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Economic and Social Sustainability: The Influence of Oligopolies on Inequality and Growth

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Abstract: To realize economic and social sustainability, it is necessary to avoid economic injustice and therefore too unequal a distribution of income and wealth. In this paper we investigate the extent to which oligopolies contribute to an unequal income distribution, and the consequences of enforcing more market competition. For this purpose, an overlapping generation growth model is developed with imperfect competition to derive the influence of market concentration on economic growth and the distribution of income. We investigate the influence of market concentration on the inter- and intra-generational distribution of income and economic growth. We show that political lobbying and corruption are important reasons for missing competition in markets. While an increasing market concentration leads to a more unequal intra-generational distribution and to a redistribution of income from the old to the young generation, the impact on economic growth is in general ambiguous, and specifically depends on the cost of lobbying.

Keywords: economic and social sustainability**;** oligopoly; economic growth; inequality; lobbying; bribing; political economy

1. Introduction

As we know "sustainability economics" is ethically founded in the idea of efficiency, that is non-wastefulness, in the use of scarce resources for achieving the two normative goals of (1) the satisfaction of the needs and wants of individual humans and (2) justice, including justice between humans of present and future generations and justice towards nature, in the setting of human–nature relationships over the long-term and inherently uncertain future" ([1], p. 447). As manifested in the literature [1], economic inequality and economic growth influence the efforts and willingness of countries to protect the environment [1–3]. The desire to realize environmental sustainability requires simultaneously the realization of economic and social sustainability. If the two latter dimensions of sustainability are ignored, then environmental sustainability can become an unimportant objective. Most environmental problems are caused by externalities or results from the fact that environmental goods are common or public goods (climate, fish stocks in oceans). Thus, the market cannot resolve these problems, and also government interventions are limited by national borders, so that it is necessary to organize a social and economic environment in which the willingness to cooperate in societies and between societies is strong. In particular, if we take into account that, for example, climate change is an intergenerational problem in the sense that the main burden of a changed climate has to be borne by following generations, it is difficult in a democracy for policy makers to convince voters to sacrifice part of their income for the environment if the majority of voters are convinced that the share of the economy's value added they receive is unfairly small.

A good example to highlight this point is the evolution of the yellow vests movement (gilets jaunes) in France, which begun to evolve as a consequence of the government plan to increase fuel taxes, where the resulting tax revenue should be used to meet ecological objectives of the French government. The supporters of the movement, who in majority earn less than the French mean income oppose the increase of the fuel tax because they feel they are being treated unfairly in general and they have the impression that they shall bear additionally the costs associated with the government's climate objectives. However, the protests were associated with a lot of violence and the government revoked the plan to increase the fuel taxes. In some sense these events were not surprising, because fuel taxes like many other environmental taxes have a regressive effect. This means poor people are relatively more affected by a tax on energy than rich people, because the share of income that the poor spend for energy exceeds the share of income that the rich spend for energy. In general, income and wealth distribution that is too unequal causes social unrest, as can be observed in many countries (https://www.theguardian.com/commentisfree/2020/jan/24/most-political-unrest-has-one-big-root-cause-soaring-inequality) and social unrest is incompatible with the societal objective to realize ecological sustainability, because the latter objective requires the willingness of citizens to cooperate at national and international levels.

In particular, social injustice and economic inequality can be seen as a major obstacle to realize environmental sustainability, because the latter requires the cooperation of citizens, and the willingness to cooperate depends strongly on whether citizens feel that they are treated fairly [4,5]. From [6] it becomes clear that, all other things being equal, citizens in countries with a relatively equal distribution of income are happier than citizens in countries with a relatively unequal distribution of income. That does not mean that absolute income has no influence on happiness, however, generally people living in richer countries are happier than people living in poorer countries. The relationship between happiness or well-being and absolute standard of living and relative living standard remains an unresolved area of interest [7–9]. Nevertheless, it is clear that inequality causes negative effects, for example a high degree of income and wealth inequality is associated with high crime rates [10].

Economic growth is necessary to finance the transition from current environmentally unsustainable societies to environmentally sustainable societies. It should be noted that economic growth and environmental sustainability are in principle compatible. Furthermore, the relationship between growth and inequality can be decisive in creating a stable and hence sustainable society.

Therefore, in this paper we focus on an economic model to investigate one of the main causes of economic and social inequality, which is market power.

It is well recognized in the literature [11–21] that the labor income share has declined in most countries in the last four decades. For example, van Reenen and Patterson [21] estimate that the decline in Austria was 9 percentage points between 1975 and 2010, in Finland 8%, in France 14%, in Germany 7%, in Italy 10%, in Japan 12%, in the Netherlands 10%, in Spain 6%, in the UK 3%, and in the USA 6%. These results indicate that income and wealth inequality has increased strongly as recognized by Piketty [15]. From the fact that the labor income share has declined most economists assume that the capital income share has increased, because both shares have to add up to one. Only Barkai [19], Barkai and Benzell [20] and Karabarbounis and Neiman [14] estimated also the capital income shares with the surprising result that the decline of the labor share was not compensated by a change of the capital share. While [14] defines the gap as factorless income share, [19,20] define the gap as profit income share, which has increased in the last 40 years. Perhaps it should be noted that usually profits are assumed to be zero in the long run in mainstream economics. The simple reason is that competition allows only short-run profits, which will vanish with entry of new firms in the market in the long run. Accordingly, most economic models, particularly growth models, do not contain any profits. In contrast, Barkai's [19] results suggest that the profit share increased from 2.5% in 1984 to 15% in 2014, and that the profit per worker in the USA has increased by $14,000 between 1984 and 2014, where the median income in 2014 was $28,000 (see: https://promarket.org/connection-market-concentration-rise-inequality/). Usually, in most growth models, perfect competition is assumed (Solow [22], Diamond [23], Romer [24,25], Mankiw et al. [26]), which implies that all economic subjects are price takers and that marginal cost pricing holds. In the models with

monopolistic competition like Romer's [27], the profits are only covering the fixed costs of production hence average cost-pricing is applied in the sector with monopolistic competition. Thus, to the best of our knowledge, there are no growth models within a neoclassical framework, which allows for positive profits in the long run. The only model which has such a feature is the static macroeconomic model of Mankiw [28].

Positive profits can only be realized if firms are able to set a price which exceeds the marginal costs and in the case of fixed costs, the average costs. However, this implies that firms have a degree of market power, which is possible if the number of firms acting in a market is limited. However, the effects of market concentration regarding allocative efficiency are clear and it is in general assumed that market power has a negative impact on economic growth.

The main focus of the paper is to develop a model to investigate the relationship between imperfect competition, inequality and economic growth.

