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Imperfect Competition, Real Estate Prices and New Stylized Facts

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Abstract: In this paper, we develop an overlapping generation model with imperfect competition and land to provide a theoretical foundation for some empirical observations made since the end of the 1970s. The problem is that these new "stylized facts" do not coincide with Kaldor's stylized facts and unfortunately the standard growth models are not able to explain these new facts. By using our model, we are able to theoretically derive these new facts and to provide a theoretical foundation for them. In particular, increasing market concentration leads to a decline in the labor income share, to a decline in the capital income share, to a decline in the natural interest rate, to an increasing wealth to income ratio, and to an over-proportional increase in land prices in developed countries. The model developed for analysis has close similarity with the standard neoclassical overlapping generation model with endogenous growth and land. The main difference between the standard neoclassical and the model in this paper is the market structure. Instead of assuming perfectly competitive markets, we assume an oligopolistic market structure. This leads to the occurrence of pure profits for firms and, accordingly, the input factors are no longer paid their marginal products.

Keywords: imperfect competition; oligopoly; endogenous growth; land; overlapping generations

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1. Introduction

In 1961, Nicholas Kaldor (1961) summarized the stylized facts on economic growth. Many growth theorists have used these stylized facts to test the validity of growth models. In most cases, growth models, which contradicted these facts, were not taken seriously. Not surprisingly, the standard neoclassical growth model of Solow (1956, 1957), the overlapping generations (OLG) model of Diamond (1965) or the AK-model of Rebelo (1991) were able to generate the stylized facts. This methodology was justified by Romer (1989, p. 54) in the following way, "In the formative stages of a body of theory, this kind of informal treatment of the data can be quite useful, for without stylized facts to aim at, theorists would be shooting in the dark."

The Kaldor's facts are:

KF1: Per capita output grows over time.
KF2: Capital per capita grows over time.
KF3: The rate of return to capital is constant.
KF4: Capital to output ratio is constant.
KF5: Factor shares are constant.
KF6: Per capita growth rates differ among countries.

Kaldor (1961, p. 178) argued that:

> Since facts, as recorded by statisticians, are always subject to numerous snags and qualifications, and for that reason are incapable of being accurately summarized, the theorist, in my view, should be free to start off with a "stylized"

> view of the facts—i.e., concentrate on broad tendencies, ignoring individual detail, and proceed on the "as if" method, i.e., construct a hypothesis that could account for these "stylized" facts, without necessarily committing himself on the historical accuracy, or sufficiency, of the facts or tendencies thus summarized.

Unfortunately, the outcomes of recent empirical research take Kaldor's facts into question. In particular, the rate of return to capital and the factor shares were not constant in the last 40 years in developed countries. In contradiction to Kaldor, recent empirical research (e.g., Eggertsson et al. 2021) states that the natural interest rate has shown the tendency to decline instead of remaining constant, and that the labor and capital income share have also exhibited the tendency to decrease instead of being constant. A number of economists (e.g., Eggertsson et al. 2021; Stiglitz 2019; Krugman 2016; Barkai 2020) explain these new stylized facts with the increasing monopoly power of firms. In other words, markets seem to be less competitive than in the period 1950–1980. In fact, a large amount of empirical literature (Kuhn et al. 2020; Barkai 2016, 2018, 2020; Barkai and Benzell 2018; Bajgar et al. 2019; Díez et al. 2019; Guinea and Erixon 2019; Van Reenen 2018; Syverson 2019; Shapiro 2019; Basu 2019; Autor et al. 2017; Autor et al. 2020; Cavalleri et al. 2019; Berry et al. 2019; Lamoreaux 2019; Ge et al. 2019; Hall 2018; Azar et al. 2019; De Loecker and Eeckhout 2017; De Loecker et al. 2020; Poschke 2018; Philippon 2019; Grullon et al. 2019) validates the observation that price markups and market power of firms have increased in the last 40 years in most developed countries.

The dwindling competition in developed countries is associated with a decline in the natural rate of interest (Laubach and Williams 2003; Holston et al. 2017; Mian et al. 2021), a decline in the capital income share (Eggertsson et al. 2021), declining labor income share (Elsby et al. 2013; Karabarbounis and Neiman 2014) and increasing profit share (Barkai 2016, 2018, 2020; Barkai and Benzell 2018; Chen et al. 2017; Karabarbounis and Neiman 2018). Another, "new" stylized fact observed by Eggertsson et al. (2021), Piketty and Zucman (2014) and Knoll et al. (2017) is that the wealth to income ratio has been increasing since the 1980s. In particular, the latter study shows that the wealth in the form of land values has increased faster than the income of the respective economies. Moreover, Knoll et al. (2017) show that the price of land is the main driver for the increase in real estate values because construction costs evolve with the income.

Unfortunately, the neoclassical growth models are not able to explain these phenomena, and for this reason, we present a model that explains that increasing market power will cause the labor income share, the capital income share, and the interest rate to decline and the wealth–income ratio to rise. We especially consider the influence of increasing market power on the price of real estate and housing rents. The model is built on the recent work of Kumar and Stauvermann (2020, 2021), Kumar et al. (2021) and Stauvermann and Kumar (2021). To consider the real estate sector, we combine these models with the model of Che et al. (2021). The structure of this approach follows a Diamond (1965) OLG model and the production side of Rebelo's AK production function. The main difference to the original Diamond economy is that the markets are not perfectly competitive, but instead the market structure is characterized by a Cournot competition.

The main advantage of the approach compared to other approaches is that the model is very close to the model of Diamond (1965), and hence it is easy to compare the outcomes. In other words, if the number of oligopolists strives to infinity, the models coincide fully with the Diamond model. In particular, the latter characteristic implies that the assumptions made are very general and commonly accepted. A further advantage is the simplicity of the approach, which makes it possible to extend the model to tackle problems such as social security, government debts, tax policy, etc. In contrast, Eggertsson et al. (2021) have developed a dynamic stochastic general equilibrium (DSGE) model for which a number of very specific assumptions (e.g., mass unit of monopolistically competitive firms, long-run risk of productivity growth, Epstein-Zin utility function, adjustment costs and so on) must be made to explain the above-mentioned phenomena. The same holds for the model developed by Melitz and Ottaviano (2008). The latter models are relatively complicated and require a number of assumptions to be fulfilled. Nevertheless, it can be argued that these models and the model proposed in this paper are complementary. Our model coincides with both the new and old stylized facts and reveals how the underlying mechanisms work. Throughout the paper, we assume that market concentration is increasing.

