LUISS

Department of Economics and Finance

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Secular Stagnation and Market Power

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Academic Year 2019/2020

Abstract

This thesis focuses on Secular Stagnation and market power and addresses the existence of a relation between the two. I provide empirical evidence concerning their evolution in the past decades and develop a theoretical analysis to understand the aforementioned relationship, by looking at the equilibrium interest rates, as indicator of Secular Stagnation, and at the level of markup, proxy for market power. I use an OLG model to do so, first in an exogenous markup environment, then by constructing it endogenously. I demonstrate that an increase in market power causes the equilibrium interest rate to fall and the economy reaches Secular Stagnation. I further make a digression about product market deregulation as a possible tool for enhancing competition and therefore reduce the negative effects that excessive market power have on the economy.

Contents

1 Introduction

In the past few decades, the World economy has been featuring several long-term trends, such as a steady decline in real interest rates, a slowdown in growth and a fall in the employment level. However, this only became apparent after the Great Recession, since the years going from 2002 to 2007 were actually associated with satisfactory levels of growth, which, ex post, are known to be caused by the financial bubble rather than a sustainable economic growth. For this reasons, the economic literature has been reconsidering the Secular Stagnation Hypothesis, an idea that was first introduced by Alvin Hansen before World War II. The term Secular Stagnation, despite lacking a unique definition, refers to an economy that, in equilibrium, is characterized by persistently low, or even negative, real interest rates, and depressed output and employment. Among other things, Hansen focused on the role played by factor accumulation as a driver for the economic slowdown. At the same time, the new proponents of the Secular Stagnation Hypothesis stress the argument that the current economic situation is mainly associated to a change in the structure of the economy, which has led to a shift in the balance between savings and investments, where the former has increased and the latter has declined. Therefore, although put in different terms, it can be argued that the two views are very close to one another, with factor accumulation on one side and investments on the other.

Going one step backwards, the current fall in investments could be caused by several mechanisms. In this respect, a recently proposed explanation in the literature is the increase in market power. Indeed, as I will show below, there is evidence of a rise in the level of markups, both in the U.S. and the rest of the World, beginning in the 1980s, which appears to have economic consequences similar to those traditionally associated to the Secular Stagnation Hypothesis, such as a fall in both the labor and

capital shares, wages and labor force participation.

Motivated by these facts, I try to uncover the relationship between Secular Stagnation and market power, by investigating how markups affect the equilibrium interest rates. To do so, I employ a 3-period OLG model with nominal rigidities characterized by monopolistic competition on the production side. In the baseline model, the markup is modelled as an exogenous function of the elasticity of substitution between goods and I show that it has a negative relationship with the equilibrium interest rate. The downward pressure on the latter caused by an increase in market power, seen as an increase in markup, works through the market for capital. Households, in fact, have two investment opportunities: lending to other households or renting capital to firms. When markups increase, the demand for capital by producers decreases, leading households to shift their investment decision towards loans. The rise in loan supply lowers the interest rates and, because of the ZLB, the economy cannot fully adjust to the shock and therefore enters Secular Stagnation. The same mechanism is at play in the extension of the baseline model, where I construct the markup as a function of the number of producers in the economy. I further introduce an entry cost, which allows me to discuss the positive effect that product market deregulation would have on the economy in terms of boosting competition and, therefore, reducing the risk of entering Secular Stagnation.

The rest of the work is organized as follows. In Section 2, I discuss the literature to which I refer. Section 3 presents some empirical evidence concerning both Secular Stagnation and market power. In Sections 4 and 5 I develop the baseline model and its extension, respectively. Section 6 addresses the conclusions.

2 Related Literature

The concept of Secular Stagnation was first introrduced by Alvin Hansen, who orginally discussed it in terms of declining economic growth, mainly due to a lower level of factor accumulation and lower population growth (Hansen, 1939). More specifically, he defined Secular Stagnation as characterized by "sick recoveries which die in their infancy and depressions which feed on themselves and leave a hard and seemingly immovable core of unemployment". Nonetheless, few years after his speech, Hansen was proven wrong, especially for what concerns population growth. The Secular Stagnation hypothesis has gained renewed importance in the economic discussion only recently, namely after the speech held by Lawrence Summers at the 2013 IMF Annual Research Conference (Summers, 2013), where he suggested that advanced economies might find themselves in the aforementioned situation. However, Summers discusses the issue in a slightly different way, focusing not only on economic growth, but also on the stability of the financial system, how these relate to each other and to the equilibrium real interest rate (Summers, 2014). Concerning financial stability, he noted that, in the past decades, the only circumstances in which the U.S. economy reached satisfying levels of growth, capacity utilization and employment were always associated to financial bubbles, hence, ex post, the previous were not achieved in a sustainable way. The reason for this, he argues, could be that changes in the structure of the economy have led to a shift in the balance between savings and investments, which causes a decline in the equilibium real rate, the one associated with full employment. Given this decrease, the issue at hand that makes the situation of stagnation "secular", is the impossibility of attaining full employment and strong growth because of the constraints associated with the zero lower bound on nominal interest rates. The latter argument has been especially relevant

since, during the period of interest, the inflation rate has been particularly low, even during those times associated with acceptable growth.

Following the above analysis, the current definition and discussion about the topic has slightly moved away from that of Hansen and now also focuses on the continuing downward tendency of real interest rates, which reflects an excess of savings as opposed to a decrease in investments (Eggertson et al. 2019), a trend, according to Secular Stagnation proponents, which has begun in the 1980s and continues as of today. At the same time, the argument concerning the decrease in investments is still very close to the decrease in factor accumulation proposed by Hansen. In this respect, a recently proposed explanation that is receiving increasing attention in the literature is the raise in market power (De Loecker et al. 2020). In this paper, the authors find evidence of an increase in the level of markups in the U.S. economy starting from the 1980s and study some implications that may arise because of it. They infer that this increasing trend has some secular consequences, namely a decrease in the labor and capital shares and in the labor force participation. Interestingly, these facts are those that are also associated to the Secular Stagnation hypothesis.

