Texto para Discussão 003 | 2021

Discussion Paper 003 | 2021

The degree of utilization and the slow adjustment of capacity to demand: reflections on the US Economy from the perspective of the Sraffian Supermultiplier

Guilherme Haluska
IBGE

Ricardo Summa
Instituto de Economia, Universidade Federal do Rio de Janeiro

Franklin Serrano
Instituto de Economia, Universidade Federal do Rio de Janeiro

The degree of utilization and the slow adjustment of capacity to demand: reflections on the US Economy from the perspective of the Sraffian Supermultiplier[1]

January, 2021

Guilherme Haluska
IBGE

Ricardo Summa
Instituto de Economia, Universidade Federal do Rio de Janeiro

Franklin Serrano
Instituto de Economia, Universidade Federal do Rio de Janeiro

Abstract

The purpose of this paper is to contribute to the recent theoretical debate about the relation between growth and capacity utilization from the perspective of the Sraffian Supermultplier demand-led growth model, by using the case of the US economy as a benchmark to check both for the possibility of changes in normal utilization, as argued by some Neo-kaleckians, and for evidence of a slow adjustment of capacity to demand, as a decline in the average degree of capacity utilization has been observed in since the early 2000s in this economy. We follow the concept of normal degree of utilization proposed by Ciccone and we use a simple version of the Supermultiplier model. First,

[1] The authors would like to thank Julia Braga and Tom Bauermann for the comments made on an early version of this paper, and the participants of the the 46th Annual Conference of the Eastern Economic Association in Boston, United States, and the 13rd Encontro Internacional da Associação Keynesiana Brasileira, São Paulo, Brazil (online), for the discussions. Ricardo Summa and Franklin Serrano would like to thank the Brazilian National Council for Scientific and Technological Development (CNPq) for the financial support.

we examined the data from several branches of the industrial sector for the US economy and found no reason to believe that this decline in actual utilization can be explained by a general reduction in the normal rates of capacity utilization. Second, we made some simulations based on our simple Sraffian Supermultiplier model to demonstrate that the process of convergence of actual utilization to its given normal degree is slow and the model is compatible with long and lasting deviations between actual and normal utilization after large shocks, such as the decrease in output growth rates in the US economy since the begin of the 2000s.

Keywords: Capacity utilization, normal capacity utilization, Sraffian Supermultiplier, demand-led growth.

1 Introduction

The well-known result of the Neo-Kaleckian growth model of a positive relation between the long run rate of growth of output and the equilibrium degree of capacity utilization – thus implying the possibility of permanent large deviations between the actual and the given normal or "planned" degrees of capacity utilization, even in a steady-state – has long been subject to criticism (see for example Commiteri, 1986, Skott, 2012, Serrano and Freitas, 2017). Recently, some authors following the Neo-Kaleckian perspective such as Nikiforos (2016,2018,2020c) and Setterfield (2019,2020) have argued for the importance and relevance of this positive long run relation between the rate of growth of output and the equilibrium degree of capacity utilization. They respond to the objections to the large and permanent deviations between the actual and normal degrees of capacity utilization by proposing that it is the normal degree of utilization that endogenously adjust to the actual degree of utilization in the long run[2]. From this particular Neo-Kaleckian perspective, in actual economies, a reduction of the trend growth rate of demand and output would lead to lower average actual degrees capacity utilization, and this would lead also to a tendency towards lower levels of the normal degree utilization.

By contrast, the Sraffian Supermultiplier demand-led growth model (Serrano, 1995, Freitas and Serrano, 2015) implies no necessary theoretical relationship between the growth rate and the normal of planned degree of capacity utilization since the model's mechanism of adjustment of capacity to demand generates a tendency for the actual degree of utilization to converge towards its exogenously given normal or desired value in fully adjusted positions. From the Supermultiplier perspective, the normal degree of utilization is exogenous, in the sense that it has no systematic relation to the level or growth rates of demand, and normal utilization is seen to depend on the technology and on the expected norms of the ratio between average of peaks in demand, that is, on the patterns of fluctuations of demand, instead of their levels or rates of growth of demand (following Ciccone, 1986, 1987, 2012). In the Sraffian Supermultiplier model, investment makes capacity gradually adjust to the trend of expected demand, following a flexible

[2] For recent criticisms on the idea of endogenous normal rate of capacity utilization, see Girardi and Pariboni (2019), Haluska (2020) and Huang (2020).

accelerator mechanism. Since some time ago Sraffians have argued that, due to the well-known dual character of investment, which implies that increases (decreases) in investment operates by first generating more (less) demand and only in subsequent periods adding more (less) to productive capacity, the process of adjusting capacity to demand, although ever present in capitalist economies, is bound to be rather slow. Thus, the gravitation towards fully adjusted positions, after a shock, may take a long time (and may well be interrupted by further shocks before completion) such that divergencies between the average and actual degrees of capacity utilization should not be seen as restricted to the short run (Ciccone, 1986, Garegnani, 1992, Freitas and Serrano, 2015). Therefore, large changes in the trend of growth rates in one direction can significantly affect the average degree of capacity utilization, even if the exogenous normal degree of utilization remains fixed during the adjustment process.

The purpose of this paper is to contribute to the theoretical debate on the relation between growth and capacity utilization from the perspective of the Sraffian Supermultplier, using the case of the performance of the US economy in the last few decades as reference to check the relative plausibility of both the Neo-Kaleckian explanation of the occurrence of an endogenous changes in the normal degree of utilization and the alternative Sraffian supermultiplier explanation of large changes in the growth of demand provoking long-lasting deviations of the average actual degrees of capacity utilization form their normal degrees, quite independently of any changes in the latter. We choose the U.S. case as a benchmark for three reasons. First, because a decline in the average degree of capacity utilization has been observed since the early 2000s in such economy while for other advanced economies the oscillation of the actual degree of capacity utilization seems to have been stationary and thus independent from the observed changes in the rate of growth (Gahn and González, 2019). Second, because a large part of the researchers who believe that this decline in actual utilization was accompanied by an endogenous decrease in the normal degree of utilization also naturally use the US case as a benchmark (Setterfield, 2019, 2020, Setterfield and Avritzer, 2020, Botte, 2020, Bassi et all, 2020). Third, because the version of the Sraffian Supermultiplier proposed by Serrano, Freitas and Bhering (2019) precisely to examine the process of adjustment of capacity to demand was estimated for the US economy by Haluska, Braga and Summa (2020) and concluded that the speed of this adjustment is indeed slow (similar results were obtained by Fazzari et all (2020)).

Given this, here we will try to show that (i) we find no evidence that the recent decline in the average actual degree of utilization can be explained by a general reduction in the normal degrees of capacity utilization in the various sectors of the American economy and that (ii) this behavior of actual capacity utilization is compatible with the slow adjustment of capacity to demand of the Sraffian Supermultiplier model in a context of successive decreases in the trend of output growth rates in the US economy since the begin of the 2000s

The rest of the paper is organized as follows. In Section 2 we discuss the concept of normal utilization proposed by Ciccone, partially based on Steindl. In section 3, we critically discuss the recent empirical estimations of normal utilization based on averages of actual degrees of utilization. In the fourth section we look at industrial data from the US to check if it is plausible that normal utilization (in Ciccone´s sense) has undergone a definite general change. In the fifth section we simulate the behavior of the actual rate of capacity utilization using our simple Sraffian Supermultiplier model to have a sense of the order of magnitude of the deviations between actual and normal utilization, given large shocks to demand. Final remarks are made in section six.

2 Determinants of normal utilization

In this section we will discuss the determinants of the normal degree of capacity utilization. We will follow the concepts presented by Ciccone (1986, 1987, 2012), partially based on Steindl (1952).[3]

It is useful to make a distinction between two types of oscillations in effective demand, i.e., profitable demand that pays at least the normal (or supply) prices: (i) seasonal and predictable fluctuations, and (ii) unexpected fluctuations. Examples of seasonal fluctuations with annual frequency are the increase in retail trade sales before Christmas, the increases in demand for natural gas for heating purpose during the months of the winter, for ice cream during the summer, and for sugar and confectionery products in the last quarter of the year – which comprehend the holidays of Halloween, Thanksgiving and Christmas. Seasonal fluctuations in demand might also be perceived during a month, a week or even during one single day. It can take place (i) during a month if, for example, workers consume more of a product immediately after they receive their monthly wages, (ii) during a week, as in the case of movie theaters, when demand is higher during the weekend, or (iii) even within a day, as is the case of restaurants, where demand is higher at lunch and dinner hours and lower during the afternoon.

In some cases, these fluctuations in demand are accommodated by changes in inventories, especially in the case of very short run fluctuations, but in other situations they are met by changes in production and thus usually, by changes in the degree of capacity utilization because (i) it might be too costly to keep large inventories, (ii) in some cases it is not possible to keep inventories, as in the case of services or perishable products.

Independently if fluctuations in demand are met by changes in production of in inventories, each individual capitalist wishes to be able to meet these peaks in effective

[3] We will thus use the concept of normal utilization different than that of Kurz (1986). For a more detailed discussion on these differences, see Ciccone (1987) and Haluska (2020). In fact, Kurz (1986) and the authors which follow his conception of normal utilization – such as Nikiforos (2013,2016) and Huang (2020) seem to focus mostly on the problem of the choice of technique not giving sufficient emphasis to what we consider the central issue of the expected pattern of demand fluctuations, as Ciccone does.

demand because on the contrary they are under the risk of losing market share to their competitors, so the size of productive capacity is installed to be able to meet peak levels in demand expected during the economic life of the equipment. On the other hand, capitalists do not want to keep idle capacity beyond the maximum expected levels of demand because investing in fixed capital is costly. The normal degree of capacity utilization, by its turn, will depend mainly on the ratio between the average demand and those peaks in demand expected over the life of the installed equipment (Ciccone, 1986, p. 26-28).

It is important to notice that there is no reason to expect that an economic crisis or a particular boom will change the way these seasonal fluctuations take place, since it depends on factors that are not explained by aggregate demand, such as holidays, cultural habits, the timing of payment of wages, weather conditions, etc.

