

# *Is there a declining trend in capacity utilization in the US economy? A technical note*

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## Abstract

Recent contributions have mentioned the possibility of a declining trend in capacity utilization in the US since the 1970s. However, no consensus has emerged on the empirical evidence. The aim of this paper is to identify if such a declining trend in capacity utilization exists in the US economy: New empirical evidence is shown confirming that this is the case, at least since 1989.

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## 1. Introduction

There is a long-standing debate between Neo-Kaleckian, Harrodian, Marxian and Sraffian authors regarding whether capacity utilization is (or not) an accommodating variable in the long-run.<sup>2</sup> Briefly, it seems possible to claim that the major critique of the baseline Neo-Kaleckian model concerned its failure to reconcile the actual and the normal rates of capacity utilization in equilibrium (Committeri 1986, 1987; Skott 2012; Cesaratto 2015).

Starting from Amadeo (1986), some Neo-Kaleckian authors have proposed the adjustment of the normal rate towards the actual one when there exists a discrepancy between the former and the latter. This mechanism prompted a renewed debate, on both theoretical and empirical grounds. We are not concerned, in this article, with the former. The interested reader can refer to Nikiforos (2016) and Girardi and Pariboni (2019). On the empirical side of the debate, relevant contributions include Lavoie, Rodríguez, and Seccareccia (2004), Braga (2006), Skott (2012), Skott and Zipperer (2012), Nikiforos (2016), Fiebiger (2018), among others.

With respect to the empirics of capacity utilization, a side argument emerged. Indeed, during the revival of the ‘utilisation controversy’ (Nikiforos 2016, 2018, 2019a, 2019b; Fiebiger, 2018; Girardi and Pariboni 2019; Gahn and González 2019a; Gahn and González 2019b), many authors have mentioned the possibility of a declining trend in the level of capacity utilization since the 1970s for the US economy. The fact that there might be a declining trend in capacity utilization could be interpreted by some authors as stagnating demand, or a consequence of low growth rates. This discussion might be divided into two different spheres: Firstly, from an empirical perspective - whether there is (or not) a declining trend in capacity utilization and its alternative measures - and secondly, the causes of the latter trend, should it exist. We leave the latter issue to further research and we try to clarify the former. In this sense, there is a further aspect, more methodological, to consider, and it deals with alternative measures of capacity utilization and the way they are constructed. The focus of this article will be on this aspect and it will try to answer the following questions:

- a. Is the Federal Reserve Board’s (FRB, hereafter) measure a valid tool to perform this kind of analysis?
- b. Is there evidence of a declining trend, if we turn our attention to alternative measures?

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<sup>2</sup> A substantial element of the first step of this debate was continued in the journal ‘Political Economy - Studies in the Surplus Approach’ (<http://www.centrosraffa.org/politicalEconomy.aspx>) during the 1980s.

On the one hand, Skott and Zipperer (2012), Duménil and Lévy (2012, 2014), Kiefer and Rada (2015), Blecker (2016), Pierce and Wisniewski (2018), Fiebiger (2018), Setterfield (2019), Nersisyan and Wray (2019) and Setterfield and Avritzer (2019) agree that there is a declining trend in capacity utilization in the US: Evidence of their views may be sourced from FRB estimates. On the other hand, Shaikh (1987, 1989, 1992, 1999, 2016) and Nikiforos (2016, 2018, 2019b) disagree with this, based on a measurement error argument, as the FRB estimates do not correctly capture the true value of capacity utilization.

Firstly, we will analyse empirically the FRB time series and its critiques. We will then analyse different estimates of capacity utilization for the US, as a response to our inquiry. New empirical evidence is shown confirming that there is a declining trend in capacity utilization, at least since 1989. Our results imply that the measure constructed by the Federal Reserve Board might be a good proxy of the effective rate of capacity utilization. Some conclusions will be drawn.