Therefore, one can argue that there is a relation between Secular Stagnation and Market Power. As a matter of fact, such relation was studied in Rovo (2017), in which the author finds (both empirically and theoretically) a positive relationship between the level of competitiveness in an economy and the associated interest rates. Motivated by this evidence, I investigate the relationship between market power and Secular Stagnation.

Concerning the structure of the model in Section 4, I follow Eggertson et al. (2019), where the consumer problem is characterized by a three-period overlapping generations (OLG) model with nominal rigidities, which mostly focuses on the role of deleveraging, decreasing population growth, rising inequality, and fall in price of cap-

ital and labor share as triggers of Secular Stagnation. However, on the production side, the authors do not consider a monopolistic competition structure. Furthermore, differently from their paper, I assume another form for the downward nominal wage rigidity, following the works of Benigno and Ricci (2011) and Schmitt-Grohè and Uribe (2016).

For what concerns, instead, the production side of the economy, the model is related to the standard monopolistic competition literature, such as Dixit and Stiglitz (1977), and follows the final-intermediate goods production structure of Rovo (2017). This work also relates to Galì (1995) and Bilbiie et al. (2012), who endogenously model the number of firms in order to study the macroeconomic implications arising from such a monopolistically competitive environment.

More specifically, in the extension of my baseline model presented in Section 5, I follow the structure laid out in Galì (1995) in order to relate market power to the number of firms present in the economy, by assuming the elasticity of substitution between intermediate goods to be an increasing function of the number of producers of those goods. This allows me to determine the equilibrium number of intermediate goods-producing firms through the zero-profit condition which characterizes monopolistic competition.

However, at this step of the analysis, I introduce an entry cost for the intermediate products market following Blanchard and Giavazzi (2003). This cost is meant to capture product market regulation coming from legal and administrative restrictions on entry, rather than a direct cost for the intermediate goods firms. For this reason, as in Blanchard and Giavazzi (2003), it is assumed to be a shadow cost in the model. The entry cost only emerges in the calculation of the steady state number of intermediate goods firms, namely in the zero- profit condition. Nevertheless, its presence allows firms to make some profits in the long-run in order to cover the

aforementioned cost, and therefore modifies the zero-profit condition. Through this procedure, I find the equilibirium number of firms in the intermediate goods market to be a negative function of the entry cost, which allows for a discussion concerning the deregulation of product markets.

Hence, the theoretical work finally relates to the literature that deals with the macroeconomic implications of deregulationary reforms that aim to reduce markups by promoting competition. Blanchard and Giavazzi (2003) is a prominent example of this literature in my work. The authors study both product and labor market deregulation in the short and long run, and argue that, while deregulation may entail some negative effects in the short-run due to the risk of a lower labor demand by incumbent firms, it proves to be beneficial in the long-run in terms of both higher wages and lower unemployment resulting from an increased competition. Concerning this last result, Ebell and Haefke (2003) quantify the beneficial effect through a fully microfounded dynamic model calibrated on the U.S. economy. Furthermore, Cacciatore and Fiori (2016) find evidence suggesting that deregulation reduces aggregate volatility, which in turn causes a reduction in the welfare costs of business cycle.

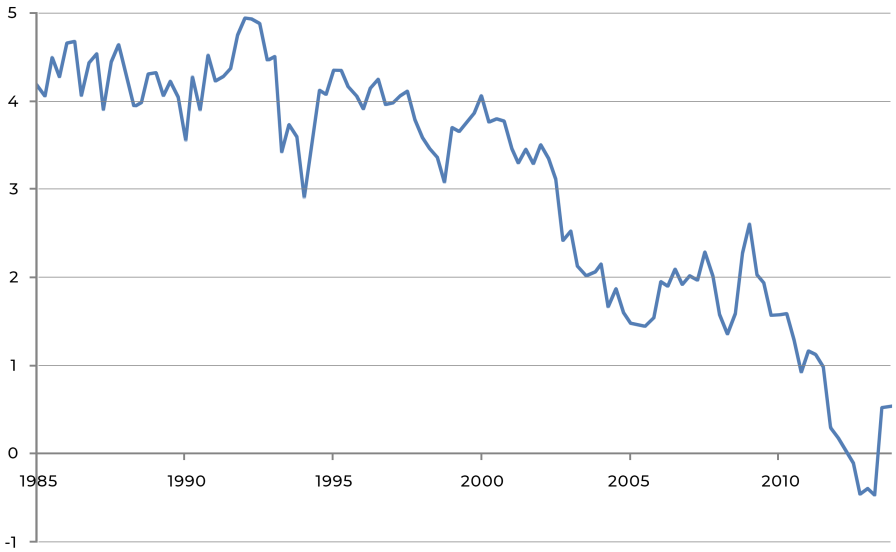
3 Empirical Motivation

In what follows, I will be discussing some stilyzed facts and empirical evidence concerning Secular Stagnation and Market Power, respectively.

