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Towards an explanation of a declining trend in capacity utilisation in the US economy

Santiago J. Gahn

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Santiago José Gahn

University of Bari
santiago.gahn@uniba.it

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Abstract

In this paper I analyse a declining trend of *effective* capacity utilisation in the United States. After identifying determinants of *normal* capacity utilisation in the literature, I find that this declining trend of the FRB's capacity utilisation is also present in the output-capital ratio of the NBER-CES sectoral database since 1958. Results suggest that *permanent* changes on technical change (K/L), distribution (W/Y) and output have *transitory* effects on the output-capital ratio, my *proxy* of *effective* capacity utilisation.

JEL classification: B50, E11, E22, O41, O47.

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1 Introduction

There is a question that has attracted a lot of attention lately in Federal Reserve Board circles. There is a declining trend in capacity utilisation in the case of the United States (Pierce and Wisniewski, 2018) and while some authors have tried to find an answer in the past (Bansak et al., 2007), it is still an open issue.

Recently during the revival of the 'utilisation controversy' among Keynesian authors (Nikiforos, 2013, 2016, 2018, 2020a, 2020b, 2021a, 2021b; Fiebiger, 2020; Girardi & Pariboni, 2019; Haluska, 2020; Gahn, 2020, 2021; Gahn & González, 2019, 2020), many have mentioned the possibility of a declining trend in the level of capacity utilisation since the 1970s for the US economy. The discussion might be divided into two different spheres: First, from an empirical perspective - whether there is (or not) a declining trend in capacity utilisation and its alternative measures - and secondly, the causes of the latter trend, should it exist.

In a companion paper (Gahn, 2020), I demonstrated that there is a declining trend of *effective* capacity utilisation in the US economy.[1] The aim of this paper is to identify possible causes of this downward trend. Following this line of argument, I will investigate some possible determinants of *normal* utilisation in Section 2 and, then, using an annual database (1958-2011) for 361 industries constructed by the NBER-CES with more than 20000 observations, I will present some empirical evidence that might allow us to rule out some explanations (i.e., technical change, distribution and output) in Section 3. Some conclusions will be drawn.

2 Determinants of *normal* level of capacity utilisation

One might argue that a declining trend in capacity utilisation could be explained in two different ways. Keeping in mind that u_n is a variable that it is not measured [2] by national institutes of statistics, observable changes on the *effective* rate of capacity utilisation - or filtered time series - is no evidence of a change in the *normal* one. A corollary of this interpretation could be that - because the process of adjustment is slow - a series of subsequent shocks has hindered a full convergence to u_n.[3]

[1] Similar results in Artica (2018) and Ederhof et al. (2017) at a firm level.

[2] The *normal* rate of capacity utilisation is an observable variable at a firm level, in particular periods of time under particular conditions. It is the average expected rate of capacity utilisation on newly installed equipment. This can be found at a firm level within firms that produce with the *dominant* technique and get a *normal* rate of profit.

[3] See Haluska, Serrano and Summa (2021) and Haluska (2021) for this notion of 'slow adjustment' in the context of the Sraffian Supermultiplier.

On the other hand, if a declining trend of *effective* capacity utilisation for so many years is observed, one might suspect that the *normal* rate is changing. Therefore, some determinants of the *normal* rate have been changing through time and the *normal* rate is that one suffering a declining trend. There are many factors that determine the level of *normal* capacity utilisation in the literature. In this section, I will try to introduce the main determinants through a theoretical literature review.[4]

2.1 Expected demand fluctuations

Stigler's (1939) is, of course, the classic analysis of rationally building flexibility into a plant, ex ante, in anticipation of demand fluctuations even though it means sacrificing the lowest achievable unit cost (Winston, 1974).

Marris presents particular attention to the effect of expected fluctuations in maximum output (1964, p. 80). According to him, the firm will probably wish to be able to meet at least a *reasonable* proportion of the peak orders without unduly long delays in delivery (ibid., p. 95) and that the output for which the plant is designed is based on some guess as to the average expected sales during its lifetime. According to the author,

> the firm is able to attach a 'probability of occurrence' so the complete set of such estimates would represent a probability-distribution of expected demand and could be described by familiar statistical concepts: the most probable, or expected average level, is the 'mathematical expectation'; the variability, or spread around the average, can be measured by the *coefficient of variation*, i.e. by the standard deviation divided by the mean. A low coefficient of variation implies that demand is expected to be rather stable, and that only a relatively small proportion of total output is expected to occur under extreme conditions; a high coefficient implies unstable demand and relatively higher probabilities of experiencing extremes
>
> Marris, 1964, pp. 96-97

Nevertheless, Marris seems to be keen on analysing the relationship between average-to-peak ratio of demand and he claims that the greater the coefficient of variation the lower 'normal' utilisation should be.

According to Steindl (1952, p. 10) the existence of an ample margin is what allows the trade cycle to operate as it does, so planned utilisation already takes into account the business cycle fluctuations. Output fluctuations (stochastic demand fluctuations), with

[4] A similar analysis might be found in Nikiforos (2021b).

their consequent adjustment costs and uncertainty, are also important aspects of the investment decision according to Betancourt and Clague (1981, p. 59).