The rest of the paper is organized as follows. In Section 2, we provide justifications for assuming that market concentration is increasing. In Section 3, we introduce the model, and show that with increasing market power, the labor income share, the capital income share and interest rate will decline. Furthermore, we derive that the wealth to income ratio, the profit share and profits increase with increasing market power. In Section 4, we summarize the results and conclude.

2. Background of Increasing Market Power

The ideals of perfectly competitive markets was never an economic reality. For example, Ogilvie (2014) or Ogilvie and Carus (2014) have noted that occupational guilds have restricted market entry and therefore competition in ancient Egypt, Greece or Rome and throughout the Middle Ages. As noted by Piketty (2014), in the age of industrialization, markets were mostly highly concentrated. Historically, among other things, politics have determined the institutional framework of markets and accordingly dictated the degree of competition. Obviously, the period between the end of World War II and the 1980s was characterized by relatively strong competition in good markets; this was also the time of relatively strong anti-trust measures giving rise to the establishment of anti-trust legislation in most western economies. In this period of the cold war, a competition between the western capitalistic system and the Soviet planned economy took place. This competition of systems has incentivized western policymakers to prevent the show up of capitalism's ugly face in the form of labor- and consumer-exploiting monopolies and oligopolies. Thus, in many western countries, welfare states were established and market concentration was either prevented by anti-trust laws or industries were directly regulated. However, this period ended according to Piketty (2014) with the victories of Margaret Thatcher (UK) and Ronald Reagan (USA) in the early 1980s. These political changes were accompanied with alternative views on market regulation, such as the idea of contestable markets of Baumol et al. (1982). The underlying idea is that even a monopolist will be prevented from setting a monopoly price if there is sufficient pressure of potential competitors, who could immediately enter the market. These political and economic developments have paved the way for a wave of deregulation in almost all industries in the economy. In particular, from the 1980s until today, a huge number of mergers between global players took place in traditional industries, which often resulted in price hikes (Kwoka 2013). However, a precondition for the evolvement of oligopolies or monopolies are barriers to enter a market.

The most common cases for the existence of a monopoly or oligopolies are declining average costs or economies of scale in the relevant range of demand.

Karakaya (2002) notes that technological or economic barriers to entry, such as absolute cost advantage held by incumbent firms, capital requirements to enter the market or the amount of sunk cost involved in entering the market, are considered as important barriers to entry in the US markets. Djankov (2009) emphasizes the role of barriers to entry induced by government regulation. Although regulations are partly in the public interest (Pigou 1938) to protect consumers from unsafe and bad products, they nevertheless represent a barrier to entry. In the view of Stigler (1971), market incumbents acquire market regulation to operate for their profits. Djankov et al. (2002), Zingales (2012, 2017) and Shleifer and Vishny (1993) go a step further and argue that policymakers erect barriers to entry with the intention obtain a share of rents earned by the protected incumbent firms. Sometimes the share of profits received by policymakers is paid indirectly by offering them posts such as membership of the board of directors or by contributions for election campaigns. Sometimes, policymakers receive direct payments, although this is illegal in many countries. However, if we see how often and how much firms support policymakers and political parties in western countries, it is obvious that policymakers cannot have an interest in perfectly competitive markets, because then firms would be unable to make significant financial contributions to policymakers and their parties.

The most recent idea used to explain the increasing market concentration in the US and elsewhere is the so-called "superstar firm" phenomenon (Autor et al. 2020). The idea works for firms with positive network externalities. This leads to the result that competition is not in the market, but for the market, and the winner of this competition takes the most or all of this market. Typical examples for these superstar firms are Google, Uber, Facebook, AirBnB, Twitter, Apple or Microsoft. Network externalities occur, if consumers' utility of a product rises with an increasing number of other consumers using or buying the product or service. 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 of survival in the market is close to zero. Therefore, the market incumbent has less to fear of competition and accordingly it can exploit this situation. In addition, one anti-competitive behavior is that incumbents in this market acquire startups, which could become potential competitors. For example, Facebook has acquired WhatsApp and Instagram to prevent competition, as well as to collect more data of customers, which potentially improves its position as a supplier of big data. A problem with these superstar firms is that, it is not really clear how to regulate them because it makes less sense to split them into parts given the market characteristics. Hence, it is most efficient from the view of consumers that only a few firms serve the market.

Another reason (Zingales 2012) for the establishment of oligopolies in the last 40 years is the "too big to fail" argument. The bigger the struggling firms in terms of number of employees, the higher the probability of governments bailing out these economically struggling firms. Because investors and banks recognize this relationship, incumbents can finance investments at much lower costs than potential or smaller competitors can (because banks can implicitly assume a state guarantee).

Because of the developments described above, it is less surprising that western economies are becoming progressively concentrated.

3. The Model

In this section, we formulate the model of a closed economy, where we use a Diamond (1965) overlapping generation model on the side of households and a combination of the models of Grossman and Yanagawa (1993) and Kumar and Stauvermann (2020) on the production side of the economy.

3.1. The Households

We follow Che et al. (2021) to model the households. The underlying idea goes back to Grossman and Yanagawa (1993) and Stauvermann (2002), who use a two period OLG approach. We assume that the population size is fixed to 2*N*, so that each generation has *N* members. A young representative individual supplies labor inelastically, earns an income $y_{i,t}$, consumes c_t^1 of it, rents a house or an apartment of size h_t and saves the remaining part of her income. In the second period of life, the consumption of an individual c_{t+1}^2 equals the interest payment plus her savings. The savings can be either invested in real capital or in land. We make the simplifying assumption, without loss of generality, that only young individuals demand housing. In particular, regarding the utility function, we follow Skinner (1996) or Deaton and Laroque (2001):