3.1 Secular Stagnation

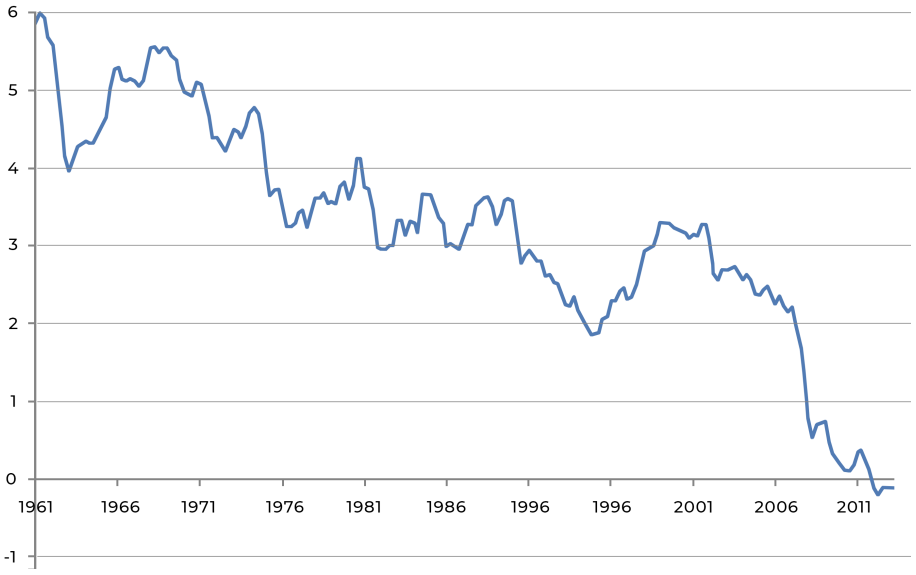
After the Great Recession, the most advanced economies such as the U.S. and the Eurozone were never able to fully recover and reach the pre-crisis output level predictions. According to the stardard view this should be surprising, as one would expect an acceleration of growth after a financial crisis. Therefore, the "new Secular Stagnation hypothesis" takes these issues into account and raises the possibility of a long-lasting economic environment where it is impossible to simultaneously achieve full employment, financial stability and adequate growth, at least with the policy instruments known and used as of today. The main problem is related to the interest rate. In fact, a shock that raises saving and reduces investment propensities is expected to downwardly affect the natural real interest rate in order for the economy to adjust, withouth impacting its levels of output and employment. However, given the zero-lower bound on interest rates, there is the possibility that the rate needed to balance saving and investment at full employment is below zero and, therefore, not attainable. Indeed, empirical evidence appears to support the existence of this circumstance and shows that both the actual real interest rate and the natural one have been on a long-term decreasing path, as can be observed in figures 1 and 2, respectively. Figure 1 shows trends in indexed bond yields for various countries, while Figure 2 is based on an estimation of the U.S. natural rate of interest made by Laubach and Williams (2003), calculated using data on actual real interest rates and measures taking into account the distance of the economy from its potential.

Figure 1: World Real Interest Rate



Source: Lawrence Summers, "Reflections on the "New Secular Stagnation Hypothesis""

Figure 2: U.S. Natural Interest Rate



Source: Thomas Laubach and John Williams, "Measuring the Natural Rate of Interest"

The reasons behind the decreasing trend in the natural interest rate are several and reflect structural changes in the modern economy. First, there is evidence of a slowdown in population growth, which, going back to Hansen (1939), is associated with a decline in the natural interest rate, and in the labor force growth. Second, the demand for debt-financed investments has decreased, reflecting a consequence of a period of excessive leverage and greater restrictions on financial intermediation. Third, a change in income distribution, both between labor and capital income and between different income classes, has operated to raise the propensity to save. The reason is that increasing inequality and capital income share have this effect, which, together with a reduction in investment demand, causes a fall in the equilibrium interest rate. Then, related to the aforementioned changes, there is cheaper capital goods, implying that investment goods can be obtained with less borrowing and spending, reducing the propensity to invest. Fifth, an increase in the demand for safe assets, observed through the increase of foreign holdings of U.S. Treasury securities, has further contributed to the decline of interest rate during the first decade of the 21st century, as empirical evidence suggests (Bernanke et al. 2004, Warnock and Warnock 2009, Beltran et al. 2013). Finally, the disinflationary policies, engineered first in the U.S. and U.K., explain much of the decrease in interest rates during the 1980s. All of these factors contribute to a weakening of demand and a reduction of the natural real interest rates.

These observations, toghether with the present low-inflation enviroment, make it more difficult to reduce real interest rates, causing the zero-lower bound to be more critical than it has ever been, due to a much higher probability of hitting it.

3.2 Market Power

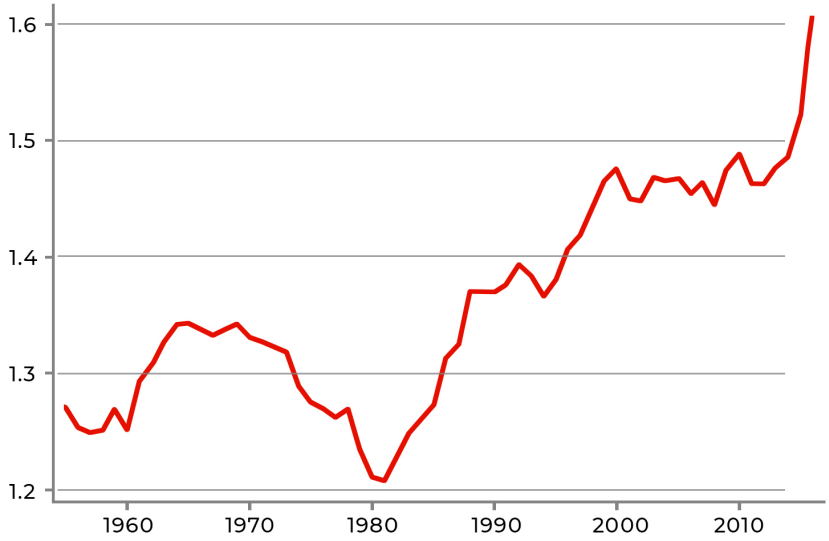
Closely related to the decrease in investment and labor capital there is another factor that has recently gained increased attention as one of the forces behind Secular Stagnation, that is the growing market power. The main reason is that lack of competition reduces the incentives to invest, therefore contributing to persisent economic weakness.

In order to understand the mechanism behind this it is useful to think of corporate profits. In fact, the latter have been steadily increasing over the last years, which could be due to high rates of returns to investment. However, this does not appear to be the case, since, as already discussed above, investments have not been taking off recently, as opposed to mergers and acquisitions, despite the possibility of raising money at an incredibly low cost. Therefore, the high level of profits may be reflecting growing monopoly power. This would imply that many corporations have no incentives to expand their capacity or improve their services, which would in turn result in an enviroment characterized by high profits but low investments, even with particularly low interest rates. In such an environment there would also be some problems in achieving or sustaining full employment, since in a situation characterized by low investments even with low interest rates, the Central Bank will have limited power in fighting recessions. Hence, lack of competition can contribute to the Secular Stagnation.

