rather, competition among firms is a form of cultural group selection.

firms with A-workers persist and firms with B-workers will be outcompeted (group-selection argument). A-workers have more human capital, which leads to income. At the same time, knowledge A contributes to the firm success. Firms are not interested in B-workers, leading to firm exclusion and no income for B-workers. B-workers would lower firm success, if they would not be excluded. In the long run, A-workers get income and persist and B-workers do not and disappear (individual-selection argument). Group-level and individual-level selection processes working on knowledge A and B invoke the same group-level outcomes (group selection and individual selection induce either firm success or firm failure). Both selection processes work in the same direction, leading to the persistence of knowledge A and disappearance of knowledge B, by applying the cultural group selection approach. It is possible that different selection processes working on knowledge C and D lead to opposing outcomes (see also the example with "How to construct sharp weapons." and "How to construct blunt weapons" from the last paragraph). In that case, there is a certain chance of a stable coexistence of knowledge C and D. Since this is a race of success, rather than a struggle of survival through culture in the past of human's history, we realize, competition among firms is an analogy construction to the cultural sphere.

Applying cultural group selection to describe market competition is a realistic way to analyze dynamic phenomena among economic actors. In fact, economic change is not only depending upon human behavior, but also on knowledge. Cultural group selection is an evolutionary force that leads to a multilevel emergence of knowledge. This theory helps us to understand, why some firms characterized by knowledge A are more successful than others that are solely aware of knowledge B. And whether there is an coexistence of both knowledge A and B. In the real word, however, competition among firms is not only characterized by either human behavior or knowledge seperately, it is characterized by human behavior and knowledge at the same time. Thus, we consider another evolutionary force which explains the emergence of both genes and culture.

3.2 Gene-culture coevolution

To combine the characteristics of competition among firms, expounded by the previous four Sections 2.1 to 3.1, gene-culture coevolution is taken into account. Here, we do not focus on selection processes acting on either genes or culture anymore. Rather, we focus on selection

processes acting on genes and culture at the same time (Boyd and Richerson, 1988; Richerson and Boyd, 2008; Boyd and Richerson, 2009). Gene-culture coevolution is, like genetic and cultural group selection, a multilevel approach, being another possible approach to examine dynamic economic phenomena between and within firms. Some firms are more successful in the long run, others less. Furthermore, some workers within firms have more success than other workers. The entities, selection is working on, are the firms as well as the firm members. Each firm is viewed, analogously to social organisms living in groups competing for reproductive success, as one group of individuals racing with other firms for economic success. But now, we do not compare competition among firms either to the biological sphere or to the cultural sphere. We compare competition to the biological-cultural sphere instead. That is, we focus on human behavior and knowledge at the same time. Gene-culture coevolution occurs in social organisms' evolutionary history and is captured by the *naturalistic approach*.

Let us have a simplified look at gene-culture coevolution. Evolutionary concepts provide insights as to the development of traits (altruism versus selfishness) codified in genes interacting with the development of culture, e.g., knowledge (A and B). Traits and knowledge are embodied by individuals that live in groups. After a variation-selection-inheritance algorithm, also utilized in each of the earlier sections, there could be a gene-culture-constellation to persist and other constellations disappear in the course of time. A coexistence of at least two different gene-culture constellations is also possible. Which genes and which culture as to their frequencies are stable, in the long run, depends upon whether selection processes at the group level and selection processes at the individual level lead to opposing outcomes (group success versus group failure, see also the two previous sections). This, in turn, depends upon how knowledge A and knowledge B are exactly defined, because within this gene-culture-coevolution approach, it matters what the gene-culture combination is. While in Section 2.3, predominantly altruistic groups with some few selfish members persist, and while in Section 3.1, "How to cook raw food." persists in the whole population, we have slightly other outcomes now. Although gene-culture coevolution is also a multilevel approach, like in Sections 2.3 and 3.1, "How to cook raw food." is not a stable outcome in the whole population anymore. Due to the fact that gene selection processes give rise to altruistic groups with some selfish members inside the group, some of the individuals in the population do not know "How to cook raw food." Few selfish individuals inside the altruistic groups are not aware of this knowledge and prefer to free-ride