Leaving these regular fluctuations aside, an economy is subjected to unpredicted changes in demand and as it was said above, capitalists want to be able to meet these maximum levels of demand because they do not want to lose market share to their competitors. However, it takes some time for firms to adjust their productive capacity, so they also tend to keep some extra margin of planned spare capacity – beyond what would be required to supply the predictable maximum levels – to be able to meet unpredictable increases in demand. Steindl (1952, p. 9) illustrates this point by comparing the reasons to keep cash with the reasons to keep idle capacity. People keep cash in their portfolios as an insurance to face unpredicted events. Under the same logic, capitalists keep idle capacity so that they can face unpredicted increases in demand. Once again, it is hard to see why an overall increase or decrease in the levels or rate of growth of demand would make firms revise their planned margins of spare capacity for **unexpected** increases in demand, a point that was also raised by Skott (2012).[4]

The reason why normal utilization is usually considered **exogenous** in relation to demand is because it depends on a set of factors that are not explained nor directly correlated to

[4] "There [is not] any reason why a negative demand shock and a decline in sales should make the firm think that the optimal degree of excess capacity has changed permanently." (Skott, 2012, p. 123)

the levels of demand, such as the breath and frequency of demand fluctuations and the margins of extra spare capacity kept by firms. Attempts to stablish a systematic connection between macroeconomic conditions such as the level or rate of growth of aggregate demand and the sizes of seasonal oscillations of demand and of extra planned spare capacity would have to be made considering the particularities of each industry and product and could hardly be extended for the entire economy.

There are other factors that may explain why these margins of spare capacity could be higher in one industry than in another – and consequently affecting the ratio between predicted average demand and installed capacity. Due to technological factors, it is possible that a firm adopts a method of production that presents lower unit costs, but which is only feasible for large scale production, for example. In this case it could be more profitable to adopt this method even if this results in a higher spare capacity. Additionally, in some cases unit costs might increase when production is above some specific level, so that maximum capacity might be dimensioned considering that the peaks in demand can be met without being required to reach this higher utilization levels. This could be the case if it is necessary to pay a higher wage for extra hours or for work shifts that fall outside normal hours. (Ciccone, 1986, p. 31-32)

The indivisibility of fixed capital also plays an important role. This characteristic implies that most of individual firms can only increase its capacity in a discontinuous way, while the demand for its production usually increases in a gradual pace, depending on the growth of total demand in each specific branch, since it is more difficult for an individual firm to expand its sales at the expense of its competitors. (Steindl, 1952, p. 10). Firms do take this into account and already expect to operate under low utilization immediately after an increase in capacity takes place, and full capacity output production might be higher than the peaks in demand expected for the near future. This means that normal utilization is the one that capitalists expect to observe, on the average, during the whole economic life of the equipment, and not in every single period. (Ciccone, 1986, p. 31)

The process of adjustment of capacity to demand will probably not be perfectly symmetrical when utilization is above or below its normal level. If utilization is too high, firms can increase their gross investment, but since fixed capital is durable and often indivisible, firms can only reduce their installed capacity slowly relying on gross investment being lower than replacement for depreciation (Ciccone, 1986, p. 30). This means the adjustment of capacity to demand might be slower if the economy is initially below its normal utilization.

Since firms also do not know exactly the size of future fluctuations in demand, they consider the capacity utilization observed in the past, since it reflects the breath and frequency of demand in the past. However, what matters in this case is **the pattern of fluctuations** in demand observed during several economic cycles, so that normal utilization, tends not to be directly affected by the average of the actual degree of capacity nor even by the more recently observed values of the ratio between average and peak demands (Ciccone, 1986, p. 36, Ciccone, 1987, p. 98).

Once we have presented the main determinants of normal utilization, it is possible to conclude that normal utilization tends to be different for each sector, depending on the size of the oscillations in demand in each industry and on several technological aspects that are singular to each one of them. This also means that if normal utilization changes for one or a few activities, there is no reason to expect a priori that these changes can be generalized to all industries, nor it is likely that they should change in the same direction as the levels or rates of growth of demand.

3 Measuring normal capacity utilization through the actual utilization

The normal degree of capacity utilization is, however, something that poses an obstacle for empirical studies. A widespread method is to use actual utilization data to calculate normal utilization as some sort of average of it. Some studies use statistical filters that consider both past and future values of utilization to determine normal utilization in each specific period, while others argue that normal utilization should depends only on past data.[5] Either way, these authors consider that actual data can somehow provide a good estimate for normal utilization, as can be seen in Lavoie, Rodriguez, and Seccareccia (2004, p. 139), Skott (2012, p. 132), Nikiforos (2016, p. 445), Setterfield (2019a, p. 455), Setterfield (2019b, p. 4), Setterfield and Avritzer (2020, p. 10) and Botte (2020, p. 3).

The use of statistical filters to estimate normal utilization from actual utilization leads to the conclusion that normal utilization has declined in the US since the beginning of the 2000s, which is the period of our main concern. This result is achieved both if normal utilization is calculated either through some Hodrick-Prescott filter that isolates the cyclical component from the trend – as can be found in Setterfield (2019a, p. 456) and Setterfield and Avritzer (2020, p. 13-14) – or it is calculated as a moving average from past utilization, as in Botte (2020, p. 6).[6]

These methods of estimating normal utilization using data about the realized degree of utilization rate assume implicitly that some sort of moving average of actual utilization is

[5] Botte (2020) criticizes the use of HP filters to estimate normal utilization because "the Hodrick–Prescott filter incorporates past values as well as future values of the utilization rate" (p. 2) and it "implies that firms have remarkable forecasting abilities and reduce their normal level of productive capacity utilization even before they face a decrease in their actual utilization rate" (p. 3). According to the author, firms revise their desired utilization ratio based only on the values observed in the past – contrary to the HP method which uses both past and future values – and he proposes that "the procedural measure of u_n is a weighted average of past values of u with exponentially decaying weight." (p. 3), a method that "is consistent with a radically uncertain economic environment and with procedural rationality à la Simon (1976)" (p. 5).

[6] Fiebiger (2020) is also critical of the idea of using HP filters to estimate the normal rate of utilization but "proceed to empirical findings based on the assumption that the normal utilisation rate can be approximated by long-run time averages" p.396).

a good proxy for normal utilization. However, if the process of adjustment of capacity to the trend of demand is slow, effective utilization can deviate from its normal level during long periods of time, and any such average will not be able to distinguish such longer lasting deviations from changes in the normal degree of utilization. So, this kind of proxy for the normal degree of capacity utilization by construction might be influenced by longer lasting changes in the actual degree of capacity utilization, which is in contradiction with the view adopted here, according to which persistent changes in the levels and growth of demand, through their effects on investment, will tend to affect the size of productive capacity instead of the desired normal degree of utilization.

Other authors use unit root tests to check if the series of actual utilization are stationary and investigate if there is a tendency for utilization to revert towards its mean (Braga (2006), Gahn and González (2019, 2020) and Nikiforos (2020a)). Normal utilization would be equal to the long period mean actual utilization obtained throughout the sample, which the actual data on utilization would converge.

Implicit in this kind of analysis is (i) the idea that not only normal utilization is exogenous, but also that it does not change over the sample; (ii) the economy faces symmetrical demand shocks of zero mean during deviations from the fixed normal rate, so that the economy on the average is operating under normal utilization. But if the process of adjustment of capacity to demand is slow and even if normal utilization does not change, successive non symmetric demand shocks in one direction could make utilization differ from normal for a long time, leading the tests to show unit roots, which could be wrongly interpreted as either (i) the absence of a tendency for the adjustment of capacity to demand or (ii) a change in the normal degree utilization, when all that happened was that the economy was not on the fully adjusted position on an exact average during the period.

Some authors believe that normal utilization is a variable influenced by conventions (Lavoie et al, 2004). It is important to clarify that according to our view, besides technology, conventions do also play a role. As firms do not know exactly what is going to be the ratio between average and peaks in demand in the future, they tend to follow the convention in each sector about what is the usual or normal pattern in terms of breath and frequency of demand fluctuations which in turn is likely to be based on what has been collectively observed during several previous economic cycles, and thus is unlikely to be just an average of what has been observed in the recent past (Ciccone, 1986,p.36).

Setterfield and Avritzer (2020) also state that normal utilization is affected by the actual rate, providing a particular economic rationale for that. According to them, normal utilization is a function of demand variability, basing their ideas in concepts from Steindl (1952) that are like the ones we discussed in the previous section. Basically, firms keep planed excessive capacity to (i) "'build ahead of demand' in an environment in which the economy is growing continuously but capital investments are discrete and 'lumpy'" (p. 16) and (ii) "hedge against potential loss of market share due to unforeseen variations of demand" (p. 16). But they add a further proposition that demand **variability** depends negatively on the **level** of demand itself, because:

> "as a long boom ends and the economy enters a crisis, the level of macroeconomic performance deteriorates and this is accompanied by an increase in the volatility of the macroeconomic environment. Macroeconomic volatility is low, meanwhile, when the economy reconstitutes an institutional framework capable of fostering buoyant animal spirits and improved macroeconomic performance." (p. 13)

The variability of demand is what stablishes the connection between actual and normal utilization. According to the argument, higher (lower) levels of demand and of the actual degree of utilization reduce (increase) the variability of demand, leading to an increase (decrease) in normal utilization. However, firms do not adjust normal utilization in response to every change in actual utilization. The model proposed states that if the variability of actual utilization (σ_u^2) remains within a specific interval ($\sigma_{uL}^2 < \sigma_u^2 < \sigma_{uH}^2$), firms do not change the normal utilization. However, when variability surpasses σ_{uH}^2, desired utilization decreases, and inversely, when variability falls below σ_{uL}^2, normal utilization increases.

By associating some information about demand variability to normal utilization, the method used by these authors is like ours. However, it is not clear that such a regular inverse relation between levels of demand and actual capacity utilization and their variability exists either in each sector or even for the economy as a whole. Moreover, Setterfield and Avritzer (2020) also assume that temporary disturbances in economic conditions, if they are large enough, can change normal utilization, an interpretation which we do not find plausible. As discussed in the previous section, we see no reason to expect that a temporary change in aggregate demand will change the three main determinants of the normal degree of utilization, namely, (i) the pattern of seasonal fluctuations in demand, since it depends on cultural and social habits that are not affected by aggregate demand, (ii) technological factors and indivisibilities and (iii) the margin of extra spare capacity to meet future unexpected increases in demand.

One of their conclusions is that the increase in volatility during the Great Recession from 2007-2009 was strong enough to lower normal utilization in the US (Setterfield and Avritzer (2020), p. 19). A more detailed discussion on this issue is made in the next section, but our conclusion finds no support for the thesis that normal utilization has changed.