To the best of our knowledge, there is no unique growth model in the literature that considers imperfect competition. Moreover, the existing growth models with imperfect competition are not comparable to the most prominent growth models with perfect competition [22,23,26,29]. Thus, in this study, we aim to develop a suitable model with imperfect competition using the overlapping generations (OLG) framework [23]. Since Romer's [27] growth model with intermediate goods, the consideration of monopolistic competition is well established in growth theory. The main feature of the model is the production function, which is linear in the variety of intermediate goods. An extension of this approach is the model of Peretto [30], which has an endogenous market structure. The disadvantage of models with monopolistic competition is that the price-markups are exclusively determined by the production technology. An exception is the model of Melitz and Ottaviano [31], in which the mark-up is flexible, but it requires a very specific utility function to derive results. We develop an endogenous growth model with oligopolistic competition which is tractable and comparable with the usual growth model. In particular, on the production side we use the AK model of Rebelo [32], which is a simplified version of [24,25]. In this kind of endogenous growth model, capital accumulation is the driver of growth. Our model integrates a Cournot oligopoly, in which the firms compete in quantities.

The rest of the paper is organized as follows. In the next section, we give an overview of the existing literature on the relationship between market power, economic growth and distribution of income and wealth. In Section 3, we introduce our model and explain the relationship between imperfect competition and economic growth. In Section 4 we investigate in the development of the model economy; in Section 5 we discuss the results and its relation to sustainability in general. In the last section, we conclude.

2. Literature Review

Schumpeter [33] argues that firms with market power are the most important source for economic progress, because only large profitable firms are able to finance large research and development (R&D) budgets. Therefore, the well-known Schumpeterian hypothesis is that larger firms are superior at creating innovations compared to small firms. This argument is theoretically and empirically supported by some studies [34,35]. On the other hand, some scholars provide an opposing view [36,37]; they argue that competition increases the incentive to create innovations. In between these two arguments, some scholars [38–40] contend that the relationship between innovation or growth and market concentration is an inverted U-shaped relationship.

The focus on market concentration, its consequences on markups and issues in antitrust, have gained much attention in the recent time, for instance by [41–57]. A precondition for perfect competition is the free market entry and costless market exit for all potential competitors. In reality, we observe in general the opposite, that most markets are characterized by barriers to entry.

From a historical point of view, barriers to entry were nearly omnipresent. According to Ogilvie [58] and Ogilvie and Carus [59], guilds existed since ancient times more or less in all societies around the world. They state that guilds were responsible for competition and market structure, security and contract enforcement, quality standards, human capital investments and technological innovations.

What is important is that the guilds had the right to decide on who could join them. Not surprisingly, Adam Smith ([60], Book I, Chapter X) characterizes guilds as a conspiracy against the public. The legal rights and economic rents of guilds were guaranteed by rulers and in return the latter received payments or other favors from the members of the guilds.

Noting the complex task of defining barriers to entry, Demsetz [61] compares the early definitions of entry barriers of Bain [62], Ferguson [63] and Stigler [64]. Karakaya [65] carries out a survey on 93 US firms to examine the existence of different types of entry barrier and their relative importance. While in the USA, mostly technological or economic barriers like 'absolute cost advantage held by incumbent firms', 'capital requirements to enter the market' or 'amount of sunk cost involved in entering the market' are recognized as important barriers to entry, Djankov [66] emphasizes the role of barriers to entry which are created by governments. The reasons for such barriers are manifold.

On the one hand, Pigou [67] argues that governments regulate market entry to avoid the occurrence of bad quality products or services offered by undesirable sellers. An example is that in most countries only physicians who received a degree in medicine from an approved university are allowed to offer healthcare services in hospitals and clinics.

On the other hand, researchers advancing public choice theory like Stigler [68] argue that regulation is acquired by market incumbents to operate for their profits. Some authors [69,70] state that political power is in the hands of major producers who erect barriers to entry, to protect them against new market entrants. Similarly, others [71,72] argue that regulations are erected by policymakers who enable participants to share economic rents with the firms via channels like campaign contributions and bribes.

Empirical studies on the barriers to entry [73–81] find that reducing the barriers to entry increase the number of market entrants and startups. However, the entry rate does not provide information about the subsequent higher productivity and growth. These studies seem to indicate that low barriers to entry are associated with a high industry turnover (number of entries and exits are related to the total number of firms). Nevertheless, this is not the case if we consider the data from the World Bank's Doing Business ranking against entry rates. Furthermore, Cabral [82] confirms empirically that entry and exit are not a good indicator for policy success.

The studies that estimate whether barriers to entry reduce productivity and growth remain inconclusive. For example, a case study [83] finds that the collapse of the US sugar cartel resulted in a 35% increase in the productivity in the sugar industry. Djankov et al. [84] show empirically, that regulation, including barriers to entry, is an obstacle for economic growth. In contrast, Mahmood and Lee [74] show that too high and too low barriers to entry can be harmful to innovation, thus implying the presence of a threshold for barriers to entry. The underlying reasoning is that the evolution of business groups like chaebols (Korea) or keiretsus (Japan) made it possible to finance high research and development and other investment expenditures, which are difficult to be financed by firms engaged in atomistic competition. Hence, the relationship between market concentration and innovation is an inverted U-shape function [38–40]. Moreover, some authors [18,85–87] support the argument that increasing market concentration may enhance productivity growth.

Another critical point from these studies on trade barriers is that, usually barriers to entry data are generated from the Doing Business database of the World Bank. The intention of the founders of Doing Business was to compile an internationally comparable data set, which can be used for the purposes of comparison. Hence, country-specific regulations, which are irrelevant for the assumed representative firm, are not represented in the data. For example, in Germany regarding 41 professions (from 2020, 53 professions are affected, whereas there were 94 professions until 2004), it is required from an individual to be a master in a specific craft to open a business in the respective field. The costs to become a master account to 10–20% of the GDP per capita and it takes 3 years of schooling. On aggregate, all crafts contribute around 16% to German GDP. Many other professions in Germany are affected by similar or stricter regulations (e.g., pharmacies, legal services, tax consultants, architects, banks and auditors). Another example for a barrier of entry which is not considered by the World Bank data is the exclusion of foreign firms from a market because of so

called "national security" issues like in the case of Huawei and the market for 5G in the USA or Australia. Furthermore, patents, copyrights or more general intellectual property rights, are not considered in the data, although they are barriers to entry. This means the data of the World Bank may underestimate the reality.

Maybe the most recent idea, to explain the increasing market concentration in the USA with the so called 'superstar firm' [18], which results from a winner-takes-all/most competition for the market. Examples for these superstar firms are Google, Uber, Facebook, AirBnB, Twitter, Apple or Microsoft. This phenomenon evolves with the occurrence of network externalities—the consumer experiences an increasing utility of a product with an increasing number of other consumers using or buying the product. In principle, the barrier to entry is the number of customers/users of the incumbents. If a market entrant is not able to catch-up immediately in this respect, the probability to survive in the market is close to zero.

To summarize the existing literature on market barriers, market concentration and growth we can state that higher barriers to entry lead to greater market concentration. Moreover, it is ambiguous if greater market concentration has a growth-retarding or growth-enhancing effect.