with less costs by taking food from their altruistic group members, lowering the frequency of the trait “How to cook raw food.” as compared to the case solely focusing on cultural selection processes, where “How to cook raw food.” persists in the whole population. Other examples of this gene-culture interaction are given by Richerson and Boyd (2008). They describe how the culture “Drinking milk.” influences genetics. Most people cannot tolerate milk, but in the course of time more and more people genetically get the enzyme necessary to digest lactose. The opposite is also true: the authors describe the omnipresent trait “Feeling pain.” encoded in genes influences culture. “Because our heads are rich in pain sensing neurons we tend to raise door jams high enough not to bump into them.” This multilevel approach has been shown, in order to describe the characteristics of economic competition comparing to simultaneous selection processes on genes and on culture in the next step.

What are the characteristics of competition between firms when applying gene-culture coevolution. Whereas, in the last sections, market competition is an analogy construction to either the biological or cultural sphere, now, market competition is an analogy construction to the biological-cultural sphere instead. At the beginning of economic evolution and in the short run, we have different types of human behavior (altruism versus selfishness) and different types of knowledge (A and B), embodied by different firm members within different firms. After a variation-selection-inheritance algorithm, there could be a constellation combined by human behavior and knowledge to persist and other constellations disappear in the course of time. A persistence of at least two different behavior-knowledge constellations is also possible. The persistence depends upon the success of the firms. Using genetic group selection, altruistic firms with few selfish members may persist. Altruistic workers contribute to the firm success and few selfish bosses contribute to the firm success as well by excluding selfish workers (see Section 2.3). Using cultural group selection, knowledge A (“How to acquire customers.”) persists and knowledge B (“Not knowing, how to acquire customers.”) disappears in the whole population of firms (see Section 3.1). However, applying gene-culture evolution knowledge B may persist to a certain extent. Some few selfish members do not know how to acquire customers. To use the same example, some selfish bosses do not acquire customers, they contribute to firm success by monitoring the firm members and excluding other selfish workers. In the long run, knowledge A is not dissimilated in the whole population anymore as predicted by cultural group selection. We focused on a race of firm success, rather than on a struggle of group survival influenced by genes

and culture. That is why competition among firms is an analogy construction to the biological-cultural sphere by applying gene-culture coevolution.

Using gene-culture coevolution, precisely simultaneous gene-culture-selection processes inside this theory, to describe market competition is an appropriate, but complex, way to analyze dynamic phenomena among economic actors. Indeed, economic change is not only depending upon human behavior or knowledge, it is depending on both at the same time. Gene-culture evolution is an evolutionary force that leads to a multilevel emergence of human behavior and knowledge. This theory helps us to understand, why some firms are more successful, and others not, embodying certain traits or not. Up to know, characteristics of economic competition have been analyzed with the help of analogy constructions to something, i.e., biological, cultural, or biological-cultural sphere. Market competition might be well described by analogy constructions to something or other, however, it is not necessary using analogy constructions.

3.3. Continuity hypothesis

The characteristics of competition in economic evolution may be best explained with the help of the continuity hypothesis (Witt, 2003, 2004; Cordes, 2006, 2015). While market competition was described with analogy constructions to the biological, biological-cultural, and cultural sphere in the earlier sections, this section explains market competition without analogy constructions. According to the continuity hypothesis, economic evolution is a form of cultural evolution. We follow this logic and deduct, as quintessence of this paper, economic competition among firms is a form of cultural group selection. Being a purely cultural phenomenon, economic competition differs to biological(-cultural) phenomena where Darwin's natural selection matters. The continuity hypothesis is an original concept and can be assigned to the *naturalistic approach*.

Table 2: Continuity hypothesis.