The hypothesis of growing market power has been confirmed in De Loecker et al. (2020). In this work, the authors document the evolution of monopoly power in the U.S. economy since the 1950s. The proxy used to measure it, as in standard literature, is the markup level, which they obtain by collecting individual firm output and input data and employing the production approach, where they solve the producer

cost minimization problem. The markup is then estimated as the wedgge between a variable's input expenditure share in revenue and that input's output elasticity. The results show that markups were quite stable in the period going from 1955 to 1980, and started to steadily rise since then, as can be seen in figure 3.

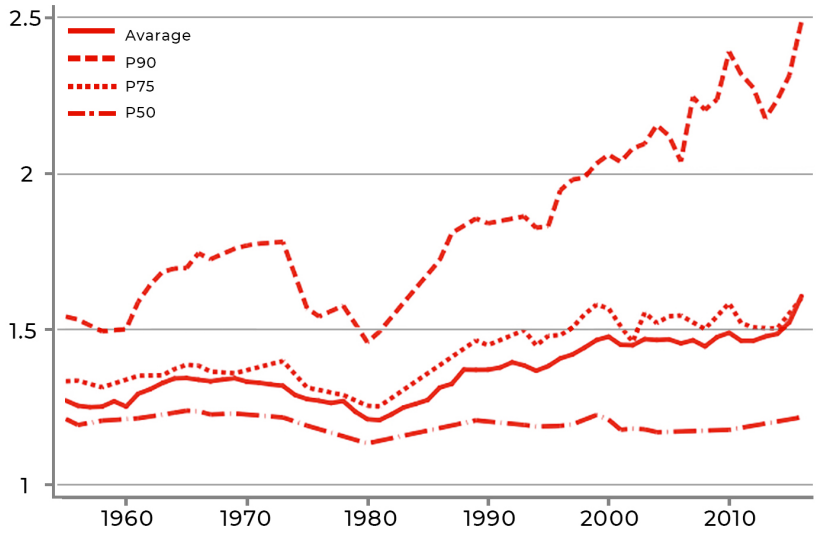
Figure 3: U.S. Average Markups



Source: De Loecker et al., "The Rise of Market Power and the Macroeconomic Implications"

However, it is important to also consider the distribution of markups, shown in figure 4 below. The latter displays the average markup together with the percentiles of the markup distribution, constructed via a ranking of the firms by their markup, then weighted by each firm's market share. By looking at the figure, it is safe to infer that the increase in average markup previously observed comes entirely from the firms in the top half of the distribution, implying that most firms have not experienced any rise in their market power.

Figure 4: Percentiles Markup Distribution



Source: De Loecker et al., "The Rise of Market Power and the Macroeconomic Implications"

This upward trend has been not only observed at U.S. level, but is present all over the world, characterized by the same timinig and distributional features, as it has been studied in De Loecker and Eeckhout (2018).

Futhermore, the appreciable decline in competition has several long-term macroeconomic implications. First of all, there appears to be a negative relationship between the level of markup and the labor share, which was empirically documented in De Loecker et al. (2020). In an analogous way, another secular consequence of the raise in market power is the decline of the capital share. A third long-term consequence of the increase in market power is the reduction in wages and labor force participation. Indeed, in a monopolistically competitive environment, an increase in markup implies a decrease in aggregate production, at least if demand is not perfecly inelastic. This, in turn, causes both wages and labor force participation to lower, as will be also shown in the following sections.

All of these consequences are closely related to some of the factors traditionally associated to the new Secular Stagnation hypothesis, which were discussed in the previous paragraph.

Motivated by the evidence discussed in the present section, I devote the rest of this work to a theoretical investigation of the relationship between Secular Stagnation and market power, that is, how the latter can cause or amplify the former.

4 Baseline Model

In this section I develop a simple model with a 3-period OLG framework for what concerns the household problem, and characterized by monopolistic competition in the firm problem, in order to observe how markups affect the economy and how they may cause it to enter Secular Stagnation.

4.1 Household

The representative household lives for three periods (young, middle age and old) and only supplies labor during middle age. I define N_t to be the population size at period t, thus the population growth rate is defined as $g_t = \frac{N_t}{N_{t-1}} - 1$
Each household maximizes the following utility function

$$max\, U = logC_t^y + \beta logC_{t+1}^m + \beta^2 logC_{t+2}^o \tag{1}$$

Where C_t^y is the household consumption when young, C_{t+1}^m when middle aged, and C_{t+2}^o when old. I assume the presence of a loan market, in which agents exchange one-period riskless debt assets, denoted by B_t^i, where i is the associated generation involved in the exchange. The household maximization is then subject to the following constraints

$$C_t^y = B_t^y \tag{2}$$

$$C_{t+1}^m + (1 + r_t)B_t^y + K_{t+1} = w_{t+1}L_{t+1} + r_{t+1}^k K_{t+1} + Z_{t+1} + B_{t+1}^m \tag{3}$$

$$C^o_{t+2} + (1 + r_{t+1})B^m_{t+1} = (1 - \delta)K_{t+1} \tag{4}$$

$$(1 + r_t)B^y_t \leq D_t \tag{5}$$

Equations (2), (3) and (4) are the budget constraints of the young, middle age and old generations, respectively. When young, the agent can only consume what he borrows. During middle age, the agent faces two alternative investments: he can either lend to the young, rent capital to firms (by buying it in the same period), or a combination of the two. His income is given by labor (where $w = \frac{W}{P}$), returns from capital ($r^k K$) and profits (Z). When old, the agent can only consume his savings, given by the returns on loans supplied, and what he gets from the sale of capital (depreciated by δ). Furthermore, equation (5) represents an exogenous borrowing constraint faced by the young generation, which I assume to be binding for any t:

$$(1 + r_t)B^y_t = D_t \tag{6}$$

Which, in turn, implies

$$C^y_t = \frac{D_t}{(1 + r_t)} \tag{7}$$

Given the consumption for the young, the model can be solved only for the middle age and old generations, by solving for $C^m_t, C^o_{t+1}, B^m_t, K_t$. The maximization yields the following optimality conditions