In addition to economic barriers to entry like economies of scale, network externalities and the like, many barriers to entry are an outcome of political decisions [88,89]. The work of [69] differentiated between an oligarchic society, where major producers have the political power to establish significant barriers to entry to deter market entrants, and a democracy where political power is more diffused and redistributive taxes, but no barriers to entry are in use. According to this idea, it is ex ante unclear which political system in terms of economic development is superior. The reason is both tax rates that are too high and barriers to entry that are too high have a growth-retarding effect. Thus, countries like Japan, Korea or China would be in the category of oligarchic societies because of the connectedness between politics and business.

In [61] it is argued that in the medium and long run only legally enforced barriers to entry (patents, taxi medallions and the like) are meaningful. Zingales [88] argues that firms with market power try to protect themselves against competitors by a mixture of innovating and lobbying, in particular, leading to a "Medici vicious circle", which means that resources are used to obtain political power and the political power is used to increase profits.

An empirical study [19] shows that the profit share in the USA has increased dramatically in the last 30 years and, therefore, capital and labor shares have fallen. In view of the author these changes could only be caused by an increase of the market power of firms. Other empirical studies [90,91] arrive at the same conclusion, that market power has a negative impact on the distribution of income and wealth. In particular, [90] which considers the USA, UK, Canada, Germany, Korea, Japan, France and Spain, concludes that on average, the wealth of the 10% richest of the population has increased by 12–21% through market power, while on average the income of the 20% poorest has depressed by 14–19%. According to this study, the excess mark-up is highest in Germany and Korea, and is lowest in the UK and USA. That such significant price mark-ups are usual in Organization for Economic Cooperation and Development (OECD) countries is also confirmed by Høj et al. [92] who estimate that the mark-up in the manufacturing sector ranges between 7% (Luxembourg) and 15% (Italy), while in the non-manufacturing sector it ranges between 17% (UK) and 38% (Italy).

From the studies above it becomes clear that the assumption of perfect competitive markets, which is made in the vast majority of economic models in neoclassical or mainstream economics is questionable. It seems to be more realistic to assume the presence of oligopolies, which have market power, where the latter is derived from the political influence of firms [69,88,89,93–96].

In oligopolistic competition, three different main approaches exist, which lead to different outcomes. Generally, the market outcome depends on whether firms compete on quantities (Cournot [97] competition) or on prices (Bertrand [98] competition). Additionally, the outcomes depend on whether firms make their decisions simultaneously (Cournot [97] and Bertrand [98] competition) or sequentially as in a Stackelberg [99] duopoly, with a leader and follower. Since there is no consensus on which model is the most appropriate, Tirole [100] or Pepall et al. [101] recommend using the approach which is most appropriate in the specific context. Considering that we refer to the corn

parable (see Section 3.1 below), it seems appropriate to use the Cournot [97] approach. Typically, to analyze oligopoly models, game theory is used and, therefore, the market equilibrium in the Cournot model [97] is called the Cournot–Nash equilibrium. While Cournot investigated originally in a symmetric duopoly setting, we find in several textbooks an extension to n firm oligopoly [100] and the consideration of non-symmetric firms (for example [101–105]). Kopel [106] has investigated the adjustment dynamics of the Cournot oligopoly and, using specific costs functions, he concludes that the stability of the Cournot–Nash equilibrium is questionable. In [107] a dynamic Cournot model is analyzed to derive Markov perfect equilibrium. In our study, we use the simplest version of the model, which implicitly uses in every period a static Cournot game with linear costs and without fixed costs. Regarding Bertrand [98] price competition, which results in marginal cost pricing, it can be argued, that this outcome is only justified if each firm has the capacity to serve the whole market at the marginal cost price. However, in a duopoly setting, this would mean that only 50% of the capacity is in use in the Bertrand–Nash equilibrium. Because of this obvious inefficiency, Edgeworth [108] was the first to investigate Bertrand competition with capacity constraints. Kreps and Scheinkman [109] have proposed a model in which firms at first choose the production capacity and in the second stage compete in prices. The equilibrium outcome is the same as in a simple Cournot model, if the efficient-rationing rule is applied.

3. The Model

3.1. Production and Distribution

We assume a single good is produced in this economy, and sold at price p. The product, Q can be used for consumption or investment purposes. There are n identical firms. The market structure is an oligopoly. In this paper we use the Cournot approach, in which firms compete in quantities. The market demand is given by:

$$p(Q) = \frac{Y}{Q}, \tag{1}$$

where Y is the aggregate income of consumers, and Q is the aggregate quantity of the good. The total quantity Q is the sum of the quantities produced by all n firms, that is:

$$Q = \sum_{i=1}^{n} Q_i, \tag{2}$$

Every firm uses the same production function (see [24,25,32,94–96]), which is given by:

$$Q_i = F\left(K_i, L_i \Phi\left(\bar{k}\right)\right), \tag{3}$$

where K_i is the capital stock of firm i, L_i is the labor force of firm i and $\bar{K} = \sum_{i=1}^{n} K_i$ the economy-wide aggregate capital stock and $L = \sum_{i=1}^{n} L_i$ the economy wide labor force. The variable $\bar{k} = \frac{\bar{K}}{L}$ represents the capital–labor ratio. Thus, $\Phi\left(\bar{k}\right)$ represents the labor productivity and is assumed to be dependent on the aggregate capital intensity. This assumption implicates spillover and learning by doing effects, which create positive externalities induced by capital accumulation. Furthermore, we assume that for each firm, the externality is exogenous; and that running a firm requires non-productive administrative work which leads to overhead costs. For simplicity, we assume that the firm or entrepreneur executes the business administration of the company. Thus, to cover the opportunity costs, the entrepreneur has to make a minimum economic profit equal to the wage rate she can earn as an employee elsewhere. Moreover, all n identical firms engage in Cournot competition, that is, each firm determines its optimal quantity of goods whilst taking the actions of other firms and the factor prizes as given. Therefore, each firm i maximizes its profit Π_i. This is expressed as:

$$\Pi_i = p\left(F\left(K_i, L_i \Phi(\bar{K})\right) + \sum_{\substack{j=1 \\ j \neq i}}^{n} Q_j\right) F\left(K_i, L_i \Phi\left(\bar{k}\right)\right) - \Phi\left(\bar{k}\right) \tilde{w} L_i - R K_i, \ \forall i \epsilon [1, n] \tag{4}$$

and $\tilde{w} = \frac{w}{\Phi(\bar{k})}$ the wage rate per effective labor unit.