$$U_t(c_t^1, c_{t+1}^2, h_t) = lnc_t^1 + qlnc_{t+1}^2 + vlnh_t, \quad (1)$$

where $q > 0$ is the subjective discount factor and $v > 0$ is the preference parameter for housing. The variable h_t represents the quantity of housing (size of an apartment or house). For the sake of simplicity, we assume that construction costs of houses, office buildings and factories are zero. Hence, only the land needed for housing determines the cost of housing. This simplifying assumption can be justified by the results of Knoll et al. (2017), who have empirically shown that the evolution of real estate prices in the last 70 years is largely (80%) driven by the evolution of land prices. The respective budget constraints of the representative individual is given by:

$$c_t^1 + r_t^h h_t = y_{i,t} - s_t, \tag{2}$$

$$c_{t+1}^2 = R_{t+1} s_t, \tag{3}$$

where the rental rate per unit of housing equals r_t^h in period t and the market interest factor is R_{t+1} in period $t + 1$. As noted above, the individual rents a house only in the first period of life and in the second life the elderly either stay in the house of their child or live in their own house. Therefore, the utility maximization problem of an individual can be written as:

$$\max_{s_t, h_t} ln\left(y_{i,t} - s_t - r_t^h h_t\right) + q ln(R_{t+1} s_t) + v ln h_t. \tag{4}$$

Differentiation of Equation (4) with respect to housing and savings yields the following necessary conditions for a utility optimum:

$$\frac{1}{y_{i,t} - s_t - r_t^h h_t} - \frac{q}{s_t} = 0, \tag{5}$$

$$\frac{1}{y_{i,t} - s_t - r_t^h h_t} - \frac{v}{h_t} = 0 \tag{6}$$

Using (5) and (6), we can determine the optimal amount of savings and housing of the representative individual:

$$s_t^* = \frac{q}{(1+q+v)} y_{i,t}, \tag{7}$$

$$h_t^* = \frac{v}{r_t^h (1 + q + v)} y_{i,t.} \tag{8}$$

The consumption in the first period of life and expenditure for housing are linear in the income. The demand for housing depends negatively on the rental rate r_t^h.

Regarding the income, we assume the existence of two types of individuals; workers, who earn a wage rate w_t and firm owners or entrepreneurs who receive also a wage income w_t and additionally a profit income π_t. We assume that the number of firms is given by $nm > 0$. The firm owners inherit the firm from their parent at the beginning of the first period of life.

The aggregate demand for housing L_t^h becomes:

$$L_t^h = \sum h_t^* = \frac{v}{r_t^h (1+q+v)} (N w_t + nm \pi_t), \tag{9}$$

3.2. The Production

To ensure that firms with market power on the intermediate good markets do not have market power on factor markets we follow Kumar et al. (2021) and assume that the quantity of final consumption goods Y is produced in a perfectly competitive market. The firms of the final good sector use intermediate inputs of quantity Q_j to produce the final good, which can be consumed or invested. Let us assume that m different intermediate goods are produced in this economy, where m is a sufficiently large number, such that the oligopolistic firms cannot influence the factor prices. A representative firm in the final good sector uses the following production function:

$$Y = m \prod_{j=1}^{m} \left(Q_j\right)^{\frac{1}{m}}, \tag{10}$$

where the quantity of intermediate inputs is represented by Q_j, which is produced in the j-th sector of the intermediate good market. Production function (10) is symmetric and linear-homogenous in all m intermediate goods. We define the final good as numeraire. The profit function of a firm in the final good is given by:

$$\Pi_y = m \prod_{j=1}^{m} (Q_j)^{\frac{1}{m}} - \sum_{j=1}^{m} p_j Q_j, \quad (11)$$

where p_j is the price of the j-th intermediate good. Reformulating the optimality conditions resulting from the profit maximization of (11), leads to the following inverted demand function for intermediate good j:

$$p_j(Q_j) = \frac{Y}{mQ_j}, \forall j = 1, \dots, m. \quad (12)$$

Furthermore, we assume that n oligopolistic firms compete in each of the m intermediate good markets. This assumption implies that we are considering aggregate nm symmetric oligopolistic firms. All firms have the same production function, which is given by:

$$Q_{k,j} = A(K_{k,j})^{\alpha} (\bar{k} N_{k,j})^{1-\alpha-\sigma} (K L_{k,j}^{p})^{\sigma}, \quad (13)$$

where $0 < \sigma + \alpha < 1$. The production function is linear-homogenous in the firm-specific input factors $\{K_{k,j} \text{ (capital)}, N_{k,j} \text{ (labor)}, L_{k,j}^{p} \text{(land)}\}$. Additionally, the following holds because of the symmetry of all firms: $K = \sum_{j=1}^{m} \sum_{k=1}^{n} K_{k,j}$, $L_t^p = \sum_j^m \sum_{k=1}^{n} L_{k,j}^p$, $N = \sum_{j=1}^{m} \sum_{k=1}^{n} N_{k,j}$ and $\bar{k} = \frac{K}{N}$.

The underlying idea of this production function is taken from Frankel (1962), Romer (1986), Rebelo (1991) and Stauvermann (1997), and specifically from Grossman and Yanagawa (1993). This production function exhibits two positive externalities. The first externality is related to the economy-wide capital intensity, which positively affects the labor productivity. The second positive externality results from the economy-wide capital stock and affects the productivity of land. The idea behind the latter externality is associated with the observation that the more agglomerated an industry, the more productive each parcel of land is. Using this production function, the profit maximization problem of an oligopolist k in the intermediate good market j, who engages in a Cournot competition, is given by:

$$\max_{K_{t,j}, N_{t,j}, L_{t,j}^{p}} \Pi_{k,j}(Q_{k,j}, Q_{j,-k}) = \max_{K_{t,j}, N_{t,j}, L_{t,j}^{p}} p(Q_j) Q_{k,j} - R K_{k,j} - w N_{k,j} - r^p L_{k,j}^{p}, \quad (14)$$

where $Q_j = \sum_{k=1}^{n} Q_{k,j}$ and $Q_{j,-k} = \sum_{\substack{k=1 \\ j \neq k}}^{n} Q_{k,j}$. Inserting (13) in (14), differentiation with respect to the input factors delivers the following first conditions:

$$\frac{\partial \Pi_{k,j}}{\partial K_{k,j}} = [p'(Q_j) Q_{k,j} + p(Q_j)]\, \alpha A(K_{k,j})^{\alpha-1} (\bar{k} N_{k,j})^{1-\alpha-\sigma} (K L_{k,j}^{p})^{\sigma} - R = 0, \quad (15)$$