$$\frac{1}{C_t^m} = \frac{\beta(1+r_t)}{C_{t+1}^o} \tag{8}$$

$$(1-r_t^k)C_{t+1}^o = \beta(1-\delta)C_t^m \tag{9}$$

Where the first gives the consumption Euler Equation, while the second represents the capital choice of the agent. By combining the two, I obtain the no-arbitrage condition between the loan and capital markets, given by

$$1 + r_t = \frac{1-\delta}{1-r_t^k} \tag{10}$$

Here, I assume the presence of money in this economy. As in Eggertson et al. (2019), combining the Euler Equations from an OLG model with and without money (i.e. endowment economy), yields the following standard Fisher equation

$$1 + r_t = 1 + i_t \frac{P_t}{P_{t+1}} \tag{11}$$

So I can equivalently rewrite the Euler Equation as

$$\frac{1}{C_t^m} = \frac{\beta}{C_{t+1}^o}(1+i_t)\frac{P_t}{P_{t+1}} \tag{12}$$

Furthermore, by no-arbitrage, the presence of money imposes a non-negativity constraint (the zero lower bound or ZLB) on the nominal interest rate i_t.

4.2 Production

Final Goods

The final goods producers work in a perfectly competitive market, where they only use intermediate goods $y_t(i)$ to produce Y_t. They face the following maximization problem

$$max\ P_t Y_t - \int_0^1 p_t(i) y_t(i) di \tag{13}$$

Where the production of Y_t follows a Constant Elasticity of Substitution (CES) function, given by

$$Y_t = \Big(\int_0^1 y_t(i)^{\frac{\epsilon-1}{\epsilon}} di \Big)^{\frac{\epsilon}{\epsilon-1}} \tag{14}$$

Here, ϵ represents the elasticity of substitution between intermediate goods, and the price index P_t is defined as $P_t = (\int_0^1 p_t(i)^{\epsilon-1} di)^{\frac{1}{\epsilon-1}}$, where $p_t(i)$ is the price charged by intermediate producer i.

Solving the final goods producers problem yields the following demand for intermediate good i

$$p_t(i) = \Big(\frac{y_t(i)}{Y_t} \Big)^{-\frac{1}{\epsilon}} P_t \tag{15}$$

Intermediate Goods

Intermediate goods producers, instead, work in a monopolistically competitive market to produce good i and use both capital and labor (provided by households) in their Cobb-Douglas production function. They seek to maximize nominal profits

$$max\ Z_t(i) = p_t(i)y_t(i) - W_tL_t(i) - P_tr_t^kK_t(i) \tag{16}$$

subject to equation (15) and their production function

$$y_t(i) = AK_t(i)^{1-\alpha}L_t(i)^{\alpha} \tag{17}$$

Solving the problem yields the following optimality conditions for labor and capital

$$\frac{W_t}{p_t(i)} = \Big(\frac{\epsilon - 1}{\epsilon}\Big)\alpha\frac{y_t(i)}{L_t(i)} \tag{18}$$

$$\frac{P_tr_t^k}{p_t(i)} = \Big(\frac{\epsilon - 1}{\epsilon}\Big)(1-\alpha)\frac{y_t(i)}{K_t(i)} \tag{19}$$

The symmetry of the model, however, implies $p_t(i) = p_t(-i) = P_t$. This, in turn, means

$$y_t(i) = Y_t\ ; \quad L_t(i) = L_t\ ; \quad K_t(i) = K_t\ .$$

Thus, I can rewrite the optimality conditions in a general form

$$\frac{W_t}{P_t} = \Big(\frac{\epsilon - 1}{\epsilon}\Big)\alpha\frac{Y_t}{L_t} \tag{20}$$

$$r_t^k = \Big(\frac{\epsilon - 1}{\epsilon}\Big)(1-\alpha)\frac{Y_t}{K_t} \tag{21}$$

Taking the definition of $\mu = \frac{\epsilon}{\epsilon - 1}$, which is a proxy for market power, it is clear that both real wages and return on capital are lower, with respect to their perfect competition counterparties, by a factor equal to $\frac{1}{\mu}$. In fact, by allowing the elasticity of substitution ϵ to grow indefinitely, the framework becomes equal to a perfectly competitive one. This implies that, the greater the market power (either seen as a low elasticity of substitution or a high markup) the larger the efficiency loss.

Monetary Policy

I assume the presence of a monetary authority in the model, which takes decisions according to a Taylor rule given by

$$1 + i_t = max\Bigg\{1, (1 + i^*)\Big(\frac{\Pi_t}{\Pi^*}\Big)^{\phi}\Bigg\} \tag{22}$$

which takes into account the zero lower bound for the nominal interest rate. For simplicity, I assume that the target interest rate, i^*, is equal to zero, and the target inflation, Π^*, equals one. This way, the ZLB becomes binding at $\Pi_t = 1$.

4.3 Equilibium

Labor Market

In this section, I introduce a nominal rigidity. Namely, I impose a downward nominal wage rigidity (DNWR) following Schmitt-Grohè and Uribe (2016), that is

$$W_t \geq \eta W_{t-1} \quad \eta > 0 \tag{23}$$

Where the parameter η determines the degree of downward nominal rigidity. The higher it is, the more nominal wages are downwardly rigid. In Schmitt-Grohè and Uribe (2016), the authors find evidence of such parameter being very close to one, meaning that workers will not accept any nominal wage that is lower with respect to that received in the previous period. In this case, the rigidity constraint becomes like the one defined in Benigno and Ricci (2011)

$$W_t \geq W_{t-1} \tag{24}$$

For the present moment, I will consider that of equation (23), but the latter will be useful in simplifying the analysis of the following section.
The implication of such nominal rigidity allows me to state that, whenever the former is not binding, the economy reaches full employment $\bar{L}$. That is

$$\forall\, W_t = P_t\Big(\frac{\epsilon - 1}{\epsilon}\Big)\alpha\frac{Y_t}{L_t} \geq \eta W_{t-1} \;\Rightarrow L_t = \bar{L} \tag{25}$$