On the factor markets, firms take the wage rate w and the interest factor R as given. A depreciation rate of 100% per period is assumed. Maximization of the profit with respect to each firm's capital and labor force results in the following first order conditions:

$$\frac{\partial \Pi_i}{\partial K_i} = [p'(Q)Q_i + p(Q)]\, F_{K_i}\left(K_i, L_i\Phi\left(\bar{k}\right)\right) - R = 0,\ \forall i \epsilon [1,n] \tag{5}$$

$$\frac{\partial \Pi_i}{\partial L_i} = [p'(Q)Q_i + p(Q)]\, F_{L_i}\left(K_i, L_i\Phi\left(\bar{k}\right)\right) - \Phi\left(\bar{k}\right)\widetilde{w} = 0,\ \forall i \epsilon [1,n] \tag{6}$$

From the symmetry assumption it follows that, $\bar{k} = k = \frac{K}{\Phi(\bar{k})L} = \frac{K_i}{\Phi(\bar{k})L_i}, \forall i \epsilon [1,n]$. To simplify the analysis, we assume that the population N is constant over time. Furthermore, we assume that the labor productivity $\Phi\left(\bar{k}\right)$ is linear in the average capital intensity:

$$\Phi\left(\bar{k}\right) = \Psi\bar{k}, \tag{7}$$

From the above, we can derive the aggregate production as:

$$Q = \sum_{i=1}^{n} F\left(K_i, L_i\Phi\left(\bar{k}\right)\right) = F\left(nK_i, nL_i\Phi\left(\bar{k}\right)\right) = F\left(K, L\Phi\left(\bar{k}\right)\right) = KF(1,\Psi) = AK \tag{8}$$

where $A \equiv F(1,\Psi)$.

The capital intensity measured in effective labor units is derived as:

$$\tilde{k} = \frac{K}{L\Psi k} = \frac{1}{\Psi} \tag{9}$$

Invoking linear homogeneity of the production function and the Euler theorem, it follows that the share of production contributed by capital is:

$$0 < \alpha = \frac{f'\left(\frac{1}{\Psi}\right)\frac{1}{\Psi}}{f\left(\frac{1}{\Psi}\right)} < 1 \tag{10}$$

Because of symmetry, we derive that $Q_i = Q/n$. Using this information and reformulating the first-order conditions yields the following:

$$\frac{\partial \Pi_i}{\partial K_i} = \left[\left(\frac{p'(Q)}{p(Q)}Q\right)\frac{1}{n} + 1\right] p(Q)\, \alpha A = R \tag{11}$$

$$\frac{\partial \Pi_i}{\partial L_i} = \left[\left(\frac{p'(Q)}{p(Q)}Q\right)\frac{1}{n} + 1\right] p(Q)(1-\alpha)Ak = \widetilde{w} \tag{12}$$

From the demand function, we can derive that the inverse price elasticity of demand $\frac{p'(Q)}{p(Q)}Q$ equals −1. Without loss of generality, we assume that the only good of the economy is a numeraire and thus the price of the good equals one. This delivers the outcome for the interest factor and wage rate per capita as follows:

$$\left(\frac{n-1}{n}\right)\alpha A = R \tag{13}$$

$$\left(\frac{n-1}{n}\right)(1-\alpha)Ak = w \tag{14}$$

Because of the relationship that the incomes (profits, wage income and capital income) has to be equal to the value of production, the profit per firm becomes:

$$\Pi_i = \frac{Y}{n^2} = \frac{AK}{n^2.}\ \forall i \epsilon [1,n] \tag{15}$$

We obtain for the maximum or the equilibrium number of firms n^{max}:

$$n^{max} = \frac{\sqrt{\alpha^2 + 4N(1-\alpha)} - \alpha}{2(1-\alpha)} \tag{16}$$

Therefore, if $n = n^{max}$ all young individuals earn the income w. This outcome is only an equilibrium if there are no barriers to entry in the market. It should be noted that $n^{max} < N$, if $N > 1$. The aggregate profits are given by:

$$\Pi = \frac{Y}{n} = \frac{AK}{n} \tag{17}$$

The aggregated interest income and aggregated wage income are given by:

$$RK = \left(\frac{n-1}{n}\right)\alpha AK \tag{18}$$

$$wL = \left(\frac{n-1}{n}\right)(1-\alpha)AK \tag{19}$$

We take the 'corn-parable' (c.f. [110], p. 212) as an illustration to explain the model where corn is the only good in the economy. Corn can be consumed or used as seed in the next period to grow corn in combination with labor input. However, some management tasks have to be undertaken to set up and manage a corn producing firm which takes the stored corn from the older generation in exchange for the promise to pay the rental rate *R* in terms of corn. Additionally, the firm hires workers and promises to pay some amount of corn as a wage. However, the difference between revenue and aggregate wages plus interest payments determines the profit of the firm. As long as there are no barriers to entry in the market, competition between firms leads to the outcome that the firms earn the same income as workers.

Hence, if the number of firms strive to infinity, the equilibrium is identical to [96,111,112], who assume perfect competition in all markets. However, that can only happen if the market size in terms of consumers is huge.

Proposition 1. *If there are no barriers to entry, then large economies in terms of population size are less concentrated than small economies. Additionally, the bigger* α *is, the more firms there are in the economy.*

$$\frac{\partial n^{max}}{\partial N} = \frac{1}{\sqrt{\alpha^2 + 4N(1-\alpha)}} > 0 \tag{20}$$

and

$$\frac{\partial n^{max}}{\partial \alpha} = \frac{2N(1-\alpha) + \alpha - \sqrt{\alpha^2 + 4N(1-\alpha)}}{2(1-\alpha)^2\sqrt{\alpha^2 + 4N(1-\alpha)}} > 0 \tag{21}$$

The latter result implies that the bigger the capital income share $\left(\frac{n^{max}-1}{n^{max}}\right)\alpha$, the more firms are in the market. A big capital share implies a small labor share, which makes it more attractive to become an entrepreneur. It is also clear that the bigger the market in terms of number of consumers, the larger is n^{max}, and the lower is the market concentration. The markup over the marginal costs is calculated as:

$$\frac{p}{MC} = \frac{n}{n-1} \tag{22}$$

This means in the case of a duopoly; the markup is 100%. In the case of an oligopoly with three firms, it is 50%, and so on.

3.2. Barriers to Entry

It is not the intention of the paper to explain the number of firms operating in the market if the number is smaller than n^{max}, but to investigate how it is possible that the numbers of firms may not increase. Regarding the number of existing firms, we assume that they are historically given. For this purpose, we use a simple political economy model of policy choice which goes back to Olson [113],

where we employ a first-price menu auction in line of Bernheim and Winston [114]. Explicitly, we assume that the economy is organized and administrated by a government, where it does not matter if the government is democratically elected or determined in another way. Let us assume that at some point of time the n^I incumbent firm owners come to the conclusion that it is a good idea to found an association, which should represent their interests in the political sphere. The main interest of the firm owners is of course to avoid stronger market competition. Depending on the political system, they are willing to offer a share of their incomes as bribes in non-democratic systems or as financial support to run election campaigns and lobbying efforts in democracies in exchange for blocking market entry. In non-democracies, barriers to entry can be easily established, whereas in democracies a more sophisticated approach is necessary, because bribery is usually illegal in most democracies. However, there are other ways to influence policy makers like lobbying, offering jobs or other income opportunities for the policy makers or their relatives, political sponsoring and so on. Additionally, existing firms can always reason with the number of current employees as voters, who can be influenced by the firm owner regarding their election behavior.