Stage of human's evolutionary history (early to late)	Evolutionary forces	Evolution of genes	Evolution of culture
(I) Biological sphere	Genetic evolution	Yes	No
(II) Biological sphere	Gene-culture coevolution	More	Less
(III) Biological sphere	Gene-culture coevolution	Similar	Similar
(IV) Biological sphere	Gene-culture coevolution	Less	More
(V) Cultural sphere	Cultural evolution	No	Yes

Table 2 illustrates the continuity hypothesis and five different stages in human's evolutionary history, characterized by different evolutionary forces. During Stage (I) to (IV), representing the biological sphere, there is a struggle of survival and natural (Darwinian) selection mediates the information transmission of genes and culture. In Stage (I), culture plays no role: the earliest ancestors of human beings were not living in social groups. At some point in time, from Stage (II) on, humans' ancestors evolved culture, leading to living in social groups, this, in turn, gives rise to more relative reproductive success. At another point in time, Stage (V) representing the cultural sphere that is characterized by no struggle of survival, Darwinian evolutionary theory, especially natural selection, lost its power to explain human behavior (Cordes, 2015). Still, human behavior can be culturally selected, as mentioned earlier, but human behavior is not genetically selected anymore according to the continuity hypothesis. In short, after a period of gene-culture coevolution, "the human species is a result of natural (Darwinian) evolution; biological evolution has shaped the ground and still defines the constraints for human-made, or cultural, evolution." Moreover, Darwin's variation-selection-retention algorithm holds true for the biological evolution (Stage (I) to Stage (IV)), but not for cultural evolution (Stage (V)). In the biological sphere, variation occurs due to accidental events such as mutation or recombination, natural selection is an a posteriori phenomenon (Darwin, 1859; Lewontin, 1970; Mayr, 1991; Cordes, 2006), and retention mechanisms are relatively slow as well as inert via DNA inheritance. In the cultural sphere, however, variation does not occur by accidence (Cordes, 2006). Variants are the results of deliberate search for improvement conducted by individuals. Cultural selection processes do not occur a posteriori (after having a pool of variation). Rather, cultural selection processes happen, in between, during individuals' deliberate creation of variation. Cultural retention mechanisms are fairly fast and the transmission does not take place via DNA inheritance, but via social learning (Boyd and Richerson, 2009). Social learning can be inaccurate, at least it is not that accurate as compared to the natural copying process of DNA. The continuity hypothesis and the differences between the biological and cultural sphere has been introduced, in order to incorporate these findings to the case of economic competition among firms.

Now, we use the continuity hypothesis to explain competition between firms. Our starting point is Stage (V), since economic evolution can be interpreted as cultural and "man-made" (Witt, 2004) or "human-made" (Cordes, 2007) evolution. At the beginning of market evolution

and in the short run, economic actors deliberately create a variation of culture, e.g., knowledge[12] (A and B). Some firm members are aware of knowledge A ("How to acquire customers."), others of knowledge B ("How to reduce costs."). Some firms have more A-workers, others more B-workers. The variation does not occur by accidence and reflects different ways of improvement, how to higher firm success. In the biological sphere, variation occurs accidentally. This knowledge creation is an ability of human beings based on genetically adapted human brains and human behavior constructed by Darwin's natural selection in Stage (I) to (IV). Human behavior was naturally selected, leading to reproductive success. Within firms and nowadays (Stage (V)), human behavior is also selected, but there is no pressure on genetic reproductive success; economic behavior is culturally selected, leading to relative firm success (e.g., market share). As these economic selection processes occur at multiple levels (firms and workers), competition among firms is a form of cultural group selection (see also Section 3.1). Cultural group selection already happens during the variation (creation) processes. Firms and individuals run a business with *selected* non-accidental knowledge, even at the very beginning or in the short run of market evolution. Some variants will be "inherited", others not. Which variants persist and which disappear depends on the firm success. It is possible to have a stable coexistence of knowledge A and B. Depending on the economic environment, it is also possible just to have only one variant in the long run. In some markets, it is beneficial to acquire a huge amount of customers, in other markets, it is important to lower costs. Via social learning, the "inheritance" of beneficial knowledge, culture can actively be adapted to economic environments by firms or individuals. In the biological sphere, genes cannot actively be adapted to the natural environment by groups or individuals. This economic evolution is fundamentally different to the Darwinian biological sphere. Rejecting analogy constructions to the biological sphere, economic evolution is a form of cultural evolution according to the continuity hypothesis, and, following this logic, economic competition among firms is a form of cultural group selection.