Asset Market

Equilibrium in the loans market implies that the demand for loans by the young must equal the supply provided by the middle age

$$N_t B_t^y = -N_{t-1} B_t^m \tag{26}$$

Which, given g_t, can be written as

$$(1+g_t) B_t^y = -B_t^m \tag{27}$$

The above gives loan demand (left-hand side) and loan supply (right-hand side). From the young borrowing constraint, equation (6), I obtain

$$L_t^d = (1+g_t) B_t^y = \frac{1+g_t}{1+r_t} D_t \tag{28}$$

Instead, loan supply is obtained by combining the Euler Equation with the time-t budget constraint of the middle age and time-t+1 budget constraint of the old, which yields the following

$$L_t^s = \frac{\beta}{1+\beta}(Y_t - D_{t-1}) - \frac{\beta}{1+\beta}\Big(\frac{1-\delta}{\beta(1+r_t)} + 1\Big) K_t \tag{29}$$

Looking at the two equations above, it is possible to analyze the relationship between the loan market and interest rate. An increase in the real interest rate dampens

loan demand as debt becomes more expensive. Instead, concerning loan supply the relation is less trivial. First of all, by observing the loan supply equation, it is straightforward that an increase in capital lowers loan supply. This happens through a substitution effect, where households shift their investment decision from the loans to the capital, which causes the real interest rate to increase. Moreover, taking into account the negative relationship between the level of markup and capital provided in equation (21), such an increase in capital may be caused by a decline in markup. This implies that market power and real interest rate have a negative relationship, where the former affects the latter through the market for capital.

In order to get the equilibrium interest rate for loans, I simply equate loan demand and supply, and obtain

$$1 + r_t = \frac{1+\beta}{\beta} \frac{(1+g_t)D_t + \frac{1-\delta}{1+\beta}K_t}{Y_t - D_{t-1} - K_t} \tag{30}$$

Given the dependence of r_t on Y_t and the above definition of $\bar{L}$, one can think of the natural real interest rate as the rate prevailing in the economy when it reaches full employment, that I define as r^f.

Instead, the equilibrium rate on capital can be easily found by the no-arbitrage condition, combining it with the equilibrium loan rate.

4.4 Steady State

Aggregate Supply

Starting from the AS side, there are two possible cases: one in which the DNWR is not binding, which implies

$$W_t^* \geq \eta W_{t-1} \Rightarrow W_t = W_t^* \, and \, L_t = \bar{L}$$

and one where the rigidity is binding, given by

$$W_t^* < \eta W_{t-1} \Rightarrow W_t = \eta W_{t-1}$$

The first of these cases is simply the situation in which wages behave as being perfectly flexible and the economy is at potential in steady state. The second case, instead, can be analyzed in steady state (assuming $W_{t-1} = W_{t-1}^*$) as follows

$$P_t\Big(\frac{\epsilon-1}{\epsilon}\Big)\alpha\frac{Y}{L} = \eta P_{t-1}\Big(\frac{\epsilon-1}{\epsilon}\Big)\alpha\frac{Y}{\bar{L}}$$

$$P_t A K^{1-\alpha} L^{\alpha-1} = \eta P_{t-1} A K^{1-\alpha} \bar{L}^{\alpha-1}$$

$$L = \Big(\frac{\Pi}{\eta}\Big)^{\frac{1}{1-\alpha}} \bar{L} \tag{31}$$

And I get that

$$L < \bar{L} \iff \Pi < \eta$$

However, given the previously mentioned evidence from Schmitt-Grohè and Uribe (2016), I consider η to be close to unity, implying that the DNWR is binding whenever $\Pi < 1$. Thus, concerning aggregate supply, two steady states may arise depending on the size of inflation.

Aggregate Demand

On the AD side, I have that, by assumption, the zero lower bound for the nominal interest rate binds in $\Pi < 1$. Thus, also here two cases may arise from the monetary policy rule.

$$\Pi > 1 \ : 1 + i_t = \Pi_t^{\phi} \ \Rightarrow 1 + r_t = \Pi_t^{\phi - 1}$$

$$\Pi < 1 \ : 1 + i_t = 1 \ \Rightarrow 1 + r_t = \Pi_t^{-1}$$

In order to characterize the steady state, I first derive the AD curve, found through the equilibrium interest rate in the loan market (equation (30)), given by

$$Y = \Big(1 + \frac{1+\beta}{\beta}\frac{1+g}{1+r}\Big)D + K\Big(1 + \frac{1-\delta}{\beta(1+r)}\Big) \tag{32}$$

Then, combining the above with the production function, capital demand, no-arbitrage condition, the two conditions for $(1+r)$ (and equation (31) for the case $\Pi < 1$) I get the steady state characterizations.

Case $\Pi > 1$

$$\begin{cases} 1 + r = \Pi^{\phi - 1} \\ Y = AK^{1-\alpha}\bar{L}^{\alpha} \\ r^k = \left(\frac{\epsilon - 1}{\epsilon}\right)(1-\alpha)\frac{Y}{K} \\ r^k = 1 - \frac{1-\delta}{1+r} \\ Y = \left(1 + \frac{1+\beta}{\beta}\frac{1+g}{1+r}\right)D + K\left(1 + \frac{1-\delta}{\beta(1+r)}\right) \end{cases} \tag{33}$$

This first case can be defined the "good" steady state, since it is characterized by full employment, the ZLB is not binding and the economy behaves as having perfectly flexible wages.

Case $\Pi < 1$

$$\begin{cases} 1 + r = \Pi^{-1} \\ L = \left(\frac{\Pi}{\eta}\right)^{\frac{1}{1-\alpha}}\bar{L} \\ Y = AK^{1-\alpha}L^{\alpha} \\ r^k = \left(\frac{\epsilon - 1}{\epsilon}\right)(1-\alpha)\frac{Y}{K} \\ r^k = 1 - \Pi(1+r) \\ Y = \left(1 + \frac{1+\beta}{\beta}(1+g)\Pi\right)D + K\left(1 + \frac{\Pi}{\beta}(1-\delta)\right) \end{cases} \tag{34}$$

I define this second steady state, instead, as the Secular Stagnation one, given the low level of inflation (making the ZLB binding) and the inefficiency in the labor market deriving from the DNWR, which translates into a lower level of output, ceteris paribus.