In addition, it is useful to provide policymakers with some arguments on why it is in the interest of the public to have stronger market regulation. For example, it can be argued that stronger safety standards are necessary and desired by the society, or that high capital requirements for firms are necessary to protect consumers. In particular, the latter barrier to entry is in favor of established firms and it is costless for them as long as they actually fulfill these capital requirements; or to require that market entrants must have a formal education in a specific profession to guarantee product and service quality. For usual voters it is difficult to decide if a market regulation will improve consumer's welfare or if it is an over-regulation to protect market incumbents and to avoid competition. Examples for such events are presented in Zingales [88]. To keep the model simple, we assume that the government has established a license system, and that the existing licenses will be transferred inside the firm dynasties. This simplification can be easily relaxed by considering a mix of other costly and costless market regulations without changing the qualitative outcomes. Thus, we assume that the association of market incumbents are offering:

$$B_I = \mu \frac{Y}{n^I} \tag{23}$$

where $0 < \mu < 1$ and B_I is the aggregated bribe or support offered to policy makers. Every firm owner has to contribute the same share μ of her profits to the association. To be sure that policy will introduce or maintain barriers to entry, it is necessary to influence all important parties.

On the other hand, we have $n^{max} - n^I$ potential market entrants. However, as long as the potential market entrants expect to make a positive profit exceeding the wage rate, they also can offer a bribe or support for policymakers. Their problem is that it is not easy for them to found an association similar to the association of incumbents, because of the usual collective action problem. The incumbent entrepreneurs have more to lose than the markets entrants can expect to win. The simple reason is, if the association of market entrants will have $n^{max} - n^I$ members, then no member will make a positive profit, because the profit will be equal to wage rate and the incentive to become an entrepreneur does not exist. Thus, the number of market entrants have to be restricted. The association of market entrants can offer the following value of bribes:

$$B_{ME}^m = \upsilon \frac{mY}{(n^I + m)^2} \tag{24}$$

where $0 < \upsilon \leq 1$ and m is the number of association members. The association will maximize the bribe to be as effective as possible. Therefore, the following maximization problem will be solved:

$$\max_m \upsilon \frac{mY}{(n^I + m)^2} \tag{25}$$

Solving this problem leads to the unique solution, so that the association should have $m = n^I$ members. This leads then to a value of bribes equal to:

$$B_{ME}^{m} = \upsilon \frac{Y}{4n^{I}} \tag{26}$$

If we further assume that the policymakers are willing to accept the highest bribe, it is easy for the incumbents to offer more than the market entrants:

$$B_{I} = \mu \frac{Y}{n^{I}} \geq \upsilon \frac{Y}{4n^{I}} = B_{ME}^{m} \tag{27}$$

given that $\mu \geq {}^{1}/_{4}$. This means that the incumbents can always maintain the barriers to entry if they are willing to give up a quarter of the profits. However, although this share seems to be high, the loss would be the half of the income if n additional firms would enter the market. If we assume that policymakers accept the highest bribes, we can conclude that the number of firms is stable in time.

A remaining problem is the stability of the association of incumbent firms. If it would be possible to decrease the number of firms, the increase in profits is sufficient to compensate the leaving members. This is particularly true if the idea is that a duopoly should be the outcome. However, this idea is not welcome by policy makers, because such change in the market structure would harm the old and workers significantly, and because interest and wage rates will decline. Also, the old who were firm owners would oppose such a change. Therefore, it is obvious that policy makers establish an anti-trust law, which does not allow mergers.

The fear of not willing be re-elected and political unrest if the distribution of income will become more unfair guarantees some stability of the market structure. In the case of a non-democratic government, it also has no interest that economic power is in the hands of only a few. Therefore, for convenience, we assume for the rest of the paper, that one quarter of the profits go to policy makers, who consume this bribe immediately.

3.3. Distribution of Income

Because of the fact that the incomes differ for the three income classes—workers, entrepreneurs and capital owners—we indicate an entrepreneur with the subscript E and a worker with W. The respective incomes are given by:

$$y_{W,t} = \left(\frac{n-1}{n}\right)(1-\alpha)\frac{AK_{t}}{N-n} \tag{28}$$

An entrepreneur receives a rent or profit income, which equals:

$$y_{E,t} = \frac{AK_{t}}{n^{2}} \tag{29}$$

From the two equations above, we derive the average income in the first period of life as:

$$\bar{y}_{t} = \frac{\frac{3AK_{t}}{4n} + \left(\frac{n-1}{n}\right)(1-\alpha)AK_{t}}{N} = \left(\frac{1+(n-1)(1-\alpha)}{nN}\right)AK_{t} \tag{30}$$

Differentiating the average income of the working generation with respect to the number of firms leads to:

$$\frac{\partial \bar{y}_{t}}{\partial n} = -\frac{Ak_{t}}{4Nn^{2}} < 0 \tag{31}$$

The explanation for this surprising result is, that an intragenerational and intergenerational redistribution is induced by a change of the number of firms. If the number of firms is increasing, the market power of each firm will decline and as a consequence the markup declines. This will increase the interest income of the capital owners and wage income of the workers in real terms. Because of the fact that a part of the income the entrepreneur loses goes to the old generation, the aggregated income of the young generation will decline.

Regarding the inequality of income within the working generation, we calculate a modified Gini coefficient, based on two groups: the workers and the firm owners. This Gini coefficient is at least determined by the relative income share of the workers and their population share, given as:

$$Gini = \frac{N^2 - Nn(1+\alpha) - n^2(1-\alpha)(N-1) - n^3(1-\alpha)}{\big((1-\alpha)n + \alpha\big)N(N-n)} \tag{32}$$

Proposition 2. *If the number of firms will increase, the inequality of income distribution within a generation will decline and hence the income distribution will become fairer.*

Proof. To derive the influence of the number of entrepreneurs on the Gini coefficient, we differentiate the latter with respect to n:

$$\frac{\partial Gini}{\partial n} = \frac{(1-\alpha)^2 n^4 + 2(1-\alpha)n^3(\alpha(N+1) - N) + (1-\alpha)n^2(N^2 - 4N - 1) - 2(1-\alpha)Nn\big((N-1)\alpha - N\big) - N^2(N(1-\alpha) - \alpha^2)}{N(N-n)^2\big((1-\alpha)n + \alpha\big)^2}$$

$$< 0$$

□

It is very tedious to show that the derivative is negative, but the intuitive reasoning is simple if we consider the following Figure 1.

