How can we explain the decline in US productivity growth, and (how) does competition come into play?

Loris André

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The continued decline in productivity growth in the United States in recent years has raised many questions in both academic and industrial circles. Today, however, there does not seem to be an unequivocal answer, but rather a bundle of potential explanations. First, I will recall some facts about the decline in productivity growth. Then, I will go through some ideas that have been put forward to explain the decline in dynamism, before focusing in a final paragraph on the role of competition. We will see that the Schumpeterian growth model makes it possible to apprehend the extent to which market concentration and the emergence of superstar firms can cause a decline in productivity growth.

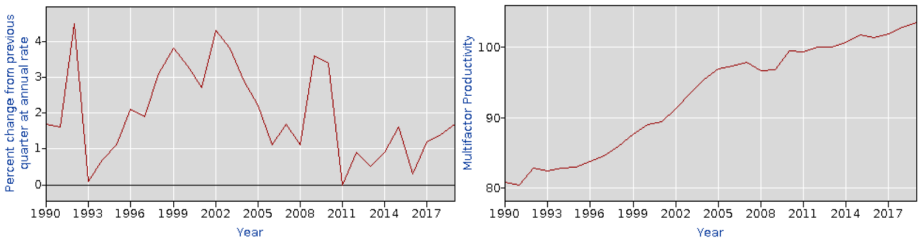
1 The decline in US productivity growth

Since 2005, the growth of productivity indicators in the US have decreased significantly.

As can be seen in the Figure 1a, from 2006 onward (apart from 2009 and 2010, the post-financial crisis years), labor productivity growth rates have been systematically lower than those of the 1996-2005 period. This suggests that the downward movement is not only a movement associated with the business cycle but rather a long-term trend.

In addition, a structural break can be observed in the multifactor productivity index (Figure 1b) in 2005. The slope of the index was actually divided by three when we compare the 1995-2005 period to the 2006-2019 period, from an average annual growth of 1.43% to 0.48%.

Figure 1: Different productivity measures of the US economy



(a) Labor productivity (output per hour) growth (in %)

(b) Multifactor Productivity (index = 100 in 2012)

Source : BLS, Bureau of Labor Statistics

2 Some potential explanations

2.1 Ideas are getting harder to find

In his book *The Rise and Fall of American Growth* , Robert Gordon suggests that growth cannot continue perpetually, as the innovations of the late 19th and early 20th centuries cannot be repeated, in his view. More recent innovations do not have the same power to transform lives as electric lighting, indoor plumbing, motor vehicles, air travel, and television. Transformative innovations are harder to find than before. It is this idea that Bloom et al. [7] take up. The authors show that in order to maintain a high level of innovation, particularly in the case of microprocessors, an increasing number of researchers is needed.

However, this approach assumes that the level of productivity brought about by new innovations is measured correctly, which is not necessarily the case, as we shall see.

2.2 The decrease comes from measurement errors

The idea that the decline in productivity was a measurement flaw emerged in the late 1980s, after the first drop in productivity growth in the US. Baily and Gordon [5] himself inspected the productivity calculations to detect a bias in the estimation. The idea is that even if nominal growth is perfectly known, obtaining real growth requires the use of a price deflator. Therefore, if inflation is overestimated, real growth is underestimated, which could be the cause of the decline in growth. At that time, the authors did not find that measurement error was a significant contributor to the decline in productivity.

In the current context, conducting the exercise on the U.S. economy leads

to different conclusions, according to Aghion et al. [2]. The omission of creative destruction is a major source of overestimation of inflation. In fact, statistics institutes do not account for the sharp drop in prices in the case of a replacement of one product by another, resulting from a breakthrough innovation. The authors find that the underestimation of growth is slightly higher in the recent period (post 2006) compared to the period before 2006. This may explain part of the decline in productivity.

In contrast, Byrne et al. [8] indicate that mismeasurement may not be part of the explanation. According to them, the wrong measure was already very important before 2005, if not more important, so that its inclusion aggravates the decline in productivity growth.

The lack of consensus on the role of poor measurement leads us to explore other avenues. Many authors have recently delved further into the role of competition, which we will focus on in the next section.

3 How does competition come into play?

In this section, we will examine the extent to which changes in competition in the U.S. market may have led to a decline in productivity growth. First, I will present recent changes in the level of competition in the US, before detailing the theoretical framework that can help tackling the question. Then, I will present all the conclusions drawn from a recent corpus of academic articles.