4.5 Effects of Market Power

Assume the economy is initially in the "good" steady state. Given that $L = \bar{L}$, the real interest rate is given by the natural one, r^f. From this setting, I want to study the effects of market power in the economy.

Consider an exogenous drop in the elasticity of substitution ϵ, implying an increase in μ and, thus, market power. On the supply side, this causes a decrease in labor demand, which now falls below $\bar{L}$, and in the wage level, making the DNWR more likely to bind. At the same time, demand for capital also drops, which impacts the household investment choice, causing a shift in investment from capital to loan supply. This, in turn, lowers the real interest rate. Thus, an increase in market power has a direct impact on the AS curve, causing a downward shift, and an indirect impact on the AD curve, which happens through the capital channel.

This mechanism means that an increase in market power puts a downward pressure on equilibrium interest rates. However, the adjustment dynamics are constrained by the ZLB and the economy enters Secular Stagnation.

5 Model with Endogenous Markup

In this section, I expand the baseline model by endogenously defining the markup. As in Galì (1995), I construct the market power μ, and thus the elasticity of substitution ϵ, as a function of the number of firms present in the intermediate goods market.

Intuitively, the household problem does not change in this setup, so I will keep the same setting of the previous section without any further description.

5.1 Production

Final Goods

As in the baseline model, final goods producers work under the same conditions and maximize nominal profits, given by

$$max\ P_t Y_t - \int_0^{n_t} p_t(i) y_t(i) di$$

However subject to a different CES technology, which is now a function of the number of intermediate inputs used (n)

$$Y_t = \left[n_t^{-(1-\frac{1}{\mu(n_t)})} \int_0^{n_t} y_t(i)^{\frac{1}{\mu(n_t)}} di \right]^{\mu(n_t)} \tag{35}$$

Where $y(i)$ is the quantity of intermediate good $i \in [0, n]$ used for final good production. The factor $n_t^{-(1-\frac{1}{\mu(n_t)})}$, as explained in Kothari (2014), scales out the love for variety from the CES production function. Following Galì (1995), $\mu : R^+ \Rightarrow R^+$

is a continuously differentiable function with the following properties:

$$\mu'(n) < 0; \quad \lim_{n\to 0} \mu(n) = \bar{\mu} > 1; \quad \lim_{n\to\infty} \mu(n) = 1 \ .$$

Furthermore, given that the elasticity of substitution among intermediate goods is $\epsilon(n) = \frac{\mu(n)}{\mu(n)-1}$, it follows that:

$$\epsilon'(n) > 0; \quad \lim_{n\to 0} \epsilon(n) = \bar{\epsilon} > 1; \quad \lim_{n\to\infty} \epsilon(n) = \infty \ .$$

The final goods producer problem yields the following demand for intermediate good i

$$y_t(i) = \frac{Y_t}{n_t}\Big(\frac{P_t}{p_t(i)}\Big)^{\epsilon(n_t)} \tag{36}$$

Where the price index P_t is defined as $P_t = \Big[\frac{1}{n_t}\int_o^{n_t} p_t(i)^{1-\epsilon(n_t)} di\Big]^{\frac{1}{1-\epsilon(n_t)}}$.

Intermediate Goods

Again for the intermediate goods sector, the producer i faces the same nominal profit maximization problem

$$max\ Z_t(i) = p_t(i)y_t(i) - W_t L_t(i) - P_t r_t^k K_t(i)$$

Subject to its production function (equation (17)) and the new demand that it faces (equation (36)). The maximization problem yields the following optimality condi-

tions for capital and labor, respectively

$$P_t r_t^k = P_t\Big(\frac{n_t}{Y_t}\Big)^{-\frac{1}{\epsilon(n_t)}}\Big(\frac{\epsilon(n_t)-1}{\epsilon(n_t)}\Big)(1-\alpha)y_t(i)^{-\frac{1}{\epsilon(n_t)}}AK_t(i)^{-\alpha}L_t(i)^{\alpha} \tag{37}$$

$$W_t = P_t\Big(\frac{n_t}{Y_t}\Big)^{-\frac{1}{\epsilon(n_t)}}\Big(\frac{\epsilon(n_t)-1}{\epsilon(n_t)}\Big)\alpha y_t(i)^{-\frac{1}{\epsilon(n_t)}}AK_t(i)^{1-\alpha}L_t(i)^{\alpha-1} \tag{38}$$

Given the symmetry of the model, marginal costs, and thus prices, are the same for all the intermediate sector firms. The same reasoning applies to the quantities demanded of each input. Hence

$$y_t(i) = \tfrac{Y_t}{n_t}\ ;\quad K_t(i) = \tfrac{K_t}{n_t}\ ;\quad L_t(i) = \tfrac{L_t}{n_t}\ .$$

So, on aggregate, the production function and the optimality conditions follow the same strucure as in the baseline model

$$Y_t = AK_t^{1-\alpha}L_t^{\alpha}$$

$$r_t^k = \Big(\frac{\epsilon(n_t)-1}{\epsilon(n_t)}\Big)(1-\alpha)\frac{Y_t}{K_t} \tag{39}$$

$$\frac{W_t}{P_t} = \Big(\frac{\epsilon(n_t)-1}{\epsilon(n_t)}\Big)\alpha\frac{Y_t}{L_t} \tag{40}$$

5.2 Entry Costs

So far, I have implicitly assumed the absence of any barriers to enter the intermediate goods market. In what follows, I introduce the existence of entry costs in order to characterize the equilibrium number of firms for the steady state analysis and to

discuss some implications arising from regulation of the intermediate goods market. As in Blanchard and Giavazzi (2003), I assume that firms face a cost for entering the market c, coming from product market regulation. For this reason, it is considered to be a shadow cost in the setup with endogenous markups and only enters the model in the steady state analysis. This assumption implies that, in steady state, firms are allowed to make profits in order to cover such cost.