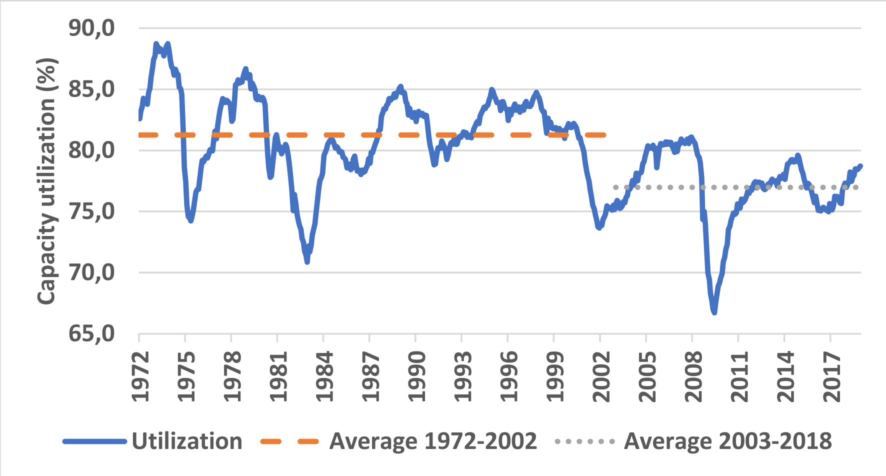
Finally, it is important to notice that all these authors try to estimate the normal degree of capacity utilization based only on aggregated data for the industrial sector, while its determination seems to us to be highly specific to each productive branch. Thus, it is useful to look at a disaggregated level of the different branches of the industrial sector[7].

[7] For one exception, see Bassi et al. (2020).

4 Was there a change in normal utilization in the US?

In this section, we look at the data for the US economy to see if we find evidence supporting the notion that not only the average but also the normal degree of capacity utilization has fallen significantly in the last decades. Figure 1 shows the aggregate capacity utilization degree of the US industrial sector estimated by the FED.

Figure 1 - Capacity utilization and averages by period



Source: FRED. Elaborated by the author.

It is important to clarify that this decline in utilization was generalized within the different branches of industry and it is not the result of changes in the composition of industrial production towards activities that present a lower utilization. Among 30 activities that compose the industrial sector, 27 of them – which represent 80.3% of total industrial output – presented a decline in average utilization in the period from 2003 to 2018 compared to the previous years – 1972 to 2002 (see detail information in Table 1 in the Appendix B). These results are supported by Pierce and Wisinewski (2018), who calculate aggregate utilization with the weight of each industry fixed at its 1972 level and conclude that this fixed-weight utilization is like the actual utilization data, calculated with time-varying weights. These authors also find out that the decline in utilization from 1972 to 2016 is widespread among the several industries, although the magnitudes vary between them.

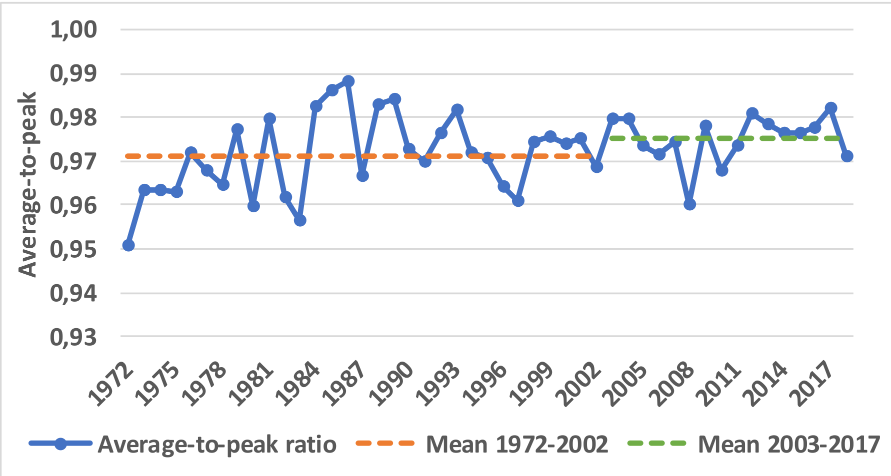
As we mentioned in section 2, maximum capacity is built to supply the maximum levels of demand predicted during the economic life of the equipment plus some margin of desired extra spare capacity maintained to meet unexpected increases in demand and perhaps some further spare capacity due to technical indivisibilities. Normal utilization depends thus on the ratio between average and expected peaks in demand and on the size of these is margin of extra spare capacity maintained even beyond the expected peaks. To assess the hypothesis that normal utilization in US has declined in the recent period, we will use the data of production for mining, manufacturing and utilities sectors provided by the Federal Reserve Economic Data (FRED)[8] as a proxy to check for average and expected peaks in demand. Since the determinants of normal utilization are specific to each sector, our analysis in this section is made at a disaggregated activity level. To check for the oscillations in output used to meet the seasonal fluctuations in demand we will use non-seasonally adjusted data on industrial production, to look at the seasonal part of the fluctuations within the different months of the year. Since the frequency of this data is monthly, we cannot check for changes in the seasonal fluctuations that take place within a month.

We calculated average-to-peak ratios for the several industries to check for the seasonal oscillation in production within each year. These ratios were calculated for each year and

[8] Recently, this more 'conventional' data for capacity utilization has been criticized by Nikiforos (2013, 2016, 2020b), who claims that it would be stationary by construction and suggests that the average workweek of capital (AWC) – which is the number of hours a plant works per week divided by the maximum hours it can work – provides a better information. In response to that, Fiebiger (2020) replies to Nikiforos saying that the AWC does capture properly the changes in production for most industrial activities. The author quotes Corrado and Mattey (1997) who "distinguish between three types of stylised technology used by manufacturing firms: pure assemblers (for example, automakers), flexibly operated workstation assemblers (for example, apparel) and continuous processors (for example, oil refinery)." (p. 387). However, the AWC does not provide a good proxy for changes in output in the case of continuous processors (who produce uninterruptedly) neither for workstations assemblers industries, which usually operate only under one single shift (*ibid*, p. 387 and 392). Only in the case of pure assemblers can the AWC provide a good proxy, but even in that case "it cannot be generalized that (…) varying the number of shifts is the main method for adjusting production levels in response to short-run rhythmic variations in demand" (Fiebiger 2020, p. 387). With that in mind, we opt to use the conventional data from the Fed, which considers the economic concept of full capacity output, instead of the AWC which is more closely related to the engineering concept of full capacity. For more empirical debates on the data of capacity utilization for the US economy, see Gahn (2020), Gahn and González (2020) and Nikiforos (2020a).

each industry, dividing the average production level of the 12 months of each year of each industry by the month with the highest production of the respective year and industry. Comparing the means of the average-to-peak ratios observed between 1972 and 2002 with the ones observed between 2003 and 2017, these ratios have increased in the most recent period in 70 out of 102 branches, which corresponds to 64.8% of the industrial production. Table 2 in the Appendix B presents the detailed data for each sector, while Figure 2 illustrates the average-to-peak ratio of total industrial production so that we can take a broader view. These results show a stability in the size of seasonal fluctuations, which in principle does not provide support to the thesis that normal utilization has decreased. On the contrary, these data are more prone to show a decrease in the size of seasonal fluctuations, which, to the extent that the firms 'conventions regarding what is the typical sectoral average to peak demand pattern were modified by this recent trend (which we find unlikely), would in fact indicate that normal utilization had increased, instead of decreased.

Figure 2 - Average-to-peak ratio of industrial production.



Source: FRED. Elaborated by the author.

Our results thus differ from the ones obtained by Setterfield and Avritzer (2020), who conclude that the rise in volatility during the years of the Financial crisis was strong enough to make firms reduce their desired utilization. The average-to-peak ratio seems to have decreased only in 2008 – perhaps suggesting an increase in volatility, – but quickly returned to its previous levels, higher on average, than in the preceding period.

It is important to clarify that this average-to-peak ratio of output should not be interpreted as proxy or some sort of estimation of normal utilization in each year. If that were the case, it would imply that normal utilization suffers small changes every year, which is not the argument being made in this paper. These indexes evaluated here provide an overview of the direction in which the patterns of seasonal fluctuations in output are changing during a longer period that encompasses one or more economic cycles, to assess the plausibility of considering that normal utilization have decreased. We thus believe from the analysis of the data that there is no clear evidence for supposing that the normal degree of utilization has decreased in the US economy.

5 Adjustment of capacity to demand in the Sraffian Supermultiplier model

In this section, we will show that the Sraffian Supermultiplier model (see Serrano, 1995, Freitas and Serrano, 2015 and Serrano, Freitas and Bhering, 2019) with a flexible accelerator and a slow process of adjustment of capacity to demand can generate long-lasting deviations between actual and a given exogenous normal utilization if the economy faces successive changes in the pace of growth of effective demand.

To demonstrate this point, we will simulate what happens with the actual capacity utilization following successive decreases in the growth rate of output. We will use the version of the Supermultiplier model presented by Serrano, Freitas and Bhering (2019) in which the induced investment share depends on the expected demand growth, while the expected growth rate adjusts according the deviations between actual and expected growth. The parameters used in the simulations are based on the estimates of the model´s investment function from Haluska, Braga and Summa (2020) for the US economy, which finds the adjustment process of adjustment is quite slow. We suppose that normal utilization is exogenous and remain unaltered in the simulations presented in this section. The formal model as well as the values of the parameters used in the simulations are presented in Appendix A.