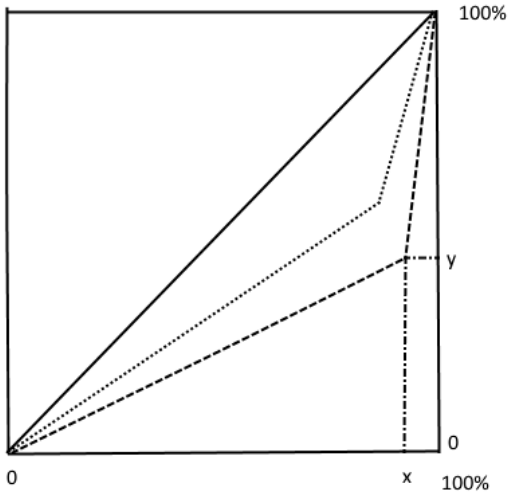


Figure 1. On the x-axes is the share of gross domestic product (GDP), and on the y-axes the share of population. In Figure 1 the value x represents the share of income which is received by the workers and the value y represents the share of population who are workers. Furthermore, in Figure 1, we see two distributions, the one with the dashed lines and the second with the dotted lines. An increase of the number of firms lead to a movement of the kink upward and leftward. These characteristics guarantee that the simplified Lorenz curves will never intersect. As noted for example by Deininger and Squire [115], this is an important characteristic, because this guarantees that all distributions of this model economy can be ranked by the Gini coefficient. The dotted modified Lorenz curve represents an economy with more firms than the economy which is represented by the dashed modified Lorenz curve. If n strives to infinity the modified Lorenz curve coincides with the 45° line. Intuitively, if the number of firms increases the labor income share also increases (upward shift of the kink) and the population share of workers decline (leftward shift of the kink).

3.4. Households

To keep the model simple, we assume that individuals live three periods. In the first period of life the individual is a child and does not make any decisions and is part of the utility of its parents. In the second period each individual has one child and is either a worker or an entrepreneur. In both cases, they save part of their income and enjoy in the third period of life their retirement and live from their savings and the respective interest income. The entrepreneur or firm owner is an individual who holds the license to run a firm. The next generation inherits the license from the current one, once the current one reaches the end of the working period. We assume further that all

individuals have identical preferences which are represented by a usual homothetic and additive separable utility function:

$$U(c_t^1, c_{t+1}^2) = u(c_t^1) + \beta(c_{t+1}^2) \tag{33}$$

where c_t^1 is the consumption in the second period of life, c_{t+1}^2 the consumption in the third period of life, and β represents the subjective discount factor of the individual. Regarding the function u, the following very general assumptions are made:

$$u'(c) > 0, u''(c) < 0 \text{ and } \lim_{c \to 0} u'(c) = +\infty, \forall c > 0 \tag{34}$$

The budget constraints of the individual are given by:

$$c_t^1 = y_t - s_t \tag{35}$$

and

$$c_{t+1}^2 = R_{t+1} s_t \tag{36}$$

where y_t represents the income in period t, s_t the savings in period t and R_{t+1} the interest factor in $t + 1$.

Inserting Equations (3) and (4), differentiating with respect to the savings, and setting the result of latter equal to zero leads to the first order condition of the utility maximization problem:

$$-u'(y_t - s_t) + \beta u'(R_{t+1} s_t) = 0 \tag{37}$$

From Equations (35)–(37) in combination with the assumptions of the utility function, the savings function is derived as:

$$s(y_t, R_{t+1}) = \theta(R_{t+1}) y_t \tag{38}$$

where $0 \leq \theta(R_{t+1}) \leq 1, \forall R_{t+1} \geq 0$ and $\frac{\partial \theta(R_{t+1})}{\partial R_{t+1}} \frac{R_{t+1}}{\theta(R_{t+1})} \geq 0$. The latter requirement ensures that the interest elasticity of savings is non-negative. For simplicity, we omit population growth and assume that the total number of individuals per generation is N.

The total savings of workers become:

$$S_{W,t} = \theta\left(\left(\frac{n-1}{n}\right)\alpha A\right)\frac{(1-\alpha)(n-1)}{n} A K_t \tag{39}$$

The effect on the workers' savings caused by an increasing competition is given by:

$$\frac{\partial S_{W,t}}{\partial n} = (\varepsilon_{s,R} + 1)\theta\left(\left(\frac{n-1}{n}\right)\alpha A\right)\frac{(1-\alpha)}{n^2} A K_t > 0 \tag{40}$$

where $\varepsilon_{s,R} = \frac{\theta'\left(\left(\frac{n-1}{n}\right)\alpha A\right)\left(\frac{n-1}{n}\right)\alpha A}{\theta\left(\left(\frac{n-1}{n}\right)\alpha A\right)}$ represents the interest elasticity of savings.

Obviously, the savings of the workers increase with increasing competition for two reasons. The first is the increased interest rate and the second more important reason is that an increasing wage rate increases workers' savings.

The aggregate savings of entrepreneurs are given by:

$$S_{E,t} = \theta\left(\left(\frac{n-1}{n}\right)\alpha A\right)\frac{3}{4}\frac{A K_t}{n} \tag{41}$$

Note the disposable income of an entrepreneur is only three quarters of the profit because one quarter is transferred as a bribe to the policy makers, who consume this share instantaneously.

Differentiating the savings of the firms with respect to the number of firms gives:

$$\frac{\partial S_{E,t}}{\partial n} = (\varepsilon_{s,R} + 1 - n)\theta\left(\left(\frac{n-1}{n}\right)\alpha A\right)\left(\frac{1}{n-1}\right)\frac{3}{4}\frac{A K_t}{n^2} \tag{42}$$

In general, the sign of the derivative is ambiguous, because the increasing competition increases the interest rate and lowers the profit. In most realistic cases, we can argue that the savings of the

entrepreneurs will decline with increasing competition, but if the elasticity of savings with respect to the interest is very high and the number of firms very low, then the savings will increase.

4. The Development of the Economy

The dynamics of this economy are caused by capital accumulation. Thus to determine the growth factor of the economy, we take into account that the capital stock in period $t + 1$ equals the aggregate savings in period t:

$$K_{t+1} = \theta\left(\left(\frac{n-1}{n}\right)\alpha A\right)\left(\frac{\frac{3}{4}+(1-\alpha)(n-1)}{n}\right)AK_t \tag{43}$$

Dividing both sides by K_t delivers the growth factor of the capital stock:

$$G_t(n) = \frac{K_{t+1}}{K_t} = \theta\left(\left(\frac{n-1}{n}\right)\alpha A\right)\left(\frac{\frac{3}{4}+(1-\alpha)(n-1)}{n}\right)A \tag{44}$$

It should be noted that the growth path described by Equation (44) is always stable and unique.

Proposition 3. *If the number of firms increases, the growth factor of the economy will increase, if* $\varepsilon_{s,R} > \frac{4\alpha-1}{(3+4(1-\alpha)(n-1))}$.