Thus, in order to characterize the steady state, I need to take into account the zero-profit condition:

$$Z = c \tag{41}$$

Where

$$Z_t = Y_t - w_t L_t - r_t^k K_t$$

$$= Y_t - \frac{1}{\mu(n_t)} \alpha \frac{Y_t}{L_t} L_t - \frac{1}{\mu(n_t)} (1-\alpha) \frac{Y_t}{K_t} K_t$$

$$= \frac{Y_t(\mu(n_t) - 1)}{\mu(n_t)} \tag{42}$$

5.3 Steady State

Given the similar structure with respect to the baseline model, the AS and AD analyses previously made still hold here. Therefore, I have again two possible steady states, given by Π.

Case $\Pi > 1$

$$\begin{cases} 1 + r = \Pi^{\phi - 1} \\ Y = AK^{1-\alpha}\bar{L}^{\alpha} \\ r^k = \left(\frac{\epsilon(n)-1}{\epsilon(n)}\right)(1-\alpha)\frac{Y}{K} \\ r^k = 1 - \frac{1-\delta}{1+r} \\ Y = \left(1 + \frac{1+\beta}{\beta}\frac{1+g}{1+r}\right)D + K\left(1 + \frac{1-\delta}{\beta(1+r)}\right) \end{cases} \tag{43}$$

Case $\Pi < 1$

$$\begin{cases} 1 + r = \Pi^{-1} \\ L = \left(\frac{\Pi}{\eta}\right)^{\frac{1}{1-\alpha}}\bar{L} \\ Y = AK^{1-\alpha}L^{\alpha} \\ r^k = \left(\frac{\epsilon(n)-1}{\epsilon(n)}\right)(1-\alpha)\frac{Y}{K} \\ r^k = 1 - \Pi(1+r) \\ Y = \left(1 + \frac{1+\beta}{\beta}(1+g)\Pi\right)D + K\left(1 + \frac{\Pi}{\beta}(1-\delta)\right) \end{cases} \tag{44}$$

Given the above, I can make a similar analysis to the one made in the baseline model regarding the consequences of market power on equilibium. The main difference is that, in this case, an increase in market power is determined by a decrease in the n. However, in order to complete the characterization of both steady states, I need to add a condition determining the number of intermediate producers that are present in the market in equilibrium. To do so, I use equations (41) and (42) to obtain

$$n^* \ : Y = \frac{c\mu(n)}{\mu(n) - 1} \tag{45}$$

Moreover, in order to find a solution for n, I need an explicit relation between the elasticy of substitution (and markup) and the number of firms, which I assume to be given by

$$\epsilon(n) = \epsilon n \tag{46}$$

with $\epsilon > 0$. The above also implies

$$\mu(n) = \frac{\epsilon n}{\epsilon n - 1} \tag{47}$$

Then, by equation (45), I find the equilibrium number of firms to be as follows

$$n^* = \frac{Y}{c\epsilon} \tag{48}$$

so the equilibrium number of firms is an increasing function of output and a decreasing function of the entry costs.

5.4 Deregulation

Deregulation of the product markets simply means the opening up of markets to greater competition, usually involving the removal of government legislation or, more generally, any barrier to competition. In this stylized model, product market regulation is captured by the entry cost c, which is, in fact, a key determinant for the structure of the intermediate goods market and, consequently, the market power

within it.

A deregulation of the goods market in this context therefore translates into a decrease in c. This intervention, as argued by Blanchard and Giavazzi (2003), may bring about some negative effects in the short-run, given that the positive effect on the number of firms only appears in the long-run. In fact, in the short-run, the incumbent firms' labor demand may decrease , hence increasing the risk of unemployment for the currently employed workers. These effects, however, are reversed in the long-run. As a matter of fact, decreasing the entry cost c would cause a rise in the number of firms present in the intermediate goods sector in the long-run, causing the elasticity of substitution ϵ to increase and, thus, reducing the market power in the hands of the incumbent firms. This would, in turn, mean moving towards a more competitive market, which implies, on the one hand, a decrease in unemployment and an increase in wages, making the DNWR constraint less likely to be binding. On the other hand, deregulation increases capital demanded by firms and consequently, for the mechanism previously discussed, the real interest rate, allowing for the possibility of the economy to exit, or even eliminate, the Secular Stagnation steady state.

6 Conclusion

In this work, I focus on market power as one of the forces driving Secular Stagnation and develop a theoretical analysis to understand the relationship between markups and equilibrium interest rates. To motivate my research, I present some empirical evidence concerning the trends that the variables of interest have been following in the past decades. After that, I propose a 3-period OLG model characterized by monopolistic competition in production that allows me to uncover and analyze the aforementioned relationship. The development of the former shows that an increase in the markup level causes the equilibrium interest rate to fall, leading to Secular Stagnation. This happens through the market for capital. In fact, households have two investment alternatives, namely lending to the young or renting capital to firms. Therefore, the model shows that an increase in the level of markup causes capital demand by firms to decrease, making household switch their investment decision from capital to loan supply, which, in turn, lowers the equilibrium interest rate. Because of the ZLB on nominal interest rate, the economy is constrained in the adjustment mechanisms and enters Secular Stagnation. The same reasoning applies to the extension of my baseline model, which, furthermore, opens the possibility for discussing some policy implications concerning the product market. Indeed, I discuss the consequences of the presence of an entry cost representing product market regulation. It leads to a reduction in the number of firms in the economy, and, therefore, a rise in their market power. Hence, product market deregulation may bring about some positive long-run effects, as it increases the competitiveness of the economy and causes labor and capital demand to also rise. This, in turn, reduces unemployment and increases wages, making the DNWR less crucial, and, through the mechanism explained above, raises the equilibrium interest rate, thus helping the

economy to exit Secular Stagnation.

Besides the argument concerning deregulation, the policy implications arising from the uncovered relationship between Secular Stagnation and market power require a more thorough analysis which was not developed here, since it would fall out of the scope of this work. Therefore, further research is needed in order to study the optimal policy to fight Secular Stagnation and taking into account its relationship with monopoly power, and also discuss it in terms of monetary and fiscal policy instruments.

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