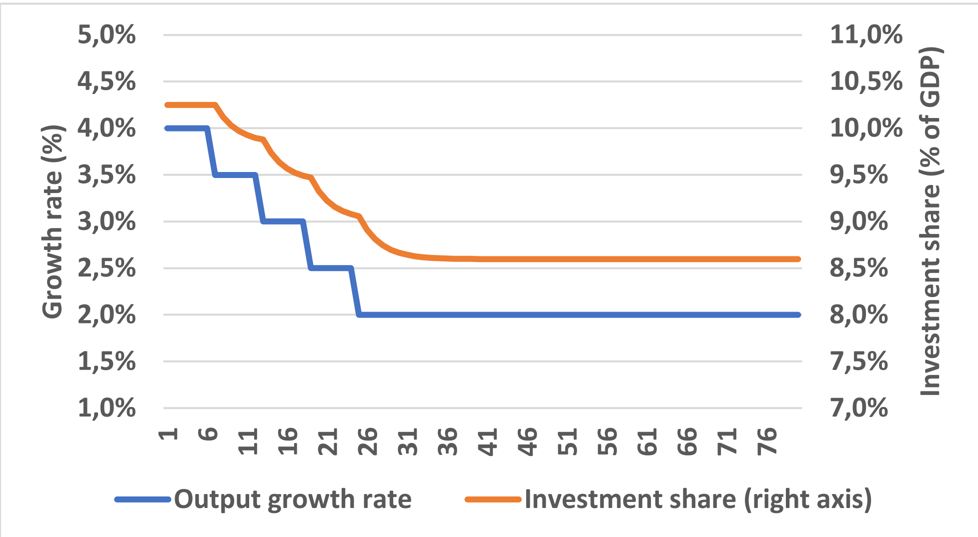
In this model, investment is responsible for increasing the stock of capital and consequently the productive capacity, but since new investment represents a small portion of the existing stock of capital, changes in the investment growth rate at first induces only a small change in the growth rate of the stock of capital, and the latter converges to the former only after some time. With the growth rate of productive capacity and the given output growth we get to the changes in capacity utilization.

We will run two different kinds of simulation. In the first simulation, we will suppose a hypothetical pattern for the growth rate of the economy, which is successively reduced from 4% to 2%. In the second, we will use the actual data on growth for the US economy. For both simulations, we assume that the economy is initially in its fully adjusted position, with utilization equal to its desired level.

In the first simulation, we suppose that output, investment and capital start growing at 4% a year. Next, we simulate how these variables reacts to successive 0.5 per cent decreases in output's growth rate, which drops from 4% to 2% a year. After output growth decreases, capitalists' expectations are not fulfilled, so they start to revise downwards their forecasts and the induced investment share declines slowly. This decline in the propensity to invest is responsible to make investment to grow less than output. However, since it takes some time for the growth of the stock of capital do adjusts to the pace of investment growth, productive capacity will grow more than output for a while and utilization will fall. After some time, the growth of the stock of capital also decreases and starts growing less then output and from this point on utilization starts to rise again, converging to its normal level. Figures 3, 4 and 5 present the basic results of the simulations.

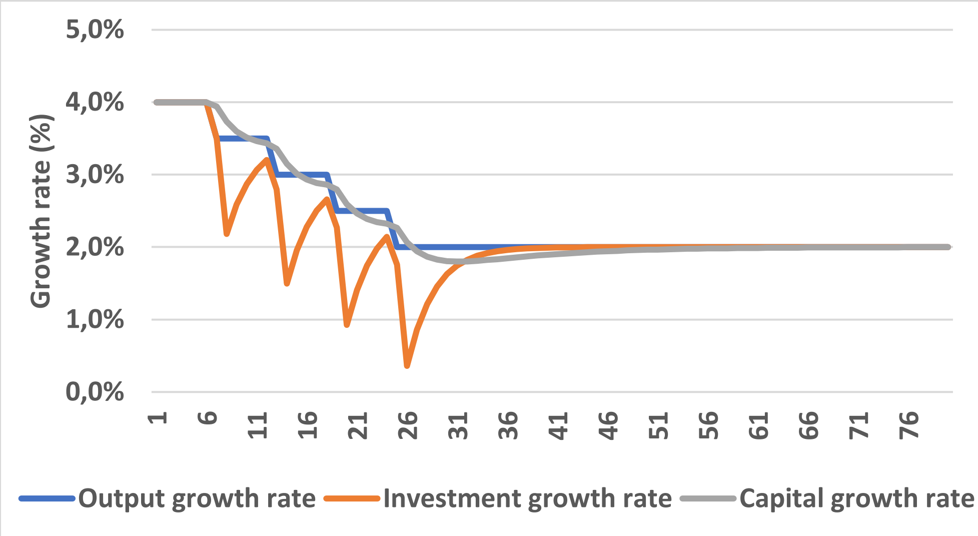
It is important to distinguish two different aspects in this adjustment process. The first one is the time required for growth expectations to change, and consequently, alter the propensity to invest – which can be seen on Figure 3. The second process is slower and depends on the first: it consists of the time required for the changes in the investment growth to provoke changes in the stock of capital that adjusts capacity to demand – Figures 4 and 5.

Figure 3 - Output growth rate and investment share



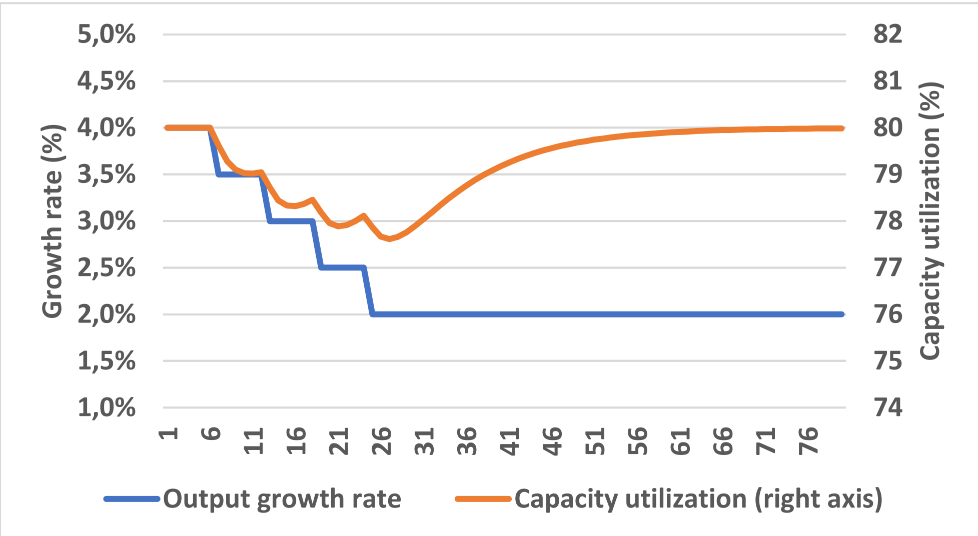
Source: Elaborated by the authors.

Figure 4 - Output, investment and capital stock growth rates



Source: Elaborated by the authors.

Figure 5 - Output growth rate and capacity utilization

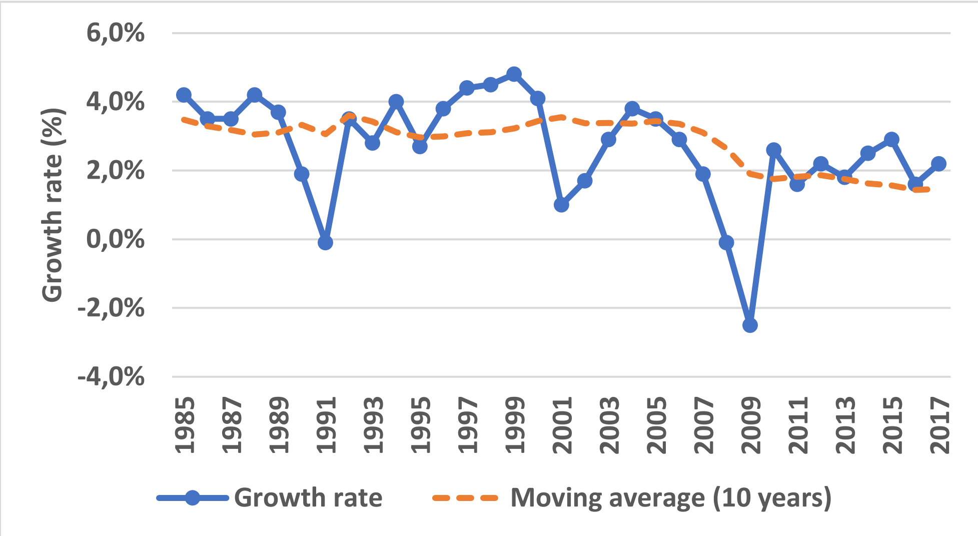


Source: Elaborated by the authors.

The first conclusion we want to highlight here is that during the transition from a higher to lower growth steady-state, there is no reason to expect that average utilization will converge quickly to its normal degree and it is probable that it will remain below its desired level during this period. Second, since it is likely that the economy will remain outside its fully adjusted position for a considerable time, taking average utilization might not be a good proxy for normal utilization even if we consider a large period, and specially, if the growth rate suffered significant changes during these years.

In the second simulation we use the effective rate of growth instead of a hypothetical one. Before presenting the simulations results, it is important to show the growth rate of the US economy and its moving average. As can be seen in Figure 6, the 10-year moving average oscillated between 3.6% and 3.0% from 1985 to 2001 and after that it presented a gradual decline, reaching 1.5% in 2017.

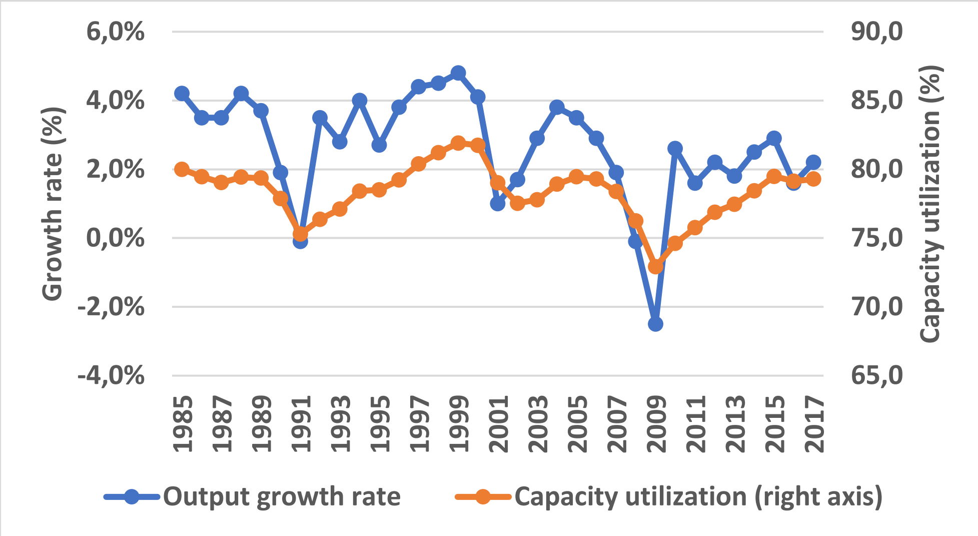
Figure 6 - US GDP growth rate and its 10-year moving average



Source: BEA. Elaborated by the authors

For the second simulation, we suppose that in the first year (1985) the growth rates of investment, stock of capital and productive capacity are all equal to the growth rate of GDP (4.2%), utilization is equal to its normal level (assumed here to be 80%) and the expected growth rate that is considered to determine the induced investment share in the first year is being fulfilled. The results of the simulation using the actual rate of growth can be seen in Figure 7 below.