$$\frac{\partial \Pi_{k,j}}{\partial N_{k,j}} = [p'(Q_i) Q_{i,j} + p(Q_i)]\, \frac{(1-\alpha-\sigma) A(K_{k,j})^{\alpha} \bar{k}^{1-\alpha-\sigma} (K L_{k,j}^{p})^{\sigma}}{(N_{k,j})^{\alpha+\sigma}} - w = 0, \quad (16)$$

$$\frac{\partial \Pi_{k,j}}{\partial L_{k,j}^{p}} = [p'(Q_i) Q_{i,j} + p(Q_i)]\, \frac{\sigma A(K_{k,j})^{\alpha} (\bar{k} N_{k,j})^{1-\alpha-\sigma} K^{\sigma} (L_{k,j}^{p})^{\sigma-1}}{(L_{k,j}^{p})^{\sigma}} - r^p = 0, \quad (17)$$

In the equilibrium the following equalities hold: $K_j = \sum_{k=1}^{n} K_{k,j} = \frac{K}{m}$, $L_j^p = \sum_{k=1}^{n} L_{k,j}^p = \frac{L^p}{m}$ and $N_j = \sum_{k=1}^{n} N_{k,j} = \frac{N}{m}$. Furthermore, the symmetry assumptions lead to the result $K_{k,j} = \frac{K}{mn}$, $L_{k,j}^p = \frac{L^p}{mn}$ and $N_{ij} = \frac{N}{mn}$.

Using these equalities, and after some reformulations, we have:

$$\left(\frac{n-1}{n}\right)\ \alpha A\left(K_{k,j}\right)^{\alpha-1}\left(\bar{k}N_{k,j}\right)^{1-\alpha-\sigma}\left(L_{k,j}^{p}\right)^{\sigma}=\left(\frac{n-1}{n}\right)\ \alpha A(L^{p})^{\sigma}=R, \tag{18}$$

$$\left(\frac{n-1}{n}\right)\frac{(1-\alpha-\sigma)A\left(K_{k,j}\right)^{\alpha}\bar{k}^{1-\alpha-\sigma}\left(KL_{k,j}^{p}\right)^{\sigma}}{\left(N_{k,j}\right)^{\alpha+\sigma}}=\left(\frac{n-1}{n}\right)(1-\alpha-\sigma)A(L^{p})^{\sigma}\frac{K}{N}=w, \tag{19}$$

$$\left(\frac{n-1}{n}\right)\frac{\sigma A\left(K_{k,j}\right)^{\alpha}\left(\bar{k}N_{k,j}\right)^{1-\alpha-\sigma}K^{\sigma}\left(L_{k,j}^{p}\right)^{\sigma-1}}{\left(L_{k,j}^{p}\right)^{\sigma}}=\left(\frac{n-1}{n}\right)\sigma A(L^{p})^{\sigma-1}K_{t}=r^{p}=r^{h}. \tag{20}$$

The price of an intermediate good, $p_j = 1$ in the equlibrium, and using results above, the value added of production becomes:

$$Y_t = AK_t(L^p)^{\sigma}. \tag{21}$$

The aggregate profits can be calculated as:

$$\Pi = AK(L^p)^{\sigma} - RK - wN - r^pL^p = \frac{AK(L^p)^{\sigma}}{n}. \tag{22}$$

Because of the symmetry of all firms, the profit per firm becomes:

$$\Pi_{k,j} = \frac{\Pi}{mn} = \frac{AK(L^p)^{\sigma}}{mn^2}. \tag{23}$$

Now we have determined all factor prices and the profits of firms.

3.3. The Allocation of Land

The rental rate of land earned as input of the factor land is r^p and the rental rate of land earned from renting out land for housing is r^h. Non-arbitrage requires that both rental rates are equal; i.e., $r^p = r^h$. From (9), (19) and (23) we can derive the rent earned on the housing market as:

$$r^h = \frac{v}{L^h(1+q+v)}\left((n-1)(1-\alpha-\sigma)+1\right)\frac{AK(L^p)^{\sigma}}{n}, \tag{24}$$

Given that the total land is fixed to L, we can substitute $L^h = L - L^p$ in (24) and then we have the non-arbitrage condition for land, which can be written as:

$$\frac{v}{(L-L^p)(1+q+v)}\left((n-1)(1-\alpha-\sigma)+1\right)\frac{AK(L^p)^{\sigma}}{n} = \left(\frac{n-1}{n}\right)\sigma A(L^p)^{\sigma-1}K. \tag{25}$$

Solving for the land used in production yields:

$$L^{p*} = \frac{(n-1)\sigma(1+q+v)}{\gamma\left((1-\alpha-\sigma)n+\sigma+\alpha\right)+\sigma\left((1+q+v)(n-1)\right)}L, \tag{26}$$

For our purposes, it is important to know how the allocation of land is affected by the number of firms in the intermediate good markets. Thus, we differentiate the land used as input factor of production with respect to the number of firms n:

$$\frac{\partial L^{p*}}{\partial n} = \frac{(n-1)\sigma v(1+q+v)L\left(n-(\alpha+\sigma)(n-1)\right)}{\left[\gamma\left((1-\alpha-\sigma)n+\sigma+\alpha\right)+\sigma\left((1+q+v)(n-1)\right)\right]^2} > 0. \tag{27}$$

From this result, we can directly derive Proposition 1 (below).

Proposition 1. *The land, which is used as input factor of production, increases with an increasing number of firms. Accordingly, more competition will decrease the allocation of land for housing. In other words, an increasing market power of firms will increase the use of land for housing and will decrease the land used in production.*

The intuition behind this result is that more competition will induce an increase in the wage incomes and an over-proportional decline in the profit incomes. A decline in the profits will lead to an increase in the labor income and capital income, because the respective income shares will increase. However, from (29) and (31) (below), it becomes implicitly clear that it is not possible that the change in the aggregated labor income can compensate the loss of profits. Because the income share of the young generation consists of the labor income share and the profit share, it is obvious that the income and income share of the young generation (see Equations (33) and (35) below) will decline, and therefore the demand for housing will become weaker. This result implies, because of the diminishing returns of land in production, that the rental rate of land will decline (see also Equation (30) below).