Del Monte (1975) claims that,

> A first reason [for desired excess capacity] is the existence of fluctuations in demand where the producer always leaves spare capacity margins to take advantage of the expansion and not to allow other competitors to take over its incremental market share. Evidently, in an expanding economy, where demand has developed quite regularly, the margins that the entrepreneur wishes to maintain will be lower than in an economy that has shown wider fluctuations in demand
>
> Del Monte, 1975, p. 244, own translation

According to Ciccone, one of the main determinants of the level of *normal* capacity utilisation consists in 'the fluctuations which, in a market economy, generally characterize demand, and hence, more or less closely, production' (Ciccone, 1986, p. 26; 1990, p. 420). As firms do not want to loose market share (Steindl, 1952, p.8, p.10; Marris, 1964, p.95; Del Monte, 1975, p.244; Ciccone, 1986, p.27; Palumbo and Trezzini, 2003, p.111; Skott, 2012, p.116; De Juán, 2013, p.114) under the pressure of competition they will adapt the 'normal' utilisation, defined as the expected realized average utilisation on investment, to *breadth* and *frequency* of demand levels. In this sense, i.e. 'normal' utilisation will be lower, the larger are the *breadth* and *frequency* of the expected falls in production with respect to the peaks for which capacity is adequate' (Ciccone, 1986, p. 27, 1990, p. 421, emphasis in *italics* added.). Committeri (1987, p. 93) also claims that potential output will be kept in line with the *expected* peaks of demand. Similar results in which the size of capacity adapts to different fluctuations can be found in Manne (1961) and Giglio (1970). Kurz also agrees that fluctuations might be a source of mismatch between demand and productive capacity (1992, p.79) although he thinks that there are other mechanisms that give flexibility to the system (old capital stock and inventories, among others).

Skott (2012) and Ryoo & Skott (2017) also agree that 'desired' utilisation might change or deviate from unity: 'Changes (. . .) in the volatility of demand, for instance, could affect desired utilization rates'. Recently, Setterfield and Avritzer (2020) claim that the *normal* rate of utilisation depends negatively on the volatility of effective rate of capacity utilisation.

2.2 Level or rate of growth of demand

From a Sraffian tradition, according to Huang (2020), the determination of a cost-minimizing technique is independent of demand if one of the following assumptions holds: (a) all machines always work with constant efficiencies (e.g., Roncaglia, 1978; Sraffa, 1960); (b) old machines are not transferable, nor jointly utilized (Baldone, 1980; Schefold, 1980; Varri, 1980; Kurz & Salvadori, 1994); (c) old machines are not allowed to be jointly utilized and the efficiencies of transferable machines are independent of the sectors in which the machines are used (Salvadori, 1999). The model provided by Kurz and Salvadori (1995, Chapter 7, Section 7) is in line with the first assumption. If the above assumptions are not satisfied (e.g., if joint utilisation of machines is allowed), then the *normal* utilisation rate is generally not independent of demand. From a Neo-Kaleckian view, the extended version and recent microfoundations can be included also in this subsection. [5]

2.3 Technical change

Maxwell (1977), while describing one of the most important enterprises related to the siderurgic industry in Argentina claimed that, 'A very similar story applies to the Rosario plant's billet mill. This was originally installed in 1950 with a production capacity of 50,000 tons per year, however this capacity has been raised by successive technical changes so that the Billet mill's capacity today is over 160,000 tons per year. This has been achieved 'without any profound variations, simply by improving equipment, channel design, reheating furnaces, etc.' and it is also claimed that the Rosario plant's billet mill is today 'more productive than some of the more modern primary rolling mills in Argentina which have twice the horsepower of the Rosario Billet mill and involved five to ten times as much investment'. (Maxwell, 1977, p. 25).

Bansak, Morin and Starr (2007) claim that flexible manufacturing makes it easier to ramp production up and down and this may encourage firms to install a broader margin of excess capacity—that is, to operate at lower average utilisation—in order to be able to handle upswings in demand. Such a strategy would be favored by declining prices of high-tech capital[6], which make excess capacity cheap (ibid., p. 632). But because automated design and modular units make capacity expansion faster and cheaper, firms may prefer to operate at higher average utilisation, expecting to be able to boost capacity should demand turn out to be strong. These are two offseting forces.

Shaikh (2009) also claims that the *normal* utilisation might change in the long-run due to changes in capital intensity of production (2009, p. 461). Nikiforos (2020b, p.7) agrees.

[5] See Gahn (2021) for a review.

[6] Levy (1995) finds an accelerated depreciation of producer durable goods and equipment since newer and more advanced technology makes older equipment obsolete. Duménil and Lévy (2016) show that the share of investment in information technologies in total investment in equipment and software increased from 5% to 55% in the last 60 years.

2.4 Relative prices

The choice of the level of 'normal' utilisation is a cost-minimising choice. According to Kurz (1986; 1992, p.78), it is analogous to what could be considered a *choice of technique*. According to him, if fluctuations are *not* taken into account, it could be demonstrated that the level of utilisation chosen depends exclusively on distribution and technology.[7]

Skott (1989, 2016), Ryoo & Skott (2017) and Skott & Ryoo (2017) also claim that the output-capital ratio might depend on the 'cost of finance'.

> The costs of excess capacity are increasing in the cost of finance, and the desired utilization rate will, therefore, depend positively on the real interest rate.
>
> Ryoo & Skott, 2017, p. 506

Marris (1964) also introduce relative prices as a determinant *assuming* given output.

2.5 Barrier to entry and intensity of competition

Building excess capacity to deter entrance of competitors is one of the mechanism present in the literature that determines normal capacity utilisation. This idea was first delivered by Spence (1977) who claims that entry is deterred in an industry when existing firms have enough capacity to make a new entrant unprofitable.[8] Steindl coincides in this aspect. According to Del Monte (1975), 'In oligopoly, on the other hand, where the existence of a few large companies prevents price competition, the degree of monopoly is higher and growth with large unused production capacity is logically consistent.' (ibid, p. 244). From a Harrodian perspective, Skott (2012, p. 116) and Ryoo & Skott (2017) a firm 'may want to hold excess capacity to deter entry' and 'changes in the degree of product market competition (...) could affect desired utilization rates.'

2.6 Indivisibilities

Del Monte assures that 'Another reason is the inability to increase production capacity as the market grows. The reasons that prevent this are the indivisibility of plant and equipment. It is part of company policy to build plants by anticipating future demand.' (1975, p. 244).