Using the continuity hypothesis to describe market competition is the most appropriate way to analyze dynamic phenomena among economic actors, in our point of view. Plausibly, economic evolution is a man-made evolution, describing the characteristics of firm success, rather than depending on natural selection pressure leading to reproductive success. Using an analogy

[12] Human behavior does play a role and can be interpreted as a dimension of culture (Richerson and Boyd, 1984). In order to analyze the culture-culture interaction combined by human behavior (altruism versus selfishness) and knowledge (A and B), we can technically use the same patterns introduced in Section 3.2.

construction is less appropriate, because the differences of cultural evolution to biological evolution are essential. Variation is deliberate, rather than accidental. Selection occurs during the variation stage, not a posteriori. Transmission is fast and traits can actively be adapted by the entities, rather than via inert DNA without active adaptation by the entities. Following the findings from this section, competition among firms is a form of cultural group selection.

4. Conclusions

Competition between firms is a crucial economic dynamic phenomenon. Some firms may become more successful in the course of time, other firms less. In order to investigate dynamic processes, it is suitable to take on an evolutionary perspective, using evolutionary concepts and inspired by evolutionary theory from biology. This paper has characterized economic competition with the help of different types of selection, social organisms had to face in evolutionary history. In fact, there are differences between economic competition and the biological sphere. We also have revealed these differences.

Competition among firms can be characterized by five forms of selection, considering economic change as analogy constructions to the biological, cultural, and biological-cultural sphere. Assuming firms as individuals, individual selection describes how some firms become more successful, others not, when time goes by. However, firms are not individuals, they are groups of individuals. Supposing firms as groups of individuals, naïve group selection characterizes economic competition more realistically. If we investigate the characteristics of competition between firms, it is also important to involve the competition dynamics within the firm, i.e., competition between individuals inside the firm at the same time. Genetic group selection combines the patterns of naïve group selection and individual selection, characterizing how some firms become more successful and others not, as well as how some workers inside the firm become more successful, other workers less. Up to here, we compare competition among firms to the biological sphere, but in the evolutionary history of social organisms, information is not only biologically transmitted, but also culturally. By using an analogy to the cultural sphere, we characterize competition among firms with cultural group selection. Cultural group selection

does not capture biologically transmitted information. Thus, we compare competition with the biological-cultural sphere, taking selection processes during gene-culture coevolution, social organisms had to face in evolutionary history, into account.

Economic competition's differences to the biological sphere are exposed by means of the continuity hypothesis. The continuity hypothesis separates evolutionary history of humans into two different periods. First, humans struggled for relative reproductive success and faced Darwin's natural selection processes which mediated information transmission of genes and culture. To use the terminology of the last paragraph, this is the biological (and biological-cultural) sphere. Second, humans do not struggle for relative reproductive success anymore. They struggle for cultural success where survival has not mattered. According to the continuity hypothesis, biological evolution has shaped the ground and still defines the constraints for human-made, or cultural, evolution (Cordes, 2015). Economic evolution is a form of human-made, or cultural, evolution, where struggle for survival does not play any role. Following this logic, economic competition among firms is a form of cultural group selection, not merely an analogy construction to the biological or cultural sphere. What are the differences between the biological and cultural sphere? In biological evolution, variation occurs by accidence, natural selection takes place a posteriori after the occurrence of variation, inheritance is slow and inert via DNA transmission. By contrast, in cultural and economic evolution, variation occurs deliberately and is positively biased, i.e., individuals are looking for improvement actively, rather than for worst variants accidentally. Cultural group selection takes place during the occurrence of variation, not after the appearance of variation. "Inheritance" of culture is fast, but the transmission process is sometimes inaccurate, via social learning.

This paper analyzes the emergence of firm success from a phylogenetic perspective. Emphasizing on selection processes, we have also taken external environmental factors into account, such as competitors and customers outside the firm. An analysis of the emergence of firm success from an ontogenetic perspective will be of outstanding interest. It should be emphasized on learning processes and internal developmental factors should be taken into account, such as individual learning, social learning, imitation, and coordination abilities inside the firm.

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