Proposition 2. *If the number of competitors increase, the rental rate for land will decline and consequently housing will become cheaper. In other words, with increasing market concentration, the rental rate of land will increase and housing will become more expensive.*

This effect is somewhat surprising, because it links market concentration to the costs of housing. The intuitive reasoning is that a redistribution of income from the old to the young generation via increasing profits is induced by declining market competition.

3.4. Comparative Statics

It is important to know how the value added of production reacts if the intermediate markets will become more competitive. For this purpose, we insert (26) in (21) and differentiate with respect to the number of firms n, as:

$$\frac{\partial Y}{\partial n} = AK(L^{p*})^{\sigma}\frac{\partial L^{p*}}{\partial n} > 0. \tag{28}$$

The derivative is positive, because the amount of land used in production increases (as a consequence of Proposition 1). The profits of firms are affected in the following way by an increase in the number of competitors. This is given by:

$$\frac{\partial \Pi}{\partial n} = -AK(L^{p*})^{\sigma}\left[\frac{((1-\sigma)n-1)\nu\big(n-(n-1)(\alpha+\sigma)\big)+\sigma(n-1)^2(1+q+\nu)}{n^2(n-1)\big(\nu\big(n-(n-1)(\alpha+\sigma)\big)+\sigma(1+q+\nu)(n-1)\big)}\right] < 0, \tag{29}$$

The aggregate profits will decline, although the value added of production increases. The reason is as follows: the increase in value added due to the re-allocation of land is outweighed by the decrease in the profit share induced by the increased number of firms. Now, we derive the changes in the factor prices as follows:

$$\frac{\partial r^p}{\partial n} = \sigma AK(L^{p*})^{\sigma-1}\left[\frac{(1-(1-\sigma)n)\nu\big(n-(n-1)(\alpha+\sigma)\big)+\sigma(n-1)^2(1+q+\nu)}{n^2\big(\nu\big(n-(n-1)(\alpha+\sigma)\big)+\sigma(1+q+\nu)(n-1)\big)}\right] < 0, \tag{30}$$

$$\frac{\partial w}{\partial n} = (1-\alpha-\sigma)AK(L^{p*})^{\sigma}\left[\frac{(1+n\sigma)\nu\big(n-(n-1)(\alpha+\sigma)\big)+\sigma(1+q+\nu)(n-1)}{Nn^2\big(\nu\big(n-(n-1)(\alpha+\sigma)\big)+\sigma(1+q+\nu)(n-1)\big)}\right] > 0, \tag{31}$$

$$\frac{\partial R}{\partial n} = \alpha A(L^{p*})^{\sigma}\left[\frac{(1+n\sigma)\nu\big(n-(n-1)(\alpha+\sigma)\big)+\sigma(1+q+\nu)(n-1)}{n^2\big(\nu\big(n-(n-1)(\alpha+\sigma)\big)+\sigma(1+q+\nu)(n-1)\big)}\right] > 0, \tag{32}$$

The derivatives show that an increasing competition leads to an increase in the wage rate and interest factor, while the rental price for land and the profits decline. This means that from the view of workers, more competition has two positive effects. On the one hand, the wages will increase, and on the other hand, the housing will become cheaper. Additionally, more competition will also lead to an increased value added of production. This effect is caused by the relocation of land from consumption (housing) to productive purposes.

We summarize the results from the derivatives above in Proposition 3.

Proposition 3. *An increase in firms' market power will result in a decline in national income, wage rates and interest rates. Furthermore, the rental rate of land and profits will increase as a consequence of a reduced number of firms in the intermediate markets.*

In reality, as noted above for developed countries over the last 40 years, the income shares of capital and labor have declined, while the profit share has increased. To show that this is also valid in this model, we recall that the labor share is $S_L = \left(\frac{n-1}{n}\right)(1-\alpha-\sigma)$, the capital share is $S_C = \left(\frac{n-1}{n}\right)\alpha$ and the profit share is $S_\Pi = \frac{1}{n}$. Differentiating these shares, we have:

$$\frac{\partial S_L}{\partial n} = \frac{(1-\alpha-\sigma)}{n^2} > 0, \tag{33}$$

$$\frac{\partial S_C}{\partial n} = \frac{\alpha}{n^2} > 0, \tag{34}$$

$$\frac{\partial S_\Pi}{\partial n} = -\frac{1}{n^2}, \tag{35}$$

Proposition 4. *An increase in firms' market power will lead to a decline in the labor and capital shares of income and to an increase in the profit share. Simultaneously, the income of landowners will also increase.*

The last part of the Proposition 4 follows from the result that more market power leads to a higher rental rate of land (30). Hence, the incomes and the income share of landlords will increase. Thus, the effect of increasing market power on the incomes of the old generation is ambiguous; the elderly who have invested their savings in capital are worse off, while the elderly who have invested their savings in land are better off. It should be noted that in the case that the purchase of land is associated with indivisibilities, so that only wealthy citizens (here former entrepreneurs) are able to buy land, the distributional effects of increasing market power are to the advantage of the wealthy citizens.

3.5. The Dynamics

In this section, we analyze the dynamic effects of imperfect competition on the equlibrium values. The capital market clearing condition is given by:

$$S_t = \frac{q(1-\alpha-\sigma)}{(1+q+v)}\left(\left(\frac{n-1}{n}\right)(1-\alpha-\sigma)+\frac{1}{n}\right)A\left(L_t^{p*}\right)^\sigma K_t - p_t^L L = K_{t+1}, \tag{36}$$

where S_t is the aggregate savings of the young generation and p_t^L is the price of a unit of land. The capital stock in period t+1 equals the aggregate savings minus the total expenditures for land purchases. Using (7), we define the savings rate as $s = \frac{q}{(1+q+v)}$, and divide both sides of (36) by K_t, then the growth factor of capital $1+g_t$ becomes:

$$1+g_t = s\big((n-1)(1-\alpha-\sigma)+1\big)\frac{A\left(L_t^{p*}\right)^\sigma}{n} - \frac{p_t}{K_t}L, \tag{37}$$