Ciccone (1986, 1990) also argues that the 'expectation of a growth in demand, together with the economic indivisibility that may characterize fixed capital, already constitutes an evident reason why it may be profitable to install a capacity greater than the peaks

[7] For a neoclassical view with similar results see Mann (1984).
[8] See Wilson (1992) for a review.

expected for the most immediate future' (ibid., p. 31; 1990, p. 424). Ryoo & Skott (2017) also agree that excess capacity may exist simply as a result of indivisibilities of investment (non-convexities in adjustment costs) (ibid., p. 116). In this sense, expectations of excess capacity's idleness is chosen deliberately by entrepreneurs.

2.7 Institutional and managerial bottlenecks

When a firm decides that it needs more capital services than it already has, it has two options. Acquire additional physical capital or use its current capital more intensively (Shapiro, 1986). According to Foss (1984, p. 5; 1985, p. 4) 'the number of hours per week a business establishment is ordinarily open and operating is an aspect of a firm's investment decision' as such the Average Workweek of Capital is one of the aspects of *normal* capacity utilisation.

According to Skott 'Managerial constraints or other bottlenecks (. . .) may make it difficult or costly to expand capacity at a rapid pace, and the desired utilization rate, consequently, may depend, *inter alia*, on the rate of accumulation.' (Skott, 2012, p. 116). Marris raises a similar point (1964, p. 92).

Foss (1981a, p.44) also claims that there might be managerial constraints in which the size of establishments is small. These are industries in which owners may provide a significant share of total labor input or may constitute the only managerial input available to the firm. The owner may feel that his presence is always needed and may balk at working the long hours required for, say, two shifts, preferring leisure over additional income.

According to Winston and McCoy (1974), these cost rhythms mean that 'it is often optimal to 'overbuild' the capital stock in order to produce only during periods of low input costs and avoid operation during periods of high costs' (ibid., p. 419). When this is true, the degree of 'overbuilding' -consequently the capital- labour and capital output ratios and the level of utilisation-becomes an economic variable determined by relative factor prices, by the rhythm of the input prices and by the elasticity of factor service substitution in their model.

2.8 Physical composition of output

The composition of output is also another determinant of aggregate *normal* utilisation of capacity. There exists industries, known as *continuous* industries, such as paper, chemicals, petroleum, and primary metal, that operate at higher rates than average rates of capacity utilisation. This implies that countries in which these kind of industries explain a great part of their output will naturally present higher levels of *normal* utilisation rates. This argument was presented by Garegnani & Palumbo (1997 and 1998[9]),

> Clearly y would normally depend on the physical composition of the output.
>
> Garegnani & Palumbo, 1997, p. 4, fn. 6.

In case capital goods industries operate with lower *normal* levels of capacity utilisation, episodes of higher growth rates (and higher levels of investment share) might be associated with lower levels of *normal* utilisation by composition effect.[10]

2.9 Inventories buffers

Inventories' stocks are part of the investment plan of a firm. Depending on its profitability, it might be convenient to reduce or increase the *normal* quantity of inventories as a percentage of output.[11] The reduction of inventories implies a reduction of one of the buffers that the companies have to respond to demand fluctuations, this might also reduce the level of capacity utilisation in order to compensate for expected fluctuations.[12]

2.10 A summing up

I found nine determinants of the *normal* level of capacity utilisation: (1) demand fluctuations, (2) demand's rate of growth/level, (3) technical change, (4) relative prices, (5) barriers to entry, (6) indivisibilities of fixed capital, (7) institutional and managerial bottlenecks, (8) physical composition of output and (9) inventories.

It is not possible to perform a proper, straightforward and complete empirical analysis, given data availability and also the fact that several possible determinants of u_n are hardly measurable. Given this, I will use a mixed strategy, based on findings of the related literature and on a simple empirical exercise. In the next section, after a literature review, I will try to introduce an empirical model that takes into account some of this determinants in order to explain a declining trend in capacity utilisation in the US economy.

[9]Here Garegnani talks about the relationship Y/K assuming *normal* utilisation. So it might be interpreted that he is talking about v instead of Y/Y^*, the latter being the relevant variable for us now. But given he assumes *technical conditions of production* as given in a previous paragraph, Garegnani is clearly talking about Y/Y^*.

[10]Thanks to Ricardo Summa that suggested this.

[11]There is a longstanding evidence that inventories are pro-cyclical (Zarnowitz, 1985; Kashyap and Wilcox, 1993).

[12]It is clear that if the level of output is given, remaining invariant the capital stock, a reduction of inventories should increase the level of capacity utilisation.

3 Causes of a declining trend in capacity utilisation: An empirical assessment

3.1 Literature review

Using the estimates of the Federal Reserve Board that, at those years was based mainly on the Mc-Graw Hill estimates, Nadiri and Rosen (1969) try to asses the impact on capacity utilisation of a shift in the demand and find that utilisation rates, hours per man and capacity utilisation 'immediately overshoot their ultimate values in the first or second period and monotonically decline to their equilibrium values as the stock adjustments proceed' (ibid., p. 465) and conclude that these 'comparisons show that the primary roles of variations in utilization rates, and to a lesser extent employment variations, serve to maintain output levels while capital stock is slowly adjusting.' (ibid., p. 466). Moreover, they find that there are essentially no long run relative factor price effects on utilisation rates, their coefficients being negative, but very close to zero; there is a positive relative factor price effect on capital stock, however, long run output effects on capital stock are four times as great as that of relative prices. Finally, the impact of output on long-run utilisation is positive but small and they claim that small this may be a manifestation of the residual nature of the measurement of this variable (ibid., pp. 467-468). Boileau and Normandin (1999) find that capacity utilisation is much more correlated with the cyclical component of output than with output growth.