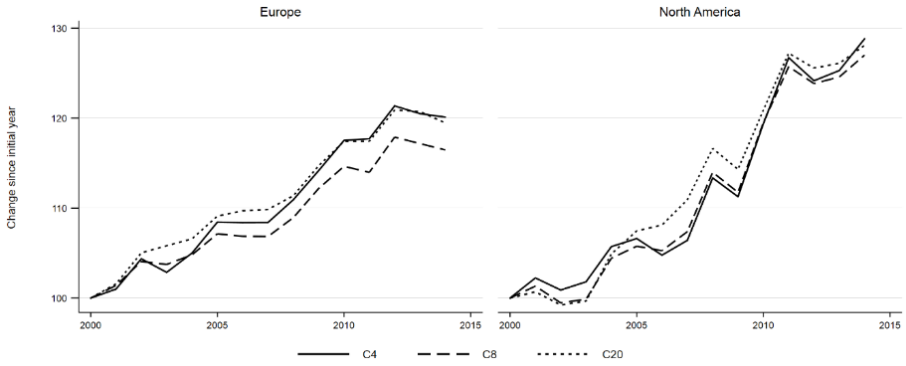
3.1 Stylized facts

Competition features evolved a lot in the United States between the end of the 90's and today. The striking fact is that the markets have become more concentrated.

Figure 2, which is taken from a working paper published by the OECD in 2019 [6], shows the evolution of three concentration indicators between 2000 and 2014. For example, C8 represents the mean market share of the Top 8 firms of the 2-digit manufacturing and non-financial services industries. Globally, these indicators have grown since the beginning of the period, less in Europe than in North America (United States and Canada), where they have all increased by 28% in 14 years.

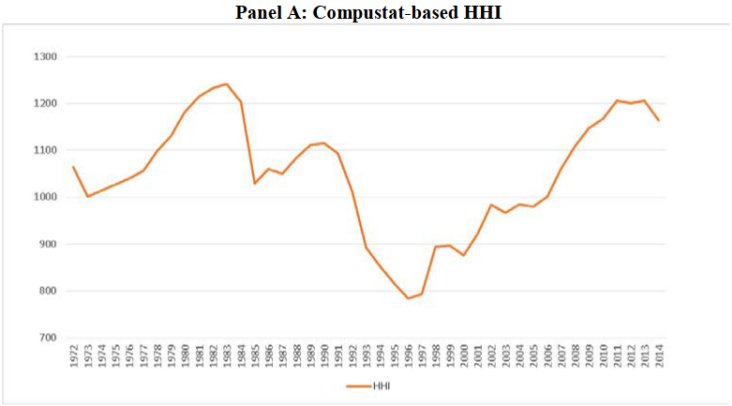
Grullon et al. [9] show that we can draw the same conclusions from the computation of the Herfindahl-Hirschman (HHI) concentration index drawn in Figure 3. Indeed, the HHI index has kept increasing since 1995. It is also interesting to note that the concentration index had already experienced a period of strong increase between 1975 and 1985. During this period, productivity growth decreased in the US. Thus, there seems to be a historical correlation

Figure 2: Differing Concentration Metrics (CR4, CR8, CR20) in Europe North America



between concentration and lower productivity growth in the U.S. It is therefore natural to inspect the role of competition in productivity growth, as many authors did in the late 1980s, and again today after more than a decade of market concentration, and slowing productivity growth.

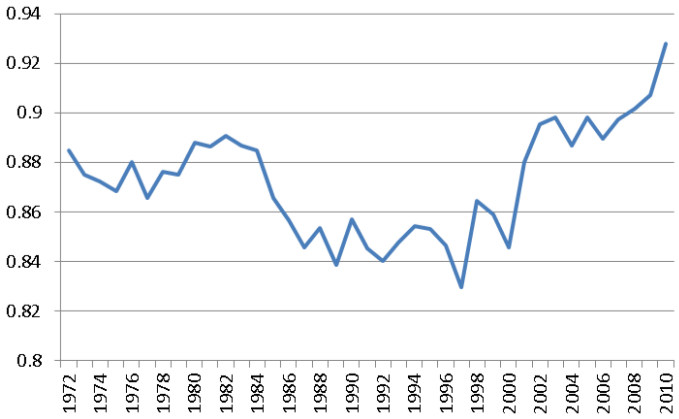
Figure 3: US aggregate HHI concentration index between 2002 and 2019



Concentration is not only true dealing with sales share, but also with patenting as can be seen on Figure 4. This suggests changes in innovation strategies may be the link between the evolution of competition features and the growth of productivity.