The non-arbitrage condition between investing in land and in real capital is given by:

$$Rp_t = r_{t+1}^p + p_{t+1} = r_{t+1}^h + p_{t+1}. \tag{38}$$

It is useful to define $\theta_t = \frac{p_t}{K_t}$, which is the land price measured in capital units. Inserting θ_t in (37), and additionally, inserting (18), (20) and (37) in (38), we have:

$$\theta_{t+1} - \frac{\alpha\left(\frac{n-1}{n}\right)A\left(L_t^{p*}\right)^\sigma\theta_t}{s\big((n-1)(1-\alpha-\sigma)+1\big)\frac{A\left(L_t^{p*}\right)^\sigma}{n} - \theta_t L} + \sigma\left(\frac{n-1}{n}\right)A\left(L_t^{p*}\right)^{\sigma-1} = 0 \tag{39}$$

In the long-run equilibrium, the equality $\theta_{t+1} = \theta_t = \theta^*$ holds. Solving for θ^* delivers a function depending on the total amount of land L and the number of firms n:

$$\theta^* = \theta(n, L), \tag{40}$$

with $\theta_n(n,L) < 0$, $\theta_{nn}(n,L) < 0$, $\theta_L(n,L) < 0$ and $\theta_{LL}(n,L) < 0$.

In particular, the characteristic that the price of land will decline with an increasing number of firms is important. This is illustrated in Figure 1, which results from a calibration.

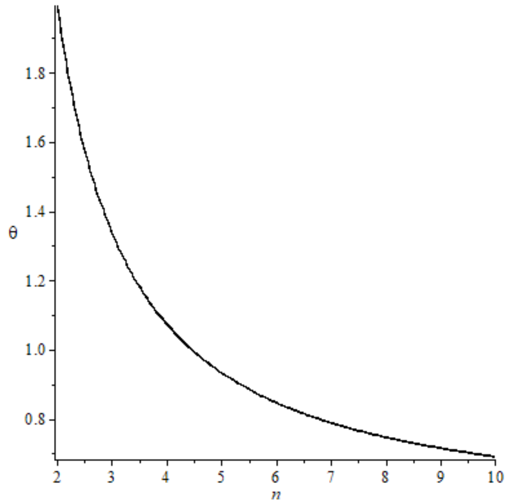

Figure 1. Price of land measured in terms of capital and number of firms.

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on 5. *If the intermediate markets will become more competitive, the price of land measured in terms of capital units will decline. In other words, if the firms gain more market power, the price of land measured in capital units will increase.*

Proof. See Appendix A. □

The intuition of Proposition 5 is as follows. If the number of firms declines and they gain more market power, the aggregate profits will increase at the costs of the workers and the capital owners. Therefore, the disposal income and the expenditure for housing of the young generation consisting of workers and firm owners will increase. This intergenerational redistribution of income will lead to an increase in the price of land and the rental rates of housing.

As we know from Hahn (1966) and Shell and Stiglitz (1967), a market equilibrium with heterogeneous assets in the absence of a full set of future markets extending infinitely far into the future or without perfect foresight is dynamically unstable. Therefore, steady-state equilibrium under such circumstances is a saddle point. This is also valid in this model. Using the implicit function defined by (39), the derivative of the implicit function delivers:

$$\frac{d\theta_{t+1}}{d\theta_t} = \frac{R^* + L\left[\left(\frac{n-1}{n}\right)\sigma A\left(L_t^{p*}\right)^{\sigma-1} + \theta^*\right]}{1 + g(\theta^*)} > 1. \quad (41)$$

The inequality holds, because of the following proposition, which states that $R^* > 1 + g(\theta^*)$.

Proposition 6. *The long-run equilibrium of this economy is always dynamically efficient, in the sense that the interest factor always exceeds the growth factor of this economy.*

Proof. Inserting $\theta^* = \theta_t = \theta_{t+1}$ in non-arbitrage condition (38) and after some reformulations, we have:

$$\left(R^* - \left(1 + g(\theta^*)\right)\right)\theta^* = \sigma A\left(L_t^{p*}\right)^{\sigma-1}\left(1 + g(\theta^*)\right). \quad (42)$$

On the RHS, we have the rental rate for land times the growth factor of capital, which is always positive, and on the LHS, we have the difference between the interest factor of capital and the growth factor of capital times the price of land in terms of capital goods, which is always non-negative. Consequently, $R^* > \left(1 + g(\varphi^*)\right)$ holds in the long-run equilibrium. □

The equilibrium situation is calibrated in Figure 2. The dashed line represents the function $\theta_{t+1} = \theta_t$ and the solid line represents the implicit function (39).

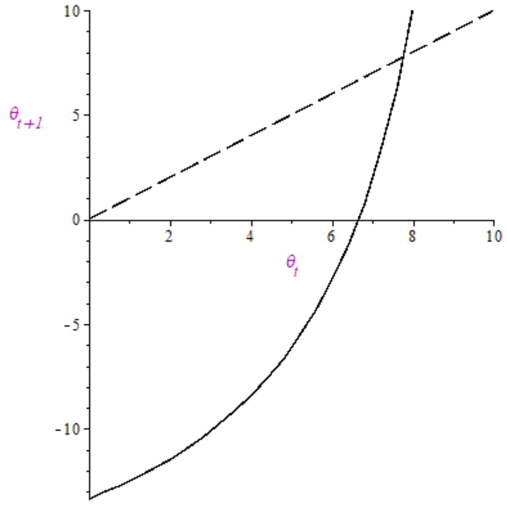

Figure 2. Equilibrium price of land measured in terms of capital.

Because of the saddle-point stability, we assume that the individuals are equipped with perfect foresight.