Foss (1963, 1981a, 1981b, 1984, 1985, 1997) analyses the impact of many variables, not on capacity utilisation, but on the Average Workweek of Capital. First, he introduces an analysis for the year 1976. The independent variables analyzed for the year 1976 were (1) capital intensity, measured by the ratio of kilowatt-hours to man-hours, (2) percentage of value added accounted for by single-unit companies (SUVA), (3) percentage of employment accounted for by women, (4) continuousness, (5) percentage of production workers unionized, and (6) capacity utilisation. (Foss, 1981a, p. 45). In his regression, the variables (1), (2) and (4) are statistically significant. For the year 1929, the same variables explains its results. Then he tried to explain changes between 1929 and 1976. The independent variables were absolute changes over the same time period in (1) capital intensity, as measured by the ratio of kilowatt-hours to man-hours, (2) the proportion of value added accounted for by single-unit companies, (3) the share of women in total employment, and (4) continuousness. The final independent variable measures the length of the labor workweek in 1929 in excess of forty hours (5). The coefficients on variables for capital intensity, single-unit value added, continuousness, and labor workweek have the correct signs, and all are significant at the .05 level. The coefficient for the share of women in total employment is significant at the .10 level. There was some uncertainty about the sign of this coefficient. The negative sign suggests that the rise in the women's share of employment has had the effect of holding down weekly plant hours (Foss, 1981a, p. 48). Foss (1984, p. 69) present another estimation in which the Average Weekly Plant hours is explained by a constant and two independent variables, the capital-labor ratio with labor adjusted for unemployment and the wage differential. With a simple OLS estimation, the capital-labor ratio impacts positively on utilisation and the wage differential negatively.

Both Esposito and Esposito (1974) and Caves, Jarrett, and Loucks (1979) generate results which indicate that partial oligopolies experience higher levels of excess capacity than either tight oligopolies or atomistic industries. Esposito and Esposito (1986) find ambiguous evidence on the impact of concentration on the level of capacity utilisation; the empirical results based on the more comprehensive Census sample support the hypothesis that partial oligopolies experience higher levels of excess capacity than tight oligopolies or atomistic industries, however, the results using the Federal Reserve sample of material input industries do not support this hypothesis. Lieberman (1987) finds that incumbents rarely built excess capacity pre-emptively in an effort to deter entry. Driver (2000) using Arellano and Bond methodology with Instrumental Variables in PIMS database at a firm level finds that the market share and the concentration index are significant explaining a change on the level of capacity utilisation.

Lieberman (1989) estimates the determinants of industry capacity utilisation in 40 chemical product industries over a period of roughly two decades following different models of capacity expansion (Manne, Newsboy and the Whitt-Luss model). He finds that the investment economy of scale parameter is not statistically significant. The results reveal a significant but relatively small positive link between growth and capacity utilisation. All of the models predict a negative relation between capacity utilisation and demand variability. General macroeconomic fluctuations, as recorded by the FRB index, account for about 22% of the overall variance in capacity utilisation observed in the data sample. There is also a positive link between capital intensity and capacity utilisation. He finds also that the number of firms do not affect the average level of utilisation, the results suggest that capacity utilisation is not strongly affected by the number of producers. The study also shows the absence of a strong relation between capacity utilisation and the average number of plants per firm. The differential plant cost model implies a negative relation between capacity utilisation and the extent of variation in plant sizes and this is also confirmed by the data.

Bansak et al. (2007) find significant negative effects of technological change [high-tech equipment as a share of total investment and the share of high-tech equipment in the capital stock] on utilisation for a panel (fixed, random effects and Arellano-Bond procedure) of 111 industries during the period 1974-2000 for the US economy. The authors control for lagged output growth, lagged ratio of investment to capital [as a *proxy* of investment level], lagged standard-deviation of industrial output [as a *proxy* of volatility], change in average age of capital equipment excluding high tech, change in average age of the high-tech capital equipment, ratio of capital to labor [technique], some measure or set of measures of high-tech capital or investment and, finally, some dummies (for the years 1989 and 1995 where the surveys changed). However, they recognise this is a short-run effect, because of the stationary nature of sectoral capacity utilisation rates (ibid., pp. 638-639).

Van Biesebroeck (2003) finds that autoassembly plants using lean manufacturing methods have lower fixed and variable costs of adding shifts, compared to plants using traditional methods. The lower variable cost of operating a shift for the lean technology and the increasing returns to shifts both cause lean producers to operate at a higher level of capacity utilisation (ibid., p. 192).

Pierce & Wisniewski (2018) analyzes this declining trend in capacity utilisation in the US economy. They discarded some explanations. They examined the role of changes in value added on industry weighting by recalculating the aggregate manufacturing utilization rate holding each industry's value added weight fixed at its 1972 level and the found that the decline in capacity utilisation is not the result of shifts in industry weighting, so it is not a consequence of a change in the composition of output. They also estimated linear trend terms for 64 individual manufacturing industries over the period from 1972 to 2016. Their estimated trends indicate that declines in utilisation rates are widespread across U.S. manufacturing industries, with 86 percent of industries exhibiting a downward trend over the period. Long-term declines in utilisation rates are widespread, but magnitudes vary substantially across industries; this means that some industries did not suffer from this declining trend. Finally, they calculated utilisation rates for the set of establishments that appear in every year of the SPC from 1979 to 1999, which we refer to as 'continuous reporters'. These establishments are a selected sample, and thus not representative of the manufacturing sector as a whole. In addition to being particularly long-lived, they are large, with fewer than 300 continuous reporters accounting for approximately 6 percent of the manufacturing sector based on SPC sample weights. Nonetheless, because we can observe the continuous reporters over a long period of time, they provide a novel look at how capacity utilisation has evolved within establishments. They concluded that capacity utilisation declines are present within continuing establishments, so this declining trend is not solely the result of entry and exit of firms.

Nikiforos (2016) follows Foss and claims that the AWW of capital was raising since 1929.

Based on this argument, the author argues that there is an increasing trend of *normal* capacity utilisation driven by aggregate demand. Furthermore, Fiebiger (2020) finds that capacity utilisation closely tracks the rate of growth of value added in the US economy, at a sectoral level trying to support the thesis that *normal* utilisation could also be endogenous. Similar path is followed by Nikiforos (2021b).