Proof. The first derivative of the growth factor (44) with respect to the number of firms becomes:

$$\frac{\partial G_t(n)}{\partial n} = \left[\varepsilon_{s,R} - \frac{4\alpha-1}{4\left(\frac{3}{4}+(1-\alpha)(n-1)\right)}\right]\theta\left(\left(\frac{n-1}{n}\right)\alpha A\right)\left(\frac{\alpha+(1-\alpha)n-\frac{1}{4}}{n^2}\right)\frac{A}{(n-1)} \tag{45}$$

□

Unfortunately, the relationship between growth and market concentration is not unique. This ambiguous result is caused on the one hand, by the fact that the sum of profits and wage incomes decline with an increasing number of firms. More competition leads to lower profits and to higher labor incomes, but unfortunately the increase of the wage incomes is less than the reduction of the profits, because a part of the profit loss will be received by the capital owners or old generation. In other words, more competition lowers the price mark up, so that the incomes of workers and retirees increase. However, only the increased wage incomes are available for saving purposes. On the other hand, this negative income effect is counteracted by an increasing savings rate. The latter effect is caused by an increasing interest factor. From the condition of the proposition we see that more competition always will lead to a high growth rate, if $\alpha < \frac{1}{4}$. The same holds as long as the interest elasticity of savings is high enough.

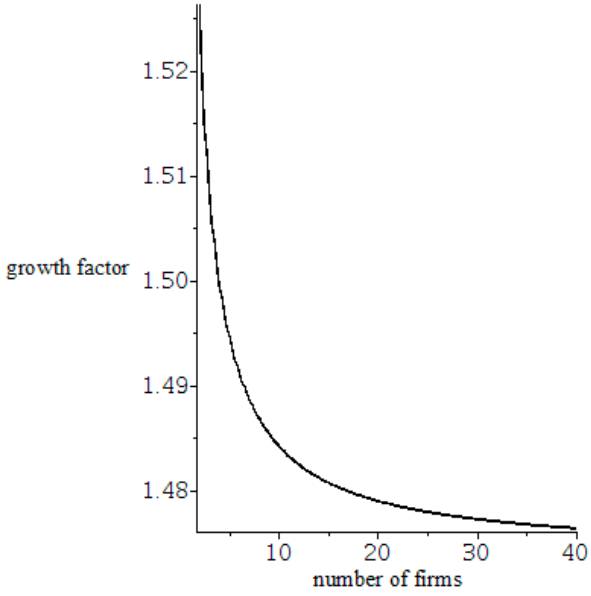
To illustrate the relationship between market concentration and growth factor we consider an example and calibrate the growth factor depending on the number of firms, where $\alpha > \frac{1}{4}$ As utility function we take a CIES (constant intertemporal elasticity of substitution) utility function:

$$u(c_i) = \frac{(c_i)^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}}, i = 1,2 \tag{46}$$

We obtain for the savings rate:

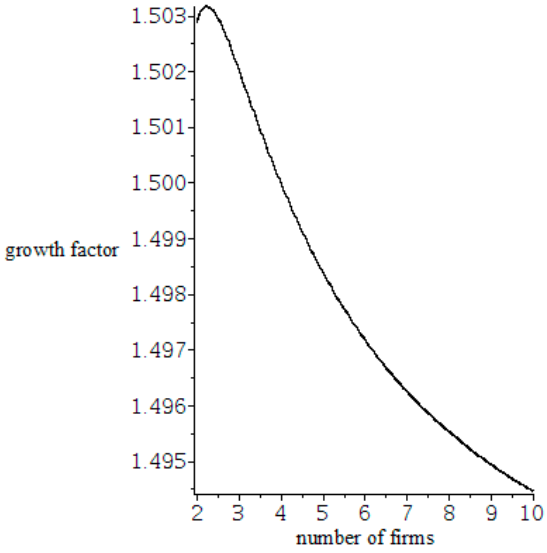
$$\theta(R_{t+1}) = \frac{1}{1+\beta^{-\sigma}(R_{t+1})^{1-\sigma}} \tag{47}$$

Next we calibrate the function $G(n) = \left(\frac{\frac{3}{4}+(1-\alpha)(n-1)}{(1+\beta^{-\sigma}(R_{t+1})^{1-\sigma})n}\right)A$ with different values of σ. We should note that the value of σ has to be bigger or equal to one, to guarantee that the interest elasticity of savings is positive. If $\sigma = 1$, the function becomes a log-linear utility function. The other parameters selected for Figures 2–5 are: $A = 4$, $\beta = 0.9$, and $\alpha = 0.3$.



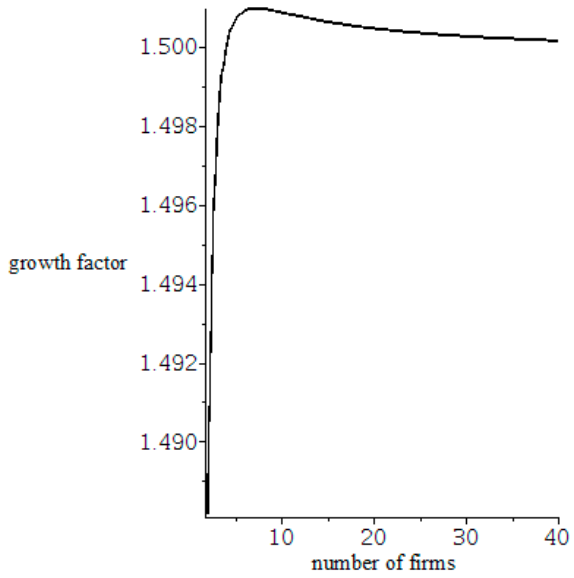
$\sigma = 1.0$

Figure 2. This figure represents the relationship between the number of firms and the economy's growth factor. If $\sigma = 1$ the relationship is negative.



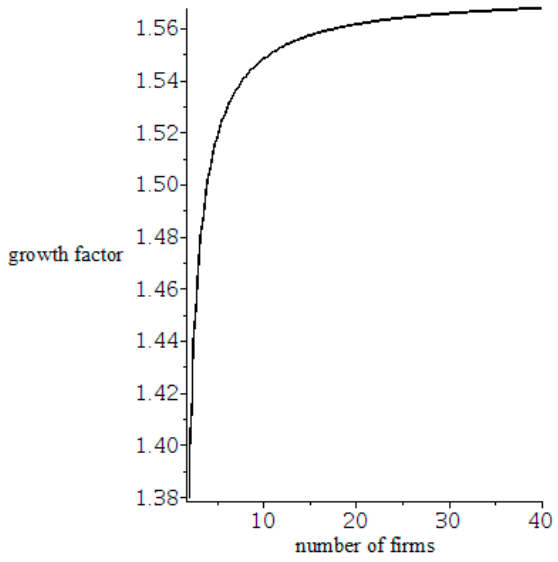
$\sigma = 1.08$

Figure 3. This figure represents the relationship between the number of firms and the economy's growth factor. If $\sigma = 1.08$ the relationship has a maximum.



$\sigma = 1.13$

Figure 4. This figure represents the relationship between the number of firms and the economy's growth factor. If $\sigma = 1.13$ the relationship has again a maximum.



$\sigma = 1.5$

Figure 5. This figure represents the relationship between the number of firms and the economy's growth factor. If $\sigma = 1.5$ the relationship is positive.