The national income *NI* is the sum of the value added of production Y_t and the income from lending out land to private households $r_t^h L_t^h$:

$$NI_t = Y_t + r_t^h L_t^h = A\left(L_t^{p*}\right)^{\sigma} K_t \left(1 + \frac{\nu\left((n-1)(1-\alpha-\sigma)+1\right)}{n(1+q+\nu)}\right). \quad (43)$$

Obviously, the national income depends linearly on the capital stock, hence the growth rate of the capital stock determines the growth rate of the national income. If we differentiate the national income with respect to the numbers of firms, we have:

$$\frac{\partial NI_t}{\partial n} = A\left(L_t^{p*}\right)^{\sigma} K_t \nu \left[\frac{\sigma\left((\nu(2-\alpha-\sigma)+1+q)n+\nu(\sigma+\alpha)\right)}{n(n-1)(1+q+\nu)\left[n\left(\nu(1-\alpha)+\sigma(1+q)\right)+n\nu-\sigma(1+q)\right]} - \frac{(\sigma+\alpha)}{n^2(1+q+\nu)}\right] \lesseqgtr 0. \quad (44)$$

We know from (28) that the value added of production will increase with the declining market power of firms, but the income earned from lending out land for housing will also decline, and thus the overall effect on the national income is ambiguous. If the preference for housing is relatively strong, the national income will decline with an increasing number of firms and if the preference for housing is relatively weak, the national income will increase.

Now, we can reformulate the equilibrium growth factor of the capital stock as follows:

$$1 + g^* = s\left((n-1)(1-\alpha-\sigma)+1\right)\frac{A\left(L_t^{p*}\right)^{\sigma}}{n} - \theta(n,L)L. \quad (45)$$

We can analyze the effect of increasing competition on the growth factor. For this purpose, we differentiate the growth rate with respect to the number of firms.

$$\frac{\partial g^*}{\partial n} = \frac{A\left(L_t^{p*}\right)^{\sigma}}{n^2}\left(\underbrace{ns(1-\alpha-\sigma)}_{>0} + \underbrace{s\left((n-1)(1-\alpha-\sigma)+1\right)\left(\sigma\eta_{L_t^{p*},n} - 1\right)}_{\lesseqgtr 0}\right) - \underbrace{\theta_n L}_{<0} \lesseqgtr 0, \quad (46)$$

where $\eta_{L_t^{p*},n} = \frac{\partial L_t^{p*}}{\partial n}\frac{n}{L_t^{p*}} > 0$ is the elasticity of the amount of land used in production with respect to the number of firms in each intermediate market. The value of elasticity is in most cases smaller than one (see Appendix A).

Unfortunately, the reaction of the growth rate on a change in the number of firms is ambiguous, because counteracting effects will be induced by an increase in the number of firms. First, the income of workers will increase, but the income of entrepreneurs will decline. Second, the share of income earned by the young generation will also decline, because part of the income loss of the entrepreneurs will be received by old capital owners. Third, the share of land used for production will increase, so that the value added of production increases. Fourth, the price of land will decline, which has a positive impact of capital accumulation. In Equation (46), the first term in brackets represents the increase in the workers' income, the second term represents the decline in the profits and the increase in national income caused by the increased share of land used for production. The last term of the expression on the RHS represents the decline in the value of land measured in capital units. Whether the growth rate will increase or decrease depends crucially on the private production elasticity of capital α, the production elasticity of land σ, and the preference for housing ν. If the sum of $\alpha + \sigma$ is sufficiently small and the preference for housing sufficiently strong, the growth rate will increase with the number of firms; however, if the opposite holds, the growth rate will decline. The reason for this consideration is that a small sum of $\alpha + \sigma$ guarantees that the inter-generational income redistribution caused by a change in market power is small, and it therefore causes mainly an intra-generational income redistribution from workers to entrepreneurs. A relative strong preference for housing guarantees that the increase in land for production purposes is relatively huge if more firms are in the markets.

In a next step, we analyze the wealth to income ratio (which, as noted in the empirical literature, has increased in the last 40 years). The wealth W in this economy is given by the capital stock plus the value of land.

$$W_t = K_t + p_t^L L = K_t(1 + \theta^* L). \tag{47}$$

Before we consider the wealth–income ratio, we differentiate the wealth with respect to the numbers of firms:

$$\frac{\partial W_t}{\partial n} = \theta_n^* K_t L < 0. \tag{48}$$

The wealth declines because the price of land declines with an increasing number of firms. Thus, the ratio between wealth and income is given by:

$$\frac{W_t}{NI_t} = \frac{K_t(1+\theta^* L)}{A\left(L_t^{p*}\right)^\sigma K_t\left(1+\frac{\nu((n-1)(1-\alpha-\sigma)+1)}{n(1+q+\nu)}\right)} = \frac{(1+\theta^* L)}{A\left(L_t^{p*}\right)^\sigma \left(1+\frac{\nu((n-1)(1-\alpha-\sigma)+1)}{n(1+q+\nu)}\right)}, \tag{49}$$

Differentiating the ratio with respect to the number of firms leads to:

$$\frac{\partial\left(\frac{W_t}{Y_t}\right)}{\partial n} = \frac{\theta_n^* L A\left(L_t^{p*}\right)^\sigma\left(1+\frac{\nu((n-1)(1-\alpha-\sigma)+1)}{n(1+q+\nu)}\right) - \frac{\partial\left(\frac{NI_t}{K_t}\right)}{\partial n}(1+\theta^* L)}{\left(A\left(L_t^{p*}\right)^\sigma\left(1+\frac{\nu((n-1)(1-\alpha-\sigma)+1)}{n(1+q+\nu)}\right)\right)^2} < 0. \tag{50}$$

The derivative is negative because the price of land measured in terms of capital declines with increasing competition, and the land used in production increases with increasing competition. Even if the national income declines, the decline is weaker than the decline in wealth (see Appendix A for details). Thus, the wealth to income ratio declines with increasing competition.

Proposition 7. *If the number of firms increases, the wealth to income ratio will decline. In other words, if the market power of firms increases, the wealth to income ratio will rise. This result is independent from the savings rate.*

Another empirical fact is that the real price of land to income has increased. We differentiate the ratio between the real price of land to income to find:

$$\frac{\partial\left(\frac{p_t^L}{Y_t}\right)}{\partial n} = \frac{\theta_n^* A\left(L_t^{p*}\right)^{\sigma} - \sigma A\left(L_t^{p*}\right)^{\sigma-1}\left(\frac{\partial L_t^{p*}}{\partial n}\right)\theta^*}{\left(A\left(L_t^{p*}\right)^{\sigma}\right)^2} < 0. \quad (51)$$

From this result, we can derive Proposition 8.