Haluska, Summa and Serrano (2021) found no reason to claim that this decline in actual utilisation can be explained by a general reduction in the *normal* rates of capacity utilisation. They analyze empirically the average-to-peak demand in order to claim this, following the theoretical developments of Ciccone (1986).

In the next section, I will try to explain this declining trend in capacity utilisation in the US economy.

3.2 Data

The database I am using here it is a joint effort between the National Bureau of Economic Research (NBER) and U.S. Census Bureau's Center for Economic Studies (CES) [13], containing annual industry-level data from 1958-2018 on output, employment, payroll and other input costs, investment, capital stocks, TFP, and various industry-specific price indexes. Because of the change from SIC to NAICS industry definitions in 1997 and 2012, the database is provided in three versions: one with 459 four-digit 1987 SIC industries (1958-2018), another one with 473 industries (1958-2018) six-digit 1997 NAICS industries and, finally, the one I am using here with 364 six-digit 2012 NAICS industries. I extracted 3 industries because of missing data and also years 2017 and 2018. The number of observations for this dataset is, after my adjustments, 21299 at an industry level (361 x 59).

This dataset contains a number of relevant variables such as value added, real capital stock, shipments, production workers' wages, payroll, quantity of workers, quantity of production workers, quantity of hours worked by production workers that will allow me to build a relevant panel data to analyze capacity utilisation by industry. Based on this database, I built an aggregate relationship between output and capital stocks, weighted by industries' share of capital stock by year.

As it can be seen from Figure 1, the relationship output-capital stock of the NBER-CES database closely tracks the Manufacturing (SIC)[14] time series of the Federal Reserve Board. Therefore, this Y/K relationship might be also a good *proxy* for capacity utili-

[13] It is publicly available and it can be downloaded here: http://data.nber.org/data/nberces.html
[14] https://fred.stlouisfed.org/series/CUMFNS

Figure 1: NBER (1958-2011) and FRB (1948-2013)

Source: own elaboration based on NBER-CES (dashed line) and Federal Reserve Board (CUMFNS - solid line).

sation.[15] Since I have a long series of capacity utilisation, I then construct some of the variables analysed in the previous section to see if these have any long-term impact on utilisation:

- Output (*proxied* by Shipments). It is the nominal value of Shipments deflated by the shipments deflator, by industry.[16]

- Distribution of income. The wage share is the nominal production workers wages divided the nominal value added, by industry.

- Technique of production (K/L). The real capital stock (K) divided the quantity of hours worked by production workers (L), by industry.

- Inventories. The nominal time series of inventories deflated by the investment deflator, by industry.

- Capacity utilisation (*proxied* by output-capital ratio). It is the real value added (value added deflated by shipments deflator) divided capital stock, by industry.

The idea is to find out whether income distribution, production technique or inventories have an impact on capacity utilisation, controlling for output levels. Given the ability

[15] It must be noticed that Y/K is not equal to Y/Y^*. Some clarifications in Haluska (2021). Clearly the source of the declining trend in installed capacity utilisation is included in this Y/K ratio.

[16] I took the real value of shipments to avoid multicollinearity with real value added.

of the panel data to empower the results obtained, I will use this database instead of aggregate time series. Given almost all the determinants of *normal* utilisation in the last subsection are not present in this database (expected fluctuations, barrier to entry, indivisibilities, bottlenecks, etc.), my estimates will suffer from omitted variables and, unfortunately, this issue will not be solved. Although the analysis is partial, it still shed some light on the influence of output, distribution, technique and inventories on *effective* capacity utilisation.

3.3 Methods and identification strategy

Given I have a panel of 361 industries I will apply a Panel SVAR methodology, following closely Pedroni (2013) which takes into account responses to both idiosyncratic and common structural shocks, while permitting full cross member heterogeneity of the response dynamics (Pedroni, 2013, p. 180). The advantage of this methodology is that takes into account substantial heterogeneity present across the individual industries of the panel and cross-sectional dependence that is likely to arise from the fact that individual industries of the panel are responding not only to their own member-specific idiosyncratic shocks, but also to shocks that are common across industries of the panel (Pedroni, 2013, p. 181). The methodology is in line with the traditional time series structural VAR literature, such as Bernanke (1986), Blanchard and Quah (1989), Blanchard and Watson (1986), Clarida and Gali (1994) and Sims (1986), among others.

My estimates, in this case, replicate the system of equations and assumptions used in Gahn (2021). I will consider a panel composed of $i = 1, \ldots, N$ individual industries, each of which consists of an $Mx1$ vector of observed endogenous variables, y_{it}, for $y_{m,it}$ with $m = 1, \ldots, M$. In this case, my endogenous variables, by order, are:

- Output (*proxied* by *Shipments*).
- Distribution of income (W/Y)
- Technique of production (K/L).
- *Inventories.*
- Capacity utilisation (U)

I assume that the shocks to *Shipments* are demand shocks, following the principle of effective demand. Although distribution and production technique could be considered the 'most exogenous' variables, as they also suffer from the impact of the 'business-cycle' I decided to rank them after the level of demand. I also incorporate inventories to understand whether this variable plays a role in explaining the secular downward trend of capacity utilisation. Our most endogenous variable is, finally, capacity utilisation.

The panel is strongly balanced. To accommodate fixed effects and to simplify the notation, the methodology considers the $Mx1$ vector of demeaned data $z_{it} = (z_{1,it}, \ldots, z_{M,it})'$, where $z_{it} = y_{it} - \bar{y}_i$, with $\bar{y}_{m,it} = T^{-1} \sum_{t=1}^{Ti} y_{m,it}$ $\forall$ i, m. In keeping with the Structural VAR literature, the structural shocks are assumed to be orthogonal[17] with respect to each other for each type, so that the various $m = 1, \ldots, M$ idiosyncratic shocks are mutually orthogonal to one another, as are the various common shocks to one another.