Figure 7 - Output growth rate and capacity utilization



Source: BEA. Elaborated by the authors

The simulated series of capacity utilization declines 2.6 percentage points from its peak of 81.9% in 1999 to 79.3% in 2017. Average utilization from 2001 to 2017 is equal to 77.7%, 1.4 pp lower than the average from 1985 to 2000 of 79.1 %. This result suggests that the decline in output growth rates observed in the US combined with the flexible accelerator mechanism (which embodies a slow adjustment of capacity to changes in growth expectations) can prevent utilization to converge to its normal level during a considerable period.

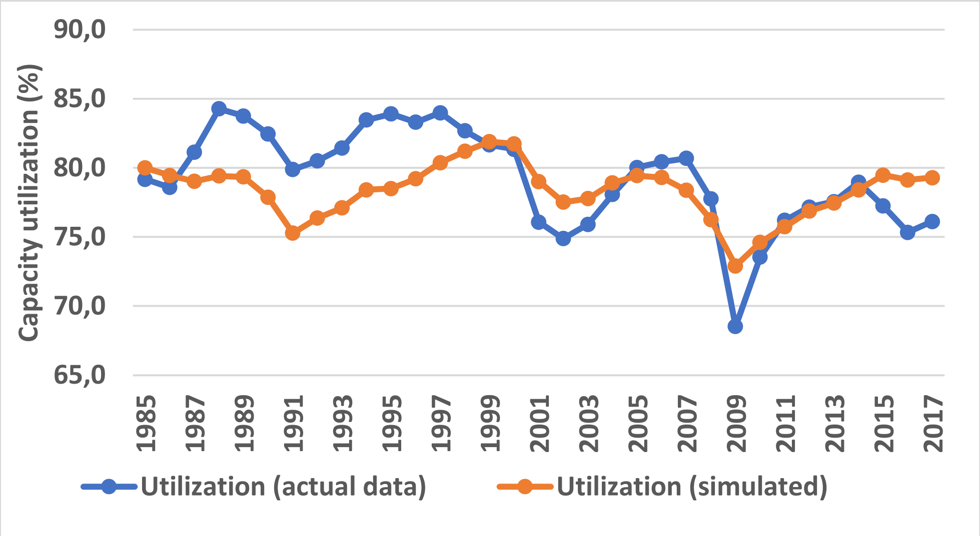
It is worth noticing that our purpose with these simulations is not to perfectly match the simulated series with the actual data, but only to demonstrate that a continuous decline in trend growth rates as observed in the US since the begin of the 2000s can deviate actual capacity utilization from its normal level for several years, in a model with slow mechanism of adjustment of capacity to demand such as our simple Sraffian Supermultiplier Model. In this way, it is important to clarify that there are some simplifications in the simulations, so it is necessary to be careful in comparing the simulated series with the actual data. First, we did not include changes in relative prices of capital and output, in the capital-to-normal output ratio and the depreciation rate. Second, the variables we are simulating refers to the whole economy, while the actual data on utilization is restricted to the industrial sector. Third, we assume that the economy is initially in its fully adjusted position, so the initial values of several variables are fixed and might present divergencies with the actual ones.

Despite the several simplifying assumptions involved in this simulation and the restrictions that must be considered to compare the simulated and actual series of capacity utilization, both series share a similar pattern of fluctuations, as can be seen in Figure 8[9, 10].

[9] As can be also seen in Figure 10, both simulated and actual series of capacity utilization present two important declines: the first one following the crisis from 2001 and the second one following the Great Financial crisis from 2008-09. In these years, the decreases in actual utilization are larger than in the simulated series, which can be explained mainly by the fact that the simulations were calculated considering GDP growth, which encompasses the entire economy, while the actual data on utilization is restricted to the industrial sector, which is subjected to larger fluctuations. As Corrado and Mattey (1997, p. 158) explain, "most of the fluctuation in aggregate output comes from changes in the demand for goods and new structures; by comparison, final demand for services is relatively stable". Since goods and structures are precisely what is produced by the industrial sector, this means that the effects of crisis are higher on industrial production than on the services activities.

[10] A further factor that might have played a minor role in explaining the slowness of the adjustment process described above, could be due to asymmetric responses of the adjustment of capacity to demand. When demand increases, firms can invest and increase capacity considerably, but when demand decreases, the downward adjustment of capacity is done by making gross investment fall below required replacement investment and this will limit the fall in capacity even if gross investment falls to zero. Although GDP growth rates in the US have always remained positive during the 2000s (except in the 2008-2009 crisis), growth was quite different among the several industrial branches, and the lower growth from the 2000s resulted in a much larger share of activities presenting decreases in production. From 1972 to 2002, only 19 out of 102 industries presented an accumulated decrease in production (representing 14.4% of industrial production in 2002) while between 2002 and 2017, the number of industries with an accumulated decline in production rose to 58 out of 102 (representing 40.0% of industrial production in 2017). See Table 3 from the Appendix B for detailed data.

Figure 8 - Capacity utilization: actual and simulated data



Source: BEA, FRED. Elaborated by the authors

6 Final remarks

In this paper we attempt to contribute to the theoretical debate between growth and capacity utilization from the Sraffian Supermultplier perspective. We follow the concept of normal degree of capacity utilization proposed by Ciccone and we use a simple version of the Supermultiplier model, in which the adjustment of productive capacity to effective demand is slow. We use the US economy case as a benchmark, as a definite decline in the average degree of capacity utilization has been observed since the early 2000s in this economy, to check both the Neo-Kaleckian explanation of changes in the normal degree of capacity utilization and the alternative explanation based on the slow adjustment via the Supermultiplier model with an exogenous normal degree of utilization. We found no reason to believe that the decline in actual utilization can be plausibly explained by a general reduction in the normal rate of capacity utilization, while the successive slowdown in the rates of growth of effective demand in the United States since the beginning of the 2000s could well explain the long-lasting deviations between actual and normal utilization if the process of adjusting productive capacity to demand converges slowly as proposed by the Sraffian Supermultiplier model.

Appendix A – Theoretical model

In this appendix, we are presenting the equations that are used in our simulations. Let us ignore changes in relative prices and assume that the depreciation ratio and the ratio between capital and full capacity output are constant for the sake of simplicity. We are adopting the specification of the Sraffian Supermultiplier model presented in Serrano, Freitas and Bhering (2019), according to which the induced investment share in output (h_t) depends on the growth rate of demand expected by capitalists (g_t^e), the depreciation ratio (δ), the technical relation between capital and full capacity output (v) and normal utilization (u_n), as in the expression below:

$$h_t = \frac{v}{u_n}(g_t^e + \delta) \qquad \text{(A.1)}$$

The ratio v/u_n is also equal to the ratio between capital and normal output – the output that would be obtained if utilization were equal to normal. The expected growth is gradually adjusted as a fraction of the discrepancies between expected and actual growth – represented by g_t^Y – as in equation A.2:

$$g_t^e = g_{t-1}^e + x(g_{t-1}^Y - g_{t-1}^e) \quad or \quad g_t^e = (1-x)g_{t-1}^e + xg_{t-1}^Y \qquad \text{(A.2)}$$

Where x represents the fraction of the error in expectations that is incorporated in new forecasts, with x positive but lower than one, and it is more likely that its value is low, which means that the propensity to invest adjusts slowly and consequently the speed of convergence of utilization towards its normal level is also slow. Combining equations A.1 and A.2 and after some algebra, we get to the following expression:

$$h_t = \frac{v}{u_n}x\delta + (1-x)h_{t-1} + \frac{v}{u_n}xg_{t-1}^Y \qquad \text{(A.3)}$$

Induced investment (I_t), by its turn, is equal to output (Y_t) multiplied by the propensity to invest:

$$I_t = h_t Y_t \qquad \text{(A.4)}$$

Its growth rate is given by:

$$1 + g_t^I = \frac{h_t}{h_{t-1}} (1 + g_t^Y) \quad \text{(A.5)}$$

The stock of capital (K_t) at the end of period t is equal to the stock existing at the end of the previous period plus the gross investment made in t minus the depreciation. The depreciation is expressed by the depreciation ratio (δ) multiplied by the stock of capital existing at the end of the previous period.

$$K_t = K_{t-1} + I_t - \delta K_{t-1} \quad \text{(A.6)}$$

Dividing all the expression A.6 by K_{t-1} and subtracting one, we obtain the expression of the growth rate of the stock of capital:

$$g_t^K = \frac{I_t}{K_{t-1}} - \delta \quad \text{(A.7)}$$

The growth rate of the stock of capital can also be written as a function of its growth rate in the previous period and the investment growth, as in equation A.8[11]:

$$g_t^K = (g_{t-1}^K + \delta)\left(\frac{1 + g_t^I}{1 + g_{t-1}^K}\right) - \delta \quad \text{(A.8)}$$

Equation A.8 tells us that if investment growth surpasses (fall behind) the growth of the stock of capital, the later increases (decreases), so that the growth of the stock of capital converges towards the growth of investment expenditures.