Moreover, some specific sectors, which have been thriving for the last decades are very concentrated sectors (Table 1). *Information* and *Utilities* sectors are the most concentrated in 2017 (whatever the measure, Top 50 firms sales share or HHI concentration index). This points out the role of IT industry

Figure 4: Patent-Based Industry Concentration



Source : [9]. For every industry and year, four firms that have generated the largest number of patents were identified. Then, the author scaled the total number of patents generated from these four firms by the number of patents generated by all public firms in the same industry and year

in the global market concentration. Thus, as we will see in 3.3, many authors were interested in technological gap which occurred between leading and laggard firms.

3.2 A theoretical framework

The work that explores the role of competition in the decline of productivity growth in the United States is mainly based on an endogenous growth model developed by Aghion and Howitt [1], to which are added extensions proposed by Klette and Kortum [10].

The Schumpeterian growth model and all its extensions are particularly well suited to understand the influence of competition on growth. Indeed, even in its simplest version, the model does not assume perfect competition and introduces a more complex market structure, implying a Bertrand competition in the production of an intermediate good. This is not the case of former classical growth models as the AK model which only embedded perfect competition. Moreover, the model is able to explain growth through entrepreneurial decisions (investment in R&D) aiming at stimulating innovation, which enables to reach situation of rents. Thus, in the Schumpetarian framework, productivity growth results from innovation, which is itself determined by the competitive characteristics of the production.

Most of the recent literature dedicated at understanding the fall in the productivity growth is based on the extension of the Schumpetarian model pro-

Table 1: Concentration index in 2017 : different sectors in the US

Sector	Top 50 firms sales share	HH index
Mining, quarrying, and oil and gas extraction	50.3	77.4
Utilities	71.6	161.4
Construction	10.6	3.0
Manufacturing	28.5	22.9
Wholesale trade	28.1	22.8
Retail trade	38.9	NA
Transportation and warehousing	42.8	112.8
Information	61.7	239
Finance and insurance	45.7	57.9
Real estate and rental and leasing	24.2	19.9
Professional, scientific, and technical services	17.8	8.6
Administrative and support and waste management and remediation services	27.7	41.7
Educational services	21.7	22.7
Health care and social assistance	18.8	10.6
Arts, entertainment, and recreation	22.7	23.1
Accommodation and food services	19.2	14.6
Other services (except public administration)	12.5	4.7

Source : Census Bureau, *Selected Sectors: Concentration of Largest Firms for the U.S.: 2017*

posed by Klette and Kortum [10] in 2004. This model brings two innovations :

- both incumbents and entrants stimulate innovation ;
- incumbents can expand in the space product (there is no more only one good but a whole collection of intermediate good) through successful innovation.

In this model, the Schumpetarian force of creative destruction is crucial : it is the driver of innovation, and thus productivity growth. Creative destruction lies in the fact that successful innovations come at the expense of competitors, who may exit the economy if they experience too harsh destruction.

The setup of the Klette and Kortum model has several ingredients :

- the final consumption good of the economy results from a continuum of intermediate goods, such that, $ln(Y_t) = \int_0^1 ln(y_{jt})\, dj$;
- the Poisson rate at which a company has a successful innovation depends on both the number of R&D scientists of the firm and the number of production units in which the company is already involved as a leader, through a Cobb-Douglas function. A successful innovation enables the company to be the leader of a new production line of an intermediate good, at the expense of another firm ;
- hiring scientists has a cost, which must be taken into in the stock-market value of a firm.

Competition features have a key role to play in solving this model. Considering that firms compete "à la Bertrand" on each production line leads to the determination of the quantity produced and the equilibrium profits, which will all be the same, whatever the production line. The stock market value of a firm must satisfies the Bellman equation derived from the definition of the Poisson innovation rate and the creative destruction process. Solving this equation leads to the determination of the equilibrium innovation intensity. Once again, competition is at play, through the assumption of free entry leading to the determination of the entry rate. Combining all these elements to the labor market clearing equation (which states that the whole workforce may be equal to the sum of production workers and scientists working for both incumbent and entrant firms), one can obtain the equilibrium growth rate of the economy as a function of exogenous parameters.