3.4 Results

The main advantage of Pedroni's methodology is that these results can be divided into idiosyncratic - that are specific to each industry - the common ones and the composites. In the latter, the idiosyncratic and the common are combined. Here I will show only the composite results. In Figure 2 I can see the impacts of:

- Output (*proxied* by Shipments)
- Distribution of income (W/Y)
- Technique of production (K/L)
- Inventories

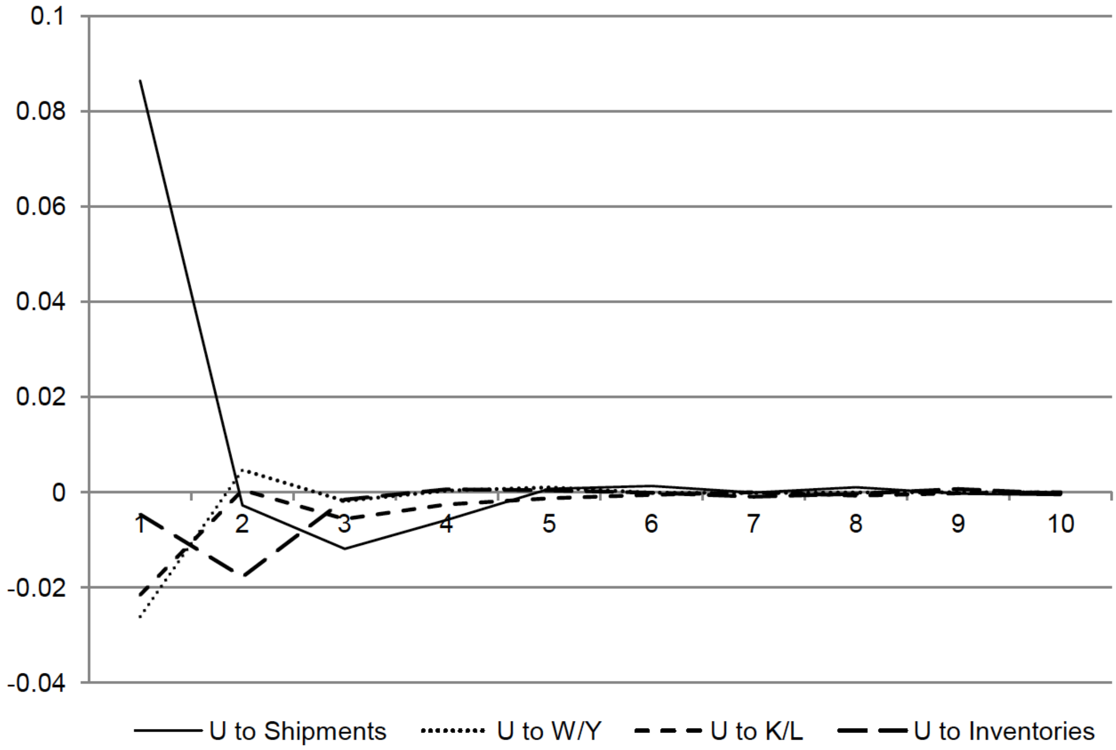
on capacity utilisation (*proxied* by the output-capital ratio - Y/K) for a time-span of 10 years. Results presented here are non-accumulated. What it can observed is that these four variables generate transitory effects on capacity utilisation. However, these transient shocks take a certain amount of time to adjust *completely*, which in the case of composite plots can take up between five to eight years. To return to the pre-shock level, however, 2 to 3 years is sufficient.

As it can be seen from Figure 2 a positive change to the level of output (see line '*U to Shipments*') has a positive and transitory effect on capacity utilisation, there is a kind of complete adjustment after 5 years. This positive and transitory effect is in line with the idea that an increase in aggregate demand is first fuelled by increasing the utilisation of installed capacity and then boosting investment and capital accumulation.

A positive shock to the wage share (see line '*U to* W/Y') impacts negatively on capacity utilisation; this is a transitory effect. After four years, this effect disappears. The negative

[17] When we perform impulse–response analysis, we ask the question, 'What is the effect of a shock to one equation, holding all other shocks constant?' To analyze that impulse, we need to keep other shocks fixed (Schenck, 2016).

Figure 2: Responses of U to *Shipments*, W/Y, K/L and *Inventories*.



Source: own elaboration based on NBER-CES.

effect could be explained by the fact that the wage share might be capturing partially a change of productivity/business-cycle. If labor productivity is more procyclical than the real wage rate, this might imply that the wage share displays an anti-cyclical behavior.

Something similar occurs with a positive change of technique (see line '*U to* K/L'), the impact is negative and after five years this change is completely absorbed. Obviously an increase in the K/L ratio first has an impact on the denominator of our utilisation variable and therefore has a negative impact. This effect, as I said, is also transitory.

Finally, the line '*U to Inventories*' shows the impact of a change in inventories on installed capacity utilisation. An increase in inventories leads to a fall in installed capacity utilisation, but again, this effect is transitory and disappears after about 3 years.

Using this novel database for the U.S. economy, for the time span under analysis, it seems possible to argue that changes in distribution or technique - as defined here - have not exerted a permanent and persistent effect on u at an aggregate level, but only transiently. Therefore, the causes of the declining trend in the installed capacity utilisation rate may have to be sought in other determinants. An alternative explanation is that the adjustment process towards the *normal* rate is by far very slow.

4 Conclusions

There is a declining trend of *effective* capacity utilisation in the US and there is still no precise answer to this phenomenon. Here I have presented several possible explanations for this declining trend. One of the possibilities is that the declining, but positive, rate of growth of aggregate demand, plus the decreasing wage share have been operating negatively on the effective capacity utilisation and its adjustment process towards the *normal* rate is by far very slow. Given the convergence towards a pre-shock utilisation seems to take like 4-7 years, caeteris paribus, it can be claimed that during this adjustment process, many new aggregate demand's shocks can perform new growth paths during the traverse. In a nutshell, it is an equilibrium concept that it is constantly operating but never realized. Other explanation possible is that the *normal* rate is changing itself.