As we can see the growth factor has a maximum in Figures 3 and 4, while the growth factor is a continuously decreasing function of n in Figure 2, and a continuously increasing function in Figure 5.

The outcome that the growth factor will decline, if the market is becoming more competitive as in Figure 2, is caused by the fact that the market power of firms makes it possible to increase the profits at the costs of capital owners. A part of this profit income is then invested with the consequence that the growth factor will increase.

From these considerations we can derive the following from Propositions 2 and 3.

Proposition 4. *The growth factor of the economy will increase and simultaneously the inequality of income and wealth will decline, if* $\varepsilon_{s,R} > \frac{4\alpha-1}{(3+4(1-\alpha)(n-1))}$ *and if the number of firms increases.*

Another point is that the inefficiency caused by the positive externalities of capital accumulation, will be increased through imperfect competition, because the more concentrated the market is, the lower is the interest rate. As a consequence, the savings rate is too low in comparison to the optimal savings rate [116]. Thus, even in this model like in the original AK model, a subsidy for savings or compulsory savings is desired [111]. The latter insight can be used to increase the growth rate in association with increasing the number of firms. However, the important prerequisite is that the political power of oligopolists has to be reduced, which means nothing else than corruption of any form has to be reduced. Our result, that the distribution of income is not related to economic growth is confirmed by the empirical results of Deininger and Squire [115] and Dollar and Kray [117].

5. Discussion

The paper discusses the problem of income and wealth inequality caused by oligopolies, which are a result of lobbying or bribes. The existence of oligopolies is explained in the context of political economy of corruption and political lobbying. An outcome of the paper is that political lobbying and corruption are important reasons for the missing competition in markets. Examples illustrating how this is working in the USA can be found in [88,89]. To this end, our analysis complements the idea of "superstar firms" [18] or the idea that innovations will increase fixed costs, but lower marginal costs [86].

The novelty of this study is that we present the model that allows for persistent economic profits in the framework of neoclassical economics. On the one hand, we can show that income inequality can be reduced by antitrust policy or by measures against political corruption, which is prevalent in different forms. On the other hand, depending on the interest elasticity of savings. it is possible that stronger competition in the market is associated with lower growth rates. In the case where a faster growth is desired, and that a stronger antitrust policy reduces growth (for example because of a too low interest elasticity of savings), a progressive income tax system can be established to reduce inequality and to maintain the growth rate.

The main difference between the oligopoly model developed in this paper and the oligopoly models in the literature is that the model in this paper is a general equilibrium model, whereas the models in the literature (Benchekroun and Van Long [118], Lambertini [119], Carraro and Soubeyran [120], or Requate [121]) are partial equilibrium models. This difference has strong consequences regarding the outcomes. In partial equilibrium Cournot models, usually the equilibrium quantity is less than the equilibrium quantity which results in the presence of perfect competition. From this outcome it can be derived that the social surplus representing the welfare in the case of imperfect competition is smaller than in the case of perfect competition. Obviously, imperfect competition leads to welfare losses in partial equilibrium models. The implicit assumption in the partial equilibrium model is that consumers can buy other goods elsewhere. However, in the model of the paper this opportunity does not exist and, therefore, the output is not affected by the market structure. In this specific endogenous model, a dynamic inefficiency will occur as was noted above, but this results from the positive externality of capital accumulation and an inefficiency results from the bribes. The problem here is that the savings are less than optimal. However, from [118–121], it is noted that a Pigouvian tax is in general no longer optimal in the case of an oligopoly. Pigouvian tax rates are in general too high in the case of an oligopoly. Therefore, a useful extension of the model presented in the paper would be to consider negative externalities associated with production, and to compare the outcomes regarding environmental taxation with the outcomes of partial equilibrium models.

An important insight drawn from the analyses is that the influence of lobbying and corruption has to be reduced. Moreover, the results resonate with the arguments of Zingales [88] on the need to tax lobby expenditures and to subsidize with the tax revenue, the under-financed lobby organizations like the consumer protection associations or environmental protection groups, thus reducing barriers to entry.

A weakness of the model is that we did not derive the number of firms endogenously. Instead, we have assumed that the number is given by history and we only explain how the existing number of firms is maintained. To enrich the model with people who have different productivities, future

studies could consider if the political-economic approach can be combined with the median-voter approach (Persson and Tabellini [122] or Alesina and Rodrik [123]).

Another extension to the model would be to introduce a second sector or to change to the approach of d'Aspremont and Dos Santos Ferreira [124–126], who combined the Dixit–Stiglitz approach with oligopoly theory. We assume that as consequence the oligopolistic equilibrium outcome will be affected by the degree of competition like in oligopolistic partial equilibrium models.

It would be useful to empirically investigate the model, but the problem is the lack of appropriate data on market power and firm profits for most countries. In practice there also some methodological problems in defining market power.

6. Conclusions

In this study we develop an OLG model with endogenous growth and imperfect competition, which is comparable with a usual OLG model using endogenous or exogenous growth. The advantage of our model is that it consists of three types of income—labor income, capital income and profit income. To the best of our knowledge this is the first dynamic general equilibrium model with endogenous growth which contains positive profits in the long run.

Moreover, our model makes it possible to analyze the distribution of income between firm owners and workers, and the relationship is that a higher market concentration leads to a more unequal distribution of income and wealth. Furthermore, its simplicity makes it possible to investigate changes of market concentration on pension systems, finance of health care systems, environmental policies or tax revenues in the future.

The outcome regarding the relationship between economic growth and market concentration is ambiguous and this is consistent with the empirical literature. In our model, the relationship depends on the costs of bribing policy makers, the propensity to save (to invest), and the share of the interest income which can be appropriated through market power.

Another important outcome from the analysis is that, under certain conditions, it is possible to lower the income inequality and enhance economic growth simultaneously. Thus, the usual tradeoff between growth and inequality vanishes.

A further insight from the model is that the relationship between market power and economic growth is non-linear and that it can be either positive, negative or an inverted U-shaped relationship.

To derive some policy recommendations from the model, at least three cases need to be considered. If there is a trade-off between growth and equality, then a progressive tax system can be recommended to reduce income inequality. In the framework of the model, we do not to expect any welfare losses caused by taxation. The alternative would be to increase competition by abolishing corruption. Of course, it must be taken into account that it is very difficult to get rid of corruption in the political sphere. Appling this option (assuming that it is possible) may lead to a decline of the growth rate of the economy. However, whether this is an acceptable outcome depends on the individuals' preferences. In the current period the individuals will benefit from increased competition. Thus, in a democracy the voters want to abolish corruption and none of the following generations will have an interest to allow corruption and market power again. This outcome is in some sense paradoxical, because only the first generation will have a higher income, but all following generations may have a relatively lower income.

In the second case, an increase in competition will lead to higher growth rates and this is what usually is expected by the proponents of strong competition. In the third case, there exist an optimal number of firms, which is associated with a maximum growth rate. In general, recommendations with respect to antitrust laws should be made very carefully, and it should be considered if a progressive tax can be a better alternative to reduce inequality.

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