This first model tells us that the growth rate depends non-linearly on the cost of entry. On the one hand, the increase in the entry cost decreases the entry rate, which has a negative effect on growth. But on the other hand, the decrease in the number of entrants frees up a R&D labor force for the incumbents, which can stimulate innovation and improve growth.

3.3 What the literature says

Several hypotheses on the competition driving forces behind the decline in productivity growth have been proposed in the recent literature.

A first driving force is the **decrease in the cost of managing several production lines within the same firm**. This force is at the heart of the work of Aghion et al. [3]. In order to study the effect of such a decrease on long-term growth, the authors propose to use a model that goes beyond that of Klette and Kortum by adding several characteristics:

- the heterogeneity between firms does not only come from differences in endogenous qualities, the result of innovation, but also from an intrinsic difference in process efficiency ;
- companies face a quadratic overhead cost, which guarantees that the most efficient firms do not overrun the whole market. The overhead cost is denoted as $\frac{1}{2}\psi_0 n^2$, where n is the number of production lines.

The calibration of the model shows that the U.S. economy did indeed experience a decline in overhead costs $\psi_0$in the early 2000s. The authors then show that this decline has a double effect on long-term productivity growth. On the one hand, there is a direct positive effect: lower costs increase the marginal value of operating on a new production line, which stimulates innovation. On the other hand, the general equilibrium effect reduces long-term growth. Indeed, the probability of facing an efficient firm increases, which decreases the

markup expectation, and undermines innovation. The calibration of the model leads to the predominance of the general equilibrium effect over the direct effect, and thus to a decrease in long-term growth, which is accompanied by market concentration. The model developed by the authors also reproduces the growth burst in the early 2000s (observed in the Figures 1a and 1b) when they calculate the transition path due to a drop in ψ_0.

All these findings suggest that lower overhead costs are a good candidate to explain the decline in productivity growth in the US.

A second driving force is **the decline in the diffusion of knowledge between leader firms and laggard firms**. Akcigit and Ates [4] demonstrates the importance of this force by building a theoretical model that includes a probability of exogenous technological spillovers. These spillovers potentially allow the pursuing firms to catch up with the leading firms.

The authors show that the decline in diffusion, which they observe empirically, increases the productivity gap between firms. This has the consequence of decreasing incentives to innovation through two channels. The first one is the discouragement of laggard firms, whose effort to catch up becomes excessive. The second one is the weakening of the *escape competition effect*: leading firms that have distanced themselves from their pursuers are no longer encouraged to invest in order to obtain a rent, since they have already acquired a considerable lead. Ultimately, the decline in innovation leads to lower productivity growth.

A third driving force is **the persistent decline in long-term interest rates**, as shown in Figure 5. The idea developed by Liu et al. [11] is that leading firms do not have the same investment behavior as followers in a context of low interest rates.

Figure 5: U.S. long-term interest rate since 1990

Source : OECD, https://data.oecd.org/interest/long-term-interest-rates.htm

At first glance, one might have thought that lower interest rates stimulate innovation, to the extent that the present value of future earnings increases, this is the traditional effect. However, the implementation of an endogenous growth model highlights another effect: leading firms see low interest rates as an opportunity to avoid neck-and-neck competition, and invest more aggressively than followers, which discourages the latter. This is called the strategic effect. Market concentration is increasing, and as in the article of Akcigit and Ates , productivity growth is ultimately reduced. The authors show that for sufficiently low interest rates, the "strategic" effect dominates the "traditional" effect so that productivity growth is reduced in the long run. The lower the interest rate, the greater the deleterious effect.

4 Conclusion

The decline in U.S. productivity growth has sparked (and continues to spark) a vivid debate about its causes. Several authors have attempted to explain this decline, without necessarily taking into account the changing competition environment, by focusing on the difficulty of finding new ideas or the mismeasurement (underestimation) of productivity growth. However, it seems that taking competition into account in the debates, with the use of endogenous growth models, makes it possible to draw more robust conclusions and to identify some driving forces. Among these, the fall in overhead costs, the decline in the diffusion of knowledge and the continuous fall in interest rates have led to the emergence of superstar firms, favoring the concentration of markets and the decline in productivity growth.

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