Full capacity output (Y_t^*), by its turn, is determined by the stock of capital and the technical capital-full output ratio. Since we are considering the stock of capital at the end

---

[11] According to equation A.7, we know that $\frac{I_{t-1}}{K_{t-2}} = g_{t-1}^K + \delta$. We can also rewrite equation A.7 in the following way: $g_t^K = \frac{I_{t-1}(1+g_t^I)}{K_{t-2}(1+g_{t-1}^K)} - \delta$. Replacing $\frac{I_{t-1}}{K_{t-2}}$ for $g_{t-1}^K + \delta$ in the above equation, we get to our expression A.8

of each period, full capacity depends on the stock of capital existing at the end of the **previous** period, because that is the one which constitutes capital available to be used during the whole period t. The new capacity installed **during** the period t is not available to be used during this entire period, only in the next one.

$$Y_t^* = \frac{K_{t-1}}{v} \tag{A.9}$$

Let us assume for now that the capital-capacity ratio remains unaltered, so the growth rate of full capacity output depends on the growth of the stock of capital in $t-1$:

$$g_t^{Y*} = g_{t-1}^K \tag{A.10}$$

At last, capacity utilization is the ratio between actual output and full capacity output (equation A.11).

$$u_t = \frac{Y_t}{Y_t^*} \tag{A.11}$$

Since Y_t and Y_t^* can be expressed by $Y_{t-1}\left(1+g_t^y\right)$ and $Y_{t-1}^*\left(1+g_t^{y*}\right)$, respectively, in our simulations we are assuming an initial value for u_t and in the next periods it will be given by:

$$u_t = u_{t-1}\left(\frac{1+g_t^Y}{1+g_t^{Y*}}\right) \tag{A.12}$$

Our simulations were calculated based on equations A.3, A.5, A.8, A.10 and A.12. Output growth rate (g_t^Y) is taken as exogenous and from this variable, combined with other parameters, we simulate the series of $h_t, g_t^I, g_t^K, g_t^{Y*}$ and u_t. The initial conditions were stablished assuming the economy is in a fully adjusted position, with output, investment, capital and capacity growing at the same rate and growth expectations being fulfilled (that is, $g_0^Y = g_0^e = g_0^I = g_0^K = g_0^{Y*}$), utilization is at its normal level, assumed to be 80% ($u_0 = u_n = 80\%$) and the propensity to invest in the initial period (h_0) is calculated using equation A.1. The other parameters where obtained from the estimates from Haluska Braga and Suma (2020) for the years from 1985 to 2017. The equation for the propensity to invest estimated in Haluska et all (2020) corresponds to equation A.3 of this Appendix and is presented below:

$$h_t = 0.629 + 0.909h_{t-1} + 0.075g^Y_{t-1} \quad \text{(A.13)}$$

According to these values, it is possible to calculate the remaining parameters required for the simulation. The ratio between capital and normal output $\left({}^{v}/_{u_n}\right)$ – which is the one estimated in the paper – is equal to 0.826, and since we are assuming that $u_n = 80\%$, capital-full capacity ratio (v) is equal to 0.661. Depreciation rate (δ) is 8.4% a year and the parameter x that represents the fraction of the errors in expectations that is incorporated into new expectations is equal to 0.091.

The value of the parameter x used in the simulations deserves some comments. The estimates from Haluska et all (2020) were made using quarterly data. The growth rate considered is calculated between one quarter and the same quarter of the previous year – i.e., four quarters before – while the propensity to invest is equal to nominal investment divided by nominal GDP in each quarter. This means induced investment share is affected by the growth rate of the immediately previous quarter, but this growth rate is expressed in comparison with four quarters before.

To calculate annual growth rate of the stock of capital it is required to sum the investment made during four quarters, being necessary to take into account the fact that the relative size of output and investment during each quarter of the year might change. In the case of our second simulation that uses actual GDP growth, we know the distribution of GDP through the several quarters (since we know the values of actual GDP), so we calculate h on quarterly basis using exactly the same parameters of equation A.13, multiply h by the nominal GDP of each quarter to calculate nominal induced investment by quarter, sum the investment of the four quarters of each year and divide it by annual GDP, obtaining the induced investment share on annual frequency. The rest of the simulation is made on annual basis using annual GDP growth and induced investment share by year.

However, our first simulation that assumes some hypothetical growth rate is made only on annual frequency, without establishing the values of output in each quarter, which means that the parameters from equation A.13 must be adapted. In this simulation, h_t represents the propensity to invest of the entire year and must be calculated as a function of the propensity to invest and the growth rate of the previous year and not the previous quarter, as in equation A.13. In this case, the propensity to invest during a year must take into account the changes in growth rate that occurred from one year to another, and not only from one quarter to the next one. In terms of our model, this implies that the value of x will be higher.

To get an approximate estimate, let us rewrite equation A.13 in the following way:

$$h_t = a + bh_{t-1} + cg_{t-1}^Y \qquad \text{(A.14)}$$

Where $a = \frac{v}{u_n} x\delta = 0.629$, $b = 1 - x = 0.909$ and $c = \frac{v}{u_n} x = 0.075$. If we replace h_{t-1} by expression A.14 adjusting the lags accordingly, we obtain h_t as a function of h_{t-2}, g_{t-1}^Y and g_{t-2}^Y. Replacing h_{t-2} by expression A.14 again, we obtain h_t as a function of $h_{t-3}, g_{t-1}^Y, g_{t-2}^Y$ and g_{t-3}^Y. As last, we replace h_{t-3} by expression A.14 one more time and obtain h_t as a function of $h_{t-4}, g_{t-1}^Y, g_{t-2}^Y, g_{t-3}^Y$ and g_{t-4}^Y and get to the following expression:

$$h_t = a(1 + b + b^2 + b^3) + b^4 h_{t-4} + c(g_{t-1} + bg_{t-2} + b^2 g_{t-3} + b^3 g_{t-4}) \qquad \text{(A.15)}$$

The inertia coefficient in this case has four lags, which is equal to one year. Adopting the simplifying assumption that the propensity to invest in a year is a simple average of the propensity to invest in each quarter of the year, it is reasonable write our equation A.3 in annual terms using the inertia coefficient expressed in equation A.15, which is equal to $b^4 = 0.684$. Since $b = 1 - x$, we obtain the value of $x = 0.316$. Maintaining the values of $^v/_{u_n} = 0.826$ and $\delta = 8.4\%$, equation A.3 can be written in annual frequency, in a way that is appropriate to be used in the first simulation:

$$h_t = 2{,}196 + 0{,}684 h_{t-1} + 0{,}261 g_{t-1} \qquad \text{(A.16)}$$

Appendix B – Detailed tables by industry

Table 1 - Average capacity utilization by industry and by time period

Industry code	Industry description	Average 1972-2002	Average 2003-2017	Increased/ Decreased?	Weight (%)
B50001	**Total index**	**81.3**	**77.0**	**Decreased**	**100.0**
G321	Wood product	79.5	70.9	Decreased	1.4
G327	Nonmetallic mineral product	78.5	64.0	Decreased	2.2
G331	Primary metal	80.7	73.3	Decreased	2.6
G332	Fabricated metal product	77.5	77.7	Increased	5.5
G333	Machinery	78.9	74.6	Decreased	5.4
G334	Computer and electronic product	79.4	73.3	Decreased	5.0
G335	Electrical equipment, appliance, and component	83.6	79.1	Decreased	1.8
G3361T3	Motor vehicles and parts	77.4	71.2	Decreased	5.7
G3364T9	Aerospace and miscellaneous transportation eq.	73.5	75.8	Increased	4.4
G337	Furniture and related product	78.6	73.0	Decreased	1.2
G339	Miscellaneous	76.8	76.4	Decreased	2.8
G311	Food	83.0	80.7	Decreased	9.0
G312	Beverage and tobacco product	79.1	69.6	Decreased	2.8
G313	Textile mills	83.1	69.6	Decreased	0.3
G314	Textile product mills	83.7	69.7	Decreased	0.3
G315	Apparel	80.5	72.0	Decreased	0.2
G316	Leather and allied product	75.9	60.2	Decreased	0.1
G322	Paper	88.3	83.4	Decreased	2.5
G323	Printing and related support activities	84.3	70.0	Decreased	1.4
G324	Petroleum and coal products	85.5	84.0	Decreased	3.2
G325	Chemical	78.6	73.3	Decreased	12.3
G326	Plastics and rubber products	84.3	77.8	Decreased	3.6
GMFO	Other manufacturing	84.7	69.8	Decreased	2.1
G211	Oil and gas extraction	92.2	94.7	Increased	9.8
N2121	Coal mining	86.1	82.1	Decreased	0.8
G2122	Metal ore mining	79.6	73.6	Decreased	0.6
G2123	Nonmetallic mineral mining and quarrying	83.7	82.1	Decreased	0.9
G213	Support activities for mining	73.2	68.9	Decreased	1.6
G2211	Electric Utilities	88.4	82.0	Decreased	9.0
G2212	Natural gas distribution	80.3	80.1	Decreased	1.4

Source: FRED. Elaborated by the author

Table 2 - Average-to-peak ratio of industrial production by industry and by time period.

Industry code	Industry description	Average 1972-2002	Average 2003-2017	Increased/ Decreased?	Weight (%)
B50001	**Total**	**0.971**	**0.975**	**Increased**	**99.80**
G211111	Crude petroleum and natural gas extraction	0.971	0.963	Decreased	9.25
G211112	Natural gas liquid extraction	0.956	0.944	Decreased	0.54
N2121	Coal mining	0.911	0.942	Increased	0.77
G2122	Metal ore mining	0.918	0.941	Increased	0.59
G2123	Nonmetallic mineral mining and quarrying	0.879	0.835	Decreased	0.88
G213	Support activities for mining	0.900	0.921	Increased	1.63
G22111	Electric power generation	0.887	0.867	Decreased	4.58
G22112	Electric power transmission, control, and distribution	0.877	0.841	Decreased	4.46
G2212	Natural gas distribution	0.611	0.538	Decreased	1.36
G3111	Animal food	0.942	0.945	Increased	0.59
G3112	Grain and oilseed milling	0.949	0.956	Increased	0.75
G3113	Sugar and confectionery product	0.803	0.855	Increased	0.50
G3114	Fruit and vegetable preserving and specialty food	0.822	0.820	Decreased	1.11
N311511	Fluid milk	0.936	0.957	Increased	0.35
N311512	Creamery butter	0.791	0.812	Increased	0.02
N311513	Cheese	0.919	0.966	Increased	0.32
N311514	Dry, condensed, and evaporated dairy product	0.801	0.881	Increased	0.27
N31152	Ice cream and frozen dessert	0.780	0.808	Increased	0.10
G3116	Animal slaughtering and processing	0.932	0.950	Increased	1.96
N3118	Bakeries and tortilla	0.966	0.959	Decreased	1.22
G3119	Other food	0.931	0.958	Increased	1.70
G3121	Beverage	0.913	0.935	Increased	1.85
G3122	Tobacco	0.877	0.881	Increased	0.96
G3131	Fiber, yarn, and thread mills	0.913	0.935	Increased	0.07
G3132	Fabric mills	0.957	0.958	Increased	0.16
G3133	Textile and fabric finishing and fabric coating mills	0.950	0.931	Decreased	0.09
G3141	Textile furnishings mills	0.903	0.915	Increased	0.17
G3149	Other textile product mills	0.960	0.949	Decreased	0.16
G315	Apparel	0.963	0.950	Decreased	0.15
G316	Leather and allied product	0.950	0.948	Decreased	0.06
N3211	Sawmills and wood preservation	0.910	0.928	Increased	0.38
G3212	Veneer, plywood, and engineered wood product	0.925	0.921	Decreased	0.31
G32191	Millwork	0.941	0.946	Increased	0.37
N32192	Wood container and pallet	0.954	0.951	Decreased	0.13
G32199	All other wood product	0.902	0.916	Increased	0.23
N32211	Pulp mills	0.945	0.958	Increased	0.08
G32212	Paper mills	0.949	0.964	Increased	0.60