Given *normal* utilisation is not measured by public institutions, I attempted to explain this declining trend through an analysis of the observable (effective) capacity utilisation. Although much more research must be done on this issue, following Pedroni (2013), applying a Panel Structural VAR model for a novel database that includes 361 industries from 1958-2016, I did not find *persistent* effects of technology, distribution and aggregate demand on *effective* capacity utilisation. In case the *normal* rate is changing, these results suggest that its causes should be looked for in other determinants. In case the adjustment towards normal use is very slow, further studies analysing the adjustment process should be pursued.

5 References

Artica, R. P. (2018). The impact of excess capacity over the investment falloff. *mimeo.*

Baldone, S. (1980). Fixed capital in Sraffa's theoretical scheme. In L. L. Pasinetti (Ed.), *Essays on the theory of joint production* (pp. 88–137). London, UK: Macmillan.

Bansak, C., Morin, N., & Starr, M. (2007). Technology, capital spending, and capacity utilization. *Economic Inquiry, 45*(3), 631-645.

Bernanke, B. S. (1986). Alternative explanations of the money-income correlation (No. w1842). *National Bureau of Economic Research.*

Betancourt, R. P., & Clague, C. (1981). Capital Utilization: A theoretical and Empirical Analysis. Cambridge University Press.

Blanchard, O. J., & Watson, M. W. (1986). Are business cycles all alike?. In The American business cycle: Continuity and change (pp. 123-180). University of Chicago Press.

Blanchard O, J., & Quah, D. (1989). The dynamic effects of aggregate demand and supply disturbances. *American Economic Review*, 19, 655-73.

Boileau, M., & Normandin, M. (1999). Capacity utilization and the dynamics of business cycle fluctuations (No. 92). CREFE, Université du Québec à Montréal.

Caves, R. E., Jarrett, J. P., & Loucks, M. K. (1979). Competitive conditions and the firm's buffer stocks: An exploratory analysis. *The Review of Economics and Statistics*, 485-496.

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

Ciccone, R. (1990). Accumulation and capacity utilization: Some critical consideration on Joan Robinson's theory of distribution. *Essays on Piero Sraffa: Critical Perspectives on the Revival of Classical Theory*, Unwin Hyman, Boston.

Clarida, R., & Gali, J. (1994, December). Sources of real exchange-rate fluctuations: How important are nominal shocks?. In Carnegie-Rochester conference series on public policy (Vol. 41, pp. 1-56). North-Holland.

Committeri, M. (1987). Capacity utilization, distribution and accumulation: a rejoinder to Amadeo. *Political Economy, 3*(1), 91-95.

De Juán, Ó. (2013). Normal paths of growth shaped by the supermultiplier. In Sraffa and the Reconstruction of Economic Theory: Volume Two (pp. 139-157). Palgrave Macmillan, London.

Del Monte, A. (1975). Grado di monopolio e sviluppo economico. *Rivista internazionale di scienze sociali, 46*(Fasc. 3), 231-263.

Driver, C. (2000). Capacity utilisation and excess capacity: Theory, evidence, and policy. *Review of Industrial Organization, 16*(1), 69-87.

Duménil, G., & Lévy, D. (2016). Technology and distribution in managerial capitalism: The chain of historical trajectories à la Marx and Countertendential traverses. *Science Society, 80*(4), 530-549.

Ederhof, M., Nagar, V., & Rajan, M. (2017). An empirical analysis of capacity costs (No. 17-26).

Esposito, F. F., & Esposito, L. (1974). Excess capacity and market structure. *The Review of Economics and Statistics*, 188-194.

Esposito, F. F., & Esposito, L. (1986). Excess Capacity and Market Structure in US Manufacturing: New Evidence. *Quarterly Journal of Business and Economics*, 3-14.

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

Foss, M. F. (1963). The utilization of capital equipment: postwar compared with prewar. *Survey of Current Business, 43*(6), 8-16.

Foss, M. F. (1981a). *Changes in the Workweek of Fixed Capital: US Manufacturing, 1929 to 1976* (Vol. 309). American Enterprise Institute Press. ISO 690.

Foss, M. F. (1981b). Long-run changes in the workweek of fixed capital. *The American Economic Review, 71*(2), 58-63.

Foss, M. F. (1984). *Changing Utilization of Fixed Capital: An Element in Long-Term Growth.* American Enterprise Institute for Public Policy Research - Business Economics - 128 pp.

Foss, M. F. (1985). Changing utilization of fixed capital: an element in long-term growth. *Monthly Lab. Rev., 108*, 3.

Foss, M. F. (1997). *Shiftwork, capital hours and productivity change.* Springer Science Business Media.

Gahn, S. J. (2020). Is There a Declining Trend in Capacity Utilization in the US Economy? A Technical Note. *Review of Political Economy, 32*(2), 283-296.

Gahn, S. J. (2021). On the adjustment of capacity utilisation to aggregate demand: Revisiting an old Sraffian critique to the Neo-Kaleckian model. *Structural Change and Economic Dynamics, 58*, 325-360.

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

Gahn, S. J., & González, A. (2019). On the empirical content of the convergence debate: Cross[U+2010]country evidence on growth and capacity utilisation. *Metroeconomica.*

Garegnani, P., & Palumbo, A. (1997). Accumulation of capital (No. 0002). Department of Economics. Roma Tre University.

Garegnani, P., & Palumbo, A. (1998). Capital Accumulation. The Elgar Companion to Classical Economics.

Giglio, R. J. (1970). Stochastic capacity models. *Management Science, 17*(3), 174-184.

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. (2021). Industrial and overall economy data on capacity utilization for the US economy: a note. Presentation at Demand-led workshop 2021 UFRJ.