Proposition 8. *If the number of firms increases, the real price of land related to income will decline. In other words, if the market power of firms increases, the real price of land to income ratio will rise.*

Proposition 8 coincides with the empirical results derived by Knoll et al. (2017) regarding land prices.

4. The Conclusions

It was the aim of the paper to develop a model, which is compatible with the new stylized facts of economic growth. The proposed model extends the established neoclassical growth model with a minimum of additional assumptions. It can be argued that the standard neoclassical growth model is a special case of the model proposed in this paper, because if the number of firms strives to infinity it will become the standard neoclassical growth model. The advantage of this approach compared to alternative models is that we can directly compare different market structures regarding their outcomes with respect to growth and welfare. The model can also be used to analyze issues such as different social security systems, government debt or taxes in a model with imperfect competition. The outcomes can then be compared with the outcomes of the standard growth model. This will probably yield new insights for policy recommendations.

We also introduced land as a factor of production and a consumer good. We were able to show that increasing market concentration contributes significantly to the disproportionate increase in land prices, as can be observed in most industrialized countries. In addition, in our model, the ratio of wealth to income increases with increasing market concentration. This is not the case with similar models without land (Kumar and Stauvermann 2020, 2021). However, this is less surprising and we would expect a similar result if financial assets were introduced in the model. Furthermore, with help of the model, we can explain why the costs of housing increase over-proportionally, if markets are becoming more concentrated.

It should be noted that the effect of increasing market concentration on the economic growth is ambigous and this confirms the results of some recent studies (Kumar and Stauvermann 2020, 2021) and Stauvermann and Kumar (2021).

One important result of this paper is the outcome that the wealth will increase, because of the fact that the price of land will increase with increasing market power. Additionally, the costs of housing will also increase with increasing market power. If we would assume indivisilibities of land as it is in reality, then only rich members are able to purchase land, with the consequence that the wealth of the rich will increase at a faster rate than the wealth of the poor with increasing market power. These outcomes partly explain the observations made by Piketty (2014). Of course, we do not deny that there could be other reasons, such as a growing population, urbanization, housing bubbles and so on that could potentially lead to the rise in land and real estate prices (c.f. Li et al. 2021). In any case, to the best of our knowledge, it is a new insight that market concentration may influence the prices in the real estate market, and hence this is worth investigating further.

In this paper, we have assumed that the agents are equipped with perfect foresight to ensure the stability of the long-run growth equlibrium, which is not unusal in this model framework, but nevertheless it is a strong assumption. If we give up this assumption, the model will become unstable in the sense that the land price would either increase until the land price bubble will burst or decrease until the price reaches a value of zero. Analyzing these scenarios may help us to understand why the US is experiencing a real estate bubble around every 18 years (Foldvary 2007).

Finally, we want to note that we have assumed throughout the paper that the changes in the industrial structure and market power are exogenous and this is a weak point of the model. Thus future work can consider endogenizing the industrial structure and market power.

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Appendix A

Here, we present the explicit results for some variables.

The optimal price of land in terms of capital units is given by:

$$\theta^* = \frac{A}{nL(1+q+\nu)}\left[\sqrt{4q\big(n-(n-1)(\alpha+\sigma)\big)\Big(\sigma(n-1)(1+q)+\nu\big(n-\alpha(n-1)\big)\Big)\left(L_p^*\right)^{2\sigma}+4\left(L_p^*\right)^{2\sigma}\left((\alpha+\sigma)(n-1)\left(\frac{1}{2}+q\right)-\frac{1}{2}n(q-\nu)\right)^2} - 2\left(L_p^*\right)^{\sigma}\left(n\left(q\left(\alpha+\sigma+\frac{1}{2}\right)-\frac{1}{2}(\alpha+\sigma+\nu)\right)-(\alpha+\sigma)\left(q+\frac{1}{2}\right)\right)\right], \quad \text{(A1)}$$

where $L_p^* = \frac{L\sigma(n-1)(1+q+\nu)}{(1+q)(n-1)\sigma+\nu(n(1-\alpha)-\alpha)}$. Now θ^* can be differentiated with respect to n and L, to find: $\theta_n(n,L) < 0$, $\theta_{nn}(n,L) < 0, \theta_L(n,L) < 0$ and $\theta_{LL}(n,L) < 0$. In particular, the derivative $\theta_n(n,L) < 0$ is sufficient to proof that Proposition 4 is valid.

The equilibrium growth factor is given by:

$$1+g^* = \frac{q}{(1+q+\nu)}\frac{\big((n-1)(1-\alpha-\sigma)+1\big)}{n}A\left(L_p^*\right)^{\sigma} - \theta^* L, \quad \text{(A2)}$$

where $L_p^* = \frac{L\sigma(n-1)(1+q+\nu)}{(1+q)(n-1)\sigma+\nu(n(1-\alpha)-\alpha)}$ and θ^* is given by (A1).

The elasticity of land used in production with respect to the number of firms is given by:

$$\eta_{L_t^{p*},n} = \frac{n\nu}{(n-1)\big[n\big((1+q)\sigma+\nu(1-\alpha)\big)-(1+q)\sigma+\alpha\nu\big]} > 0 \quad \text{(A3)}$$

The elasticity of land used in production with respect to the number of firms is smaller than one, if n is sufficiently huge.

The derivative of the wealth–income ratio is given by:

$$\frac{\partial\left(\frac{W_t}{Y_t}\right)}{\partial n} = \left[\frac{\theta_n^* L\left(1+\frac{\nu((n-1)(1-\alpha-\sigma)+1)}{n(1+q+\nu)}\right)-\left(\nu\left[\frac{\sigma((\nu(2-\alpha-\sigma)+1+q)n+\nu(\sigma+\alpha))}{n(n-1)(1+q+\nu)[n(\nu(1-\alpha)+\sigma(1+q))+n\nu-\sigma(1+q)]}-\frac{(\sigma+\alpha)}{n^2(1+q+\nu)}\right]\right)(1+\theta^* L)}{A\left(L_t^{p*}\right)^{\sigma}\left(1+\frac{\nu((n-1)(1-\alpha-\sigma)+1)}{n(1+q+\nu)}\right)^2}\right] < 0. \quad \text{(A4)}$$

The detailed proof can be requested from the corresponding author.

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