N32213	Paperboard mills	0.949	0.970	Increased	0.57
N32221	Paperboard container	0.916	0.940	Increased	0.73
G32222	Paper bag and coated and treated paper	0.954	0.950	Decreased	0.25
G32223A9	Other converted paper products	0.953	0.960	Increased	0.30
G323	Printing and related support activities	0.896	0.973	Increased	1.44
G32411	Petroleum refineries	0.949	0.954	Increased	2.58
N32412A9	Paving, roofing, and other petroleum and coal products	0.915	0.877	Decreased	0.58
G3254	Pharmaceutical and medicine	0.954	0.968	Increased	4.46
G32511A9	Organic chemicals	0.952	0.949	Decreased	2.52
G32512T8	Basic inorganic chemicals	0.937	0.942	Increased	0.71
N325211	Plastics material and resin	0.936	0.952	Increased	0.96
G325212	Synthetic rubber	0.906	0.949	Increased	0.09
N32522	Artificial and synthetic fibers and filaments	0.920	0.925	Increased	0.08
G3253	Pesticide, fertilizer, and other agricultural chemical	0.936	0.930	Decreased	0.56
G3255T9	Paints, soaps and toiletries, and other chemical products	0.944	0.968	Increased	2.92
G3261	Plastics product	0.953	0.975	Increased	3.02
G32621	Tire	0.887	0.905	Increased	0.25
G32622A9	Rubber products ex. tires	0.930	0.959	Increased	0.35
G32711	Pottery, ceramics, and plumbing fixture	0.950	0.938	Decreased	0.05
G32712	Clay building material and refractories	0.928	0.928	Decreased	0.11
G3279	Other nonmetallic mineral product	0.949	0.957	Increased	0.46
G3274	Lime and gypsum product	0.907	0.915	Increased	0.13
G3272	Glass and glass product	0.951	0.963	Increased	0.48
N32731	Cement	0.803	0.827	Increased	0.16
N32732T9	Concrete and product	0.905	0.908	Increased	0.82
G3311A2	Iron and steel products	0.903	0.931	Increased	1.26
G3313	Alumina and aluminum production and processing	0.932	0.933	Increased	0.38
G3314	Nonferrous metal (ex. aluminum) production & processing	0.913	0.942	Increased	0.49
G3315	Foundries	0.944	0.955	Increased	0.50
G332	Fabricated metal product	0.966	0.970	Increased	5.51
G33311	Agricultural implement	0.837	0.881	Increased	0.43
G33312	Construction machinery	0.878	0.864	Decreased	0.44
N33313	Mining and oil and gas field machinery	0.915	0.901	Decreased	0.21
G3332	Industrial machinery	0.931	0.936	Increased	0.53
G3333A9	Commercial & service industry machinery & other general	0.945	0.959	Increased	1.98
G3334	Ventilation, heating, air-conditioning, & refrigeration eq	0.875	0.806	Decreased	0.67
G3335	Metalworking machinery	0.932	0.951	Increased	0.54
G3336	Engine, turbine, and power transmission equipment	0.924	0.914	Decreased	0.57
G3341	Computer and peripheral equipment	0.852	0.899	Increased	0.36

G3342	Communications equipment	0.906	0.907	Increased	0.53
G3343	Audio and video equipment	0.800	0.853	Increased	0.04
G3344	Semiconductor and other electronic component	0.876	0.830	Decreased	1.29
G3345	Navigational, measuring, electromedical, control instrument	0.949	0.963	Increased	2.76
G33521	Small electrical appliance	0.914	0.851	Decreased	0.06
G33522	Major appliance	0.868	0.895	Increased	0.26
G3351	Electric lighting equipment	0.935	0.969	Increased	0.23
G3353	Electrical equipment	0.940	0.959	Increased	0.48
G33591	Battery	0.825	0.928	Increased	0.17
N33592	Communication and energy wire and cable	0.939	0.948	Increased	0.18
G33593T9	Other electrical equipment	0.941	0.954	Increased	0.47
G336111	Automobile	0.825	0.855	Increased	0.62
G336112	Light truck and utility vehicle	0.832	0.845	Increased	1.88
G33612	Heavy duty truck	0.821	0.836	Increased	0.23
G3362	Motor vehicle body and trailer	0.901	0.889	Decreased	0.46
G3363	Motor vehicle parts	0.888	0.899	Increased	2.49
G3364	Aerospace product and parts	0.934	0.951	Increased	3.44
N3365	Railroad rolling stock	0.913	0.901	Decreased	0.10
G3366	Ship and boat building	0.954	0.925	Decreased	0.61
N3369	Other transportation equipment	0.926	0.919	Decreased	0.23
N3371	Household and institutional furniture and kitchen cabinet	0.948	0.961	Increased	0.64
G3372A9	Office and other furniture	0.922	0.906	Decreased	0.56
G339	Miscellaneous	0.960	0.973	Increased	2.79
N1133	Logging	0.888	0.911	Increased	0.16
G51111	Newspaper publishers	0.923	0.934	Increased	0.52
G51112T9	Periodical, book, and other publishers	0.913	0.856	Decreased	1.42

Source: FRED. Elaborated by the author

Table 3 - Accumulated production growth by industry and by time period.

Industry code	Industry description	Accumulated growth (%) 1972-2002	Accumulated growth (%) 2002-2017	Weight (%) 2002	Weight (%) 2017
B50001	**Total**	**116.0**	**11.9**	**100.00**	**100.00**
G211111	Crude petroleum and natural gas extraction	-27.4	62.8	3.81	9.25
G211112	Natural gas liquid extraction	14.3	90.9	0.31	0.54
N2121	Coal mining	58.3	-32.1	0.64	0.77
G2122	Metal ore mining	34.1	0.9	0.21	0.59
G2123	Nonmetallic mineral mining and quarrying	32.5	-5.8	0.66	0.88
G213	Support activities for mining	-11.8	-17.8	0.76	1.63
G22111	Electric power generation	177.7	1.0	4.23	4.58
G22112	Electric power transmission, control, and distribution	128.6	15.4	4.18	4.46
G2212	Natural gas distribution	-9.2	1.7	1.25	1.36
G3111	Animal food	147.0	31.3	0.44	0.59
G3112	Grain and oilseed milling	101.5	11.1	0.74	0.75
G3113	Sugar and confectionery product	45.2	-1.4	0.56	0.50
G3114	Fruit and vegetable preserving and specialty food	58.5	6.0	1.24	1.11
N311511	Fluid milk	3.0	-10.0	0.35	0.35
N311512	Creamery butter	-13.3	80.2	0.01	0.02
N311513	Cheese	143.6	55.5	0.21	0.32
N311514	Dry, condensed, and evaporated dairy product	35.6	64.6	0.18	0.27
N31152	Ice cream and frozen dessert	90.8	-29.6	0.18	0.10
G3116	Animal slaughtering and processing	117.8	16.9	1.70	1.96
N3118	Bakeries and tortilla	18.3	-4.3	1.34	1.22
G3119	Other food	117.1	39.6	1.40	1.70
G3121	Beverage	62.3	42.3	1.37	1.85
G3122	Tobacco	-32.7	-39.6	1.40	0.96
G3131	Fiber, yarn, and thread mills	40.1	-45.1	0.15	0.07
G3132	Fabric mills	-4.3	-53.2	0.44	0.16
G3133	Textile and fabric finishing and fabric coating mills	-9.4	-54.2	0.22	0.09
G3141	Textile furnishings mills	73.1	-53.8	0.35	0.17
G3149	Other textile product mills	25.1	-13.7	0.21	0.16
G315	Apparel	-36.0	-79.1	0.84	0.15
G316	Leather and allied product	-71.5	-33.9	0.12	0.06
N3211	Sawmills and wood preservation	26.7	-0.6	0.32	0.38
G3212	Veneer, plywood, and engineered wood product	74.3	-18.6	0.34	0.31
G32191	Millwork	57.5	-12.3	0.40	0.37
N32192	Wood container and pallet	95.0	49.8	0.10	0.13
G32199	All other wood product	-17.1	-20.7	0.32	0.23
N32211	Pulp mills	123.4	-5.4	0.07	0.08