Haluska, G.; Summa, R. and Serrano, F. (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. *IE-UFRJ Discussion Paper.*

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

Kashyap, A. K., & Wilcox, D. W. (1993). Production and Inventory Control at the General Motors Corporation During the 1920's and 1930's. *The American Economic Review*, 383-401.

Kurz, H. D. (1986). Normal positions and capital utilization. *Political Economy, 2(*1), 37-54.

Kurz, H. D. (1992). *Accumulation, effective demand and income distribution.* In Beyond the Steady State (pp. 73-95). Palgrave Macmillan, London.

Kurz, H. D., & Salvadori, N. (1994). Choice of technique in a model with fixed capital. *European Journal of Political Economy*, 10, 545–569.

Kurz, H. D., & Salvadori, N. (1995). *Theory of production. A long-period analysis.* Cambridge, UK: Cambridge University Press.

Levy, D. (1995). Capital Stock Depreciation, Tax Rules, and Composition of Aggregate Investment. *Journal of Economic and Social Measurement, 21*(1), 45-65.

Lieberman, M. B. (1987). Excess capacity as a barrier to entry: An empirical appraisal. *The Journal of Industrial Economics*, 607-627.

Lieberman, M. B. (1989). Capacity utilization: Theoretical models and empirical tests. *European Journal of Operational Research, 40*(2), 155-168.

Manne, A. S. (1961). Capacity expansion and probabilistic growth. *Econometrica: Journal of the Econometric Society*, 632-649.

Marris, R. (1964). The economics of capital utilisation (No. 10). *CUP Archive.*

Maxwell, P. (1977). Learning and technical change in the steelplant of Acindar S.A. in Rosario, Argentina.

Mann, B. S. (1984). Capital heterogeneity, capital utilization, and the demand for shift-workers. *Canadian Journal of Economics*, 450-470.

Nadiri, M. I., & Rosen, S. (1969). Interrelated factor demand functions. *The American Economic Review, 59*(4), 457-471.

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,*(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. (2021a). Notes on the accumulation and utilization of capital: Some empirical issues. *Metroeconomica, 72*(4), 679-695.

Nikiforos, M. (2021b). The Endogeneity-to-Demand of the National Emergency Utilization Rate. Levy Economics Institute, Working Papers, (989).

Palumbo, A., & Trezzini, A. (2003). Growth without normal capacity utilization. *European Journal of the History of Economic Thought, 10*(1), 109-135.

Pedroni, P. (2013). Structural Panel VARs. *Econometrics, 1*(2), 180-206.

Perry, G. L. (1973). Capacity in manufacturing. *Brookings Papers on Economic Activity, 1973*(3), 701-742.

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).

Roncaglia, A. (1978). *Sraffa and the Theory of Prices.* New York: Wiley.

Ryoo, S., & Skott, P. (2017). Fiscal and monetary policy rules in an unstable economy. *Metroeconomica, 68*(3), 500-548.

Salvadori, N. (1999). Transferable machines with uniform efficiency paths. In G. Mongiovi & F. Petri (Eds.), *Value, distribution and capital. Essays in honour of Pierangelo Garegnani* (pp. 270–285). London and New York: Routledge.

Schefold, B. (1980). Fixed capital as a joint product and the analysis of accumulation with different forms of technical progress. In L. L. Pasinetti (Ed.), *Essays on the theory of joint production* (pp. 138–217). London, UK: Macmillan.

Schenck, D. (2016). Structural vector autoregression models. *The STATA Blog, 20*.

Setterfield, M., & David Avritzer, J. (2020). Hysteresis in the normal rate of capacity utilization: A behavioral explanation. *Metroeconomica, 71*(4), 898-919.

Shaikh, A. (2009). Economic policy in a growth context: a classical synthesis of Keynes and Harrod. *Metroeconomica, 60*(3), 455-494.

Shapiro, M. D. (1986). Capital utilization and capital accumulation: Theory and evidence. *Journal of Applied Econometrics, 1*(3), 211-234.

Sims, C. A. (1986). Are forecasting models usable for policy analysis?. *Quarterly Review*, 2-16.

Skott, P. (1989). Effective demand, class struggle and cyclical growth. *International Economic Review*, 231-247.

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

Skott, P. (2016). Aggregate demand, functional finance, and secular stagnation. *European Journal of Economics and Economic Policies: Intervention, 13*(2), 172-188.

Skott, P., & Ryoo, S. (2017). Functional finance and intergenerational distribution in neoclassical and Keynesian OLG models. *Review of Keynesian Economics, 5*(1), 112-134.

Spence, A. M. (1977). Entry, capacity, investment and oligopolistic pricing. *The Bell Journal of Economics*, 534-544.

Sraffa, P. (1960). *Production of commodities by means of commodities*. Cambridge: Cambridge University Press.

Steindl, J. (1952). Maturity and Stagnation in American Capitalism, Basil Blackwell, Oxford.

Stigler, G. (1939). Production and distribution in the short run. *Journal of Political Economy, 47*(3), 305-327.

Van Biesebroeck, J. (2003). Productivity dynamics with technology choice: An application to automobile assembly. *The Review of Economic Studies, 70*(1), 167-198.

Varri, P. (1980). Prices, rate of profit and life of machines in Sraffa's fixed capital model. In L. L. Pasinetti (Ed.), *Essays on the theory of joint production* (pp. 55–87). London, UK: Macmillan.

Wilson, R. (1992). Strategic models of entry deterrence. *Handbook of game theory with economic applications*, 1, 305-329.

Winston, G. C. (1974). The theory of capital utilization and idleness. *Journal of Economic Literature, 12*(4), 1301-1320.

Winston, G. C., & McCoy, T. O. (1974). Investment and the optimal idleness of capital. *The Review of Economic Studies, 41*(3), 419-428.

Zarnowitz, V. (1985). Recent Work on Business Cycles in Historical Perspective: A Review of Theories and Evidence. *Journal of Economic Literature, 23*(2), 523-580.