G32212	Paper mills	56.6	-30.8	1.06	0.60
N32213	Paperboard mills	33.6	-1.6	0.45	0.57
N32221	Paperboard container	23.7	-3.7	0.73	0.73
G32222	Paper bag and coated and treated paper	32.8	-23.9	0.35	0.25
G32223A9	Other converted paper products	141.4	-14.2	0.49	0.30
G323	Printing and related support activities	105.5	-27.4	2.46	1.44
G32411	Petroleum refineries	33.7	15.2	1.18	2.58
N32412A9	Paving, roofing, and other petroleum and coal products	41.1	-1.9	0.36	0.58
G3254	Pharmaceutical and medicine	286.9	-14.0	4.36	4.46
G32511A9	Organic chemicals	41.9	34.4	1.15	2.52
G32512T8	Basic inorganic chemicals	22.0	-32.5	0.76	0.71
N325211	Plastics material and resin	139.2	-1.8	0.69	0.96
G325212	Synthetic rubber	33.3	-26.4	0.11	0.09
N32522	Artificial and synthetic fibers and filaments	11.6	-33.1	0.15	0.08
G3253	Pesticide, fertilizer, and other agricultural chemical	51.4	28.6	0.39	0.56
G3255T9	Paints, soaps and toiletries, and other chemical products	88.0	-5.2	3.10	2.92
G3261	Plastics product	319.1	-1.9	3.14	3.02
G32621	Tire	6.3	-20.8	0.32	0.25
G32622A9	Rubber products ex. tires	60.4	-9.3	0.39	0.35
G32711	Pottery, ceramics, and plumbing fixture	-8.2	-49.7	0.09	0.05
G32712	Clay building material and refractories	-12.3	-17.9	0.13	0.11
G3279	Other nonmetallic mineral product	71.1	18.0	0.39	0.46
G3274	Lime and gypsum product	45.3	-4.6	0.10	0.13
G3272	Glass and glass product	29.8	-6.3	0.54	0.48
N32731	Cement	4.9	-23.0	0.19	0.16
N32732T9	Concrete and product	53.1	-15.4	0.83	0.82
G3311A2	Iron and steel products	-21.6	0.1	1.02	1.26
G3313	Alumina and aluminum production and processing	0.5	6.8	0.39	0.38
G3314	Nonferrous metal (ex. aluminum) production & processing	-26.7	14.2	0.33	0.49
G3315	Foundries	-10.9	-19.1	0.64	0.50
G332	Fabricated metal product	45.5	-2.9	5.77	5.51
G33311	Agricultural implement	2.8	24.2	0.40	0.43
G33312	Construction machinery	3.4	35.4	0.31	0.44
N33313	Mining and oil and gas field machinery	-18.7	53.6	0.15	0.21
G3332	Industrial machinery	28.6	-13.5	0.75	0.53
G3333A9	Commercial & service industry machinery & other general	153.2	19.2	1.70	1.98
G3334	Ventilation, heating, air-conditioning, & refrigeration eq	28.2	-2.7	0.69	0.67
G3335	Metalworking machinery	3.4	1.6	0.66	0.54
G3336	Engine, turbine, and power transmission equipment	13.9	-12.4	0.72	0.57

G3341	Computer and peripheral equipment	130918.3	172.1	1.42	0.36
G3342	Communications equipment	2676.3	106.4	1.34	0.53
G3343	Audio and video equipment	146.7	-61.1	0.14	0.04
G3344	Semiconductor and other electronic component	30528.9	843.3	2.84	1.29
G3345	Navigational, measuring, electromedical, control instrument	401.4	36.7	2.36	2.76
G33521	Small electrical appliance	16.6	-24.8	0.11	0.06
G33522	Major appliance	78.6	-9.7	0.31	0.26
G3351	Electric lighting equipment	10.4	-12.6	0.30	0.23
G3353	Electrical equipment	10.0	-22.5	0.69	0.48
G33591	Battery	111.1	30.6	0.14	0.17
N33592	Communication and energy wire and cable	91.4	-20.9	0.19	0.18
G33593T9	Other electrical equipment	77.0	10.5	0.47	0.47
G336111	Automobile	-6.5	6.9	1.20	0.62
G336112	Light truck and utility vehicle	2387.0	23.4	2.27	1.88
G33612	Heavy duty truck	139.7	31.6	0.13	0.23
G3362	Motor vehicle body and trailer	6.6	29.8	0.37	0.46
G3363	Motor vehicle parts	132.7	17.7	3.61	2.49
G3364	Aerospace product and parts	48.5	36.2	2.67	3.44
N3365	Railroad rolling stock	-41.6	37.2	0.16	0.10
G3366	Ship and boat building	19.6	13.5	0.51	0.61
N3369	Other transportation equipment	133.7	47.0	0.24	0.23
N3371	Household and institutional furniture and kitchen cabinet	68.8	-33.6	1.06	0.64
G3372A9	Office and other furniture	110.8	-17.5	0.75	0.56
G339	Miscellaneous	142.3	2.0	3.24	2.79
N1133	Logging	44.1	-11.2	0.21	0.16
G51111	Newspaper publishers	-17.5	-63.8	1.55	0.52
G51112T9	Periodical, book, and other publishers	126.7	-49.8	2.90	1.42

Source: FRED. Elaborated by the author

References

Bassi, F., Bauermann, T., Lang, D., & Setterfield, M. (2020). Is capacity utilization variable in the long run? An agent-based sectoral approach to modeling hysteresis in the normal rate of capacity utilization. *Department of Economics, The New School for Social Research*, Working Paper 07/2020.

Botte, F. (2020). Estimating normal rates of capacity utilisation and their tolerable ranges: a comment on Mark Setterfield. *Cambridge Journal of Economics*, 44(2), 475-482.

Braga, J. (2006). *Raiz unitária, histerese e inércia: A controvérsia sobre a NAIRU na economia norte-americana nos anos 1990* (PhD dissertation). Universidade Federal do Rio de Janeiro. Retrieved from http://www.ie.ufrj.br/images/pesquisa/publicacoes/teses/2006/raiz_unitaria_histerese_e_inercia_a_controversia_sobre_a_nairu_na_economia_norte_americana_nos_anos_1990.pdf

Ciccone, R. (1986). Accumulation and capacity utilization: some critical considerations on Joan Robinson's theory of distribution. *Political Economy: Studies in the Surplus Approach*, *2(1)*, 17-36.

Ciccone, R. (1987). Accumulation, capacity utilization and distribution: a reply. *Political Economy: Studies in the Surplus Approach*, *3(1)*, 97-111.

Ciccone, R. (2012). Capacity utilization, mobility of capital and the classical process of gravitation: Roberto Ciccone. In *Sraffa and Modern Economics Volume II* (pp. 86-96). Routledge.

Committeri, M. (1986). Some comments on recent contributions on capital accumulation, income distribution and capacity utilization. *Political Economy: Studies in the Surplus Approach*, *2*(2), 161-186.

Corrado, C., & Mattey, J. (1997). Capacity utilization. *Journal of Economic Perspectives*, *11*(1), 151-167.

Fazzari, S. M., Ferri, P., & Variato, A. M. (2020). Demand-led growth and accommodating supply. *Cambridge Journal of Economics*, 44(3), 583-605.

Fiebiger, B. (2020). Some observations on endogeneity in the normal rate of capacity utilisation. *Review of Keynesian Economics*, 8(3), 385-406.

Freitas, F., & Serrano, F. (2015). Growth rate and level effects, the stability of the adjustment of capacity to demand and the Sraffian supermultiplier. *Review of Political Economy, 27(3)*, 258-281.

Gahn, S. (2020). Is There a Declining Trend in Capacity Utilization in the US Economy? A Technical Note. *Review of Political Economy*, 1-14.

Gahn, S. J., & González, A. (2019). On the empirical content of the convergence debate: Cross country evidence on growth and capacity utilization, *Post-keynesian Economics Society*, Working paper 1922.

Gahn, S. J., & González, A. (2020). On the 'utilisation controversy': a comment. *Cambridge Journal of Economics*, 44(3), 703-707.

Garegnani(1992), P. (1992) 'Some notes for an analysis of accumulation', in J. Halevi, D. Laibman and E. Nell (eds.), *Beyond the steady state. A revival of growth theory*, London and Basingstoke, Macmillan.

Girardi, D., & Pariboni, R. (2019). Normal utilization as the adjusting variable in Neo-Kaleckian growth models: A critique. *Metroeconomica*, 70(2), 341-358.

Haluska, G. (2020). A critical evaluation of some Kaleckian proposals to deal with the issue of convergence towards normal capacity utilization. *Review of Keynesian Economics*, 8(3), 407-427.

Haluska, G., Braga, J., & Summa, R. (2020) Growth, investment share and the stability of the Sraffian Supermultiplier model in the US economy (1985–2017). *Metroeconomica (advanced access)*.

Huang, B. (2020) Normal utilization rate in the Sraffa framework. *Metroeconomica*, v. 71, n. 4, p. 767-780.

Kurz, H. D. (1986). Normal positions and capital utilization. *Political Economy: Studies in the Surplus Approach*, 2(1), 37-54.

Lavoie, M., Rodriguez, G., & Seccareccia, M. (2004). Similitudes and discrepancies in post-Keynesian and Marxist theories of investment: a theoretical and empirical investigation. *International Review of Applied Economics*, *18*(2), 127-149.

Nikiforos, M. (2013). The (normal) rate of capacity utilization at the firm level. *Metroeconomica*, *64*(3), 513-538.

Nikiforos, M. (2016). On the 'utilisation controversy': a theoretical and empirical discussion of the Kaleckian model of growth and distribution. *Cambridge journal of economics*, *40*(2), 437-467.

Nikiforos, M. (2018). Some comments on the Sraffian Supermultiplier approach to growth and distribution. *Journal of Post Keynesian Economics*, 41(4), 659-675.

Nikiforos, M. (2020a). On the 'utilisation controversy': a rejoinder and some comments. *Cambridge Journal of Economics*, 44(3), 709-722.

Nikiforos, M. (2020b). Notes on the Accumulation and Utilization of Capital: Some Theoretical Issues. *Levy Economics Institute*, Working Papers, (952).

Nikiforos, M. (2020c). Notes on the Accumulation and Utilization of Capital: Some Empirical Issues. *Levy Economics Institute*, Working Papers, (953).

Pierce, J. R., & Wisniewski, E. (2018). *Some Characteristics of the Decline in Manufacturing Capacity Utilization* (No. 2018-03-01). Board of Governors of the Federal Reserve System (US).

Serrano, F. (1995). Long period effective demand and the Sraffian supermultiplier. *Contributions to Political Economy*, *14*(1), 67-90.

Serrano, F., & Freitas, F. (2017). The Sraffian supermultiplier as an alternative closure for heterodox growth theory. *European Journal of Economics and Economic Policies: Intervention*, 14(1), 70-91.

Serrano, F., Freitas, F., & Bhering, G. (2019). The Trouble with Harrod: the fundamental instability of the warranted rate in the light of the Sraffian Supermultiplier. *Metroeconomica*, *70*(2), 263-287.

Setterfield, M. (2019). Long-run variation in capacity utilization in the presence of a fixed normal rate. *Cambridge Journal of Economics*, *43*(2), 443-463.

Setterfield, M. (2020). Tolerable ranges of variation in the rate of capacity utilisation and corridor instability: a reply to Florian Botte. *Cambridge Journal of Economics*, 44(2), 483-488.

Setterfield, M., & Avritzer, J. D. (2020). Hysteresis in the normal rate of capacity utilization: a behavioural explanation. *Metroeconomica, (advanced access)*

Skott, P. (2012). Theoretical and empirical shortcomings of the Kaleckian investment function. *Metroeconomica*, *63*(1), 109-138.

Steindl, J. (1952), Maturity and Stagnation in American Capitalism, *Monthly Review Press*, New York and London, 1976.