## **2. Federal Reserve Board measures of capacity utilization and its critiques**

### *2.1. Federal Reserve Board measures of capacity utilization*

If we take as valid the FRB<sup>3</sup> measurement of capacity utilization, we might find a declining trend<sup>4</sup> as can be seen in Figure 1. The FRB measurement of capacity utilization is built in a very specific way and for this reason, some authors are sceptical of this estimate.<sup>5</sup>

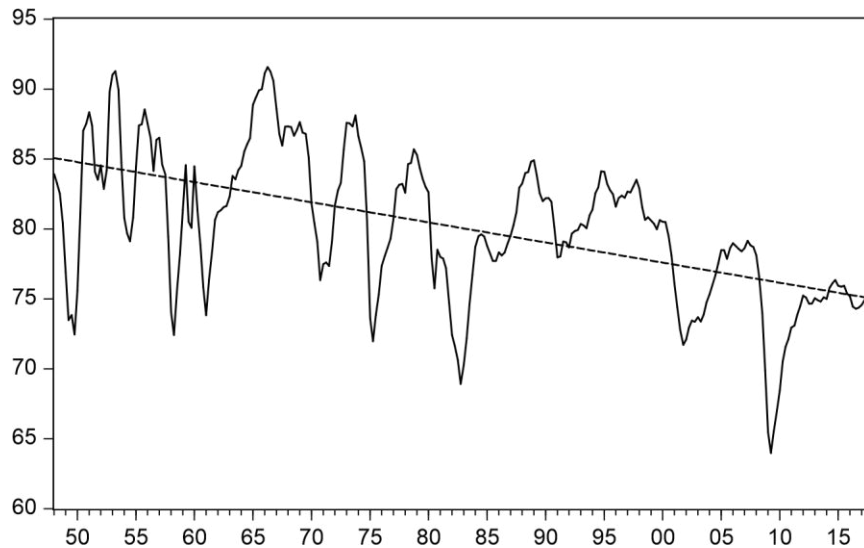
Figure 1. Federal Reserve Board Utilization Rate (1948Q1 – 2017Q4)

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<sup>3</sup> Board of Governors of the Federal Reserve System (US), Capacity Utilisation: Manufacturing [CAPUTLB00004SQ], quarterly, seasonally adjusted, retrieved from FRED, Federal Reserve Bank of St. Louis; <https://fred.stlouisfed.org/series/CAPUTLB00004SQ>

<sup>4</sup> In Appendix A.1. some econometric tests are presented to prove this claim.

<sup>5</sup> See Nikiforos (2019b) for a critical review of this measure.



Note: Utilization rate (solid line) - Trend (dashed line). Source: Federal Reserve Board, link in Footnote 6.

According to the Board of Governors of the Federal Reserve System<sup>6</sup> (Gilbert et al. 2000 and private communication), a survey of firms, initially by McGraw-Hill, which started in the mid-1950s, was the primary determinant of the level of utilization in manufacturing. The US Census Bureau survey - analysed later - was started in the mid-1970s and became the only source of utilization rate data in the late 1980s, when the McGraw-Hill survey was discontinued. The rates from the McGraw-Hill survey are currently the basis for the earlier years of the published FRB rates, but they tend to be higher than those from the Census survey (the two surveys overlapped for 14 years). A level adjustment is applied to estimates from more recent years, in order to maintain consistency with the historical levels, based on the earlier survey. Moreover, the level difference between the McGraw-Hill rates and the Census rates may come from differences in their samples. McGraw-Hill was a firm-level survey, whereas Census carried out a plant-level survey. Finally, FRB estimates industry capacity using a regression model relating survey-based capacity to measures of capital input and measures of the average age of the industry's capital stock. The final capacity indexes - denominator of FRB's capacity utilization - for a year are derived from the fitted values of these regressions.

The fact that the FRB makes use of multiple surveys to build on the whole period from 1948 to the present and estimates capacity using a regression model whose step-by-step results are not publicly published has raised some doubts on its reliability. These critiques will be analysed in the next subsection.

<sup>6</sup> Source:<https://www.federalreserve.gov/Releases/g17/Meth/MethCap.htm>  
<https://www.federalreserve.gov/pubs/Bulletin/2000/0300secnd.pdf>

and <https://www.federalreserve.gov/pubs/Bulletin/2000/0300secnd.pdf>

## 2.2. *Recent main critiques to FRB's measure*

### 2.2.1. *Nikiforos' critique*

Nikiforos (2016, 2018, 2019b)<sup>7</sup>, on the Federal Reserve Board claims, that, the data are ‘stationary by construction and they represent how much capacity is utilised compared with the desired rate of utilisation’ (Nikiforos 2016, p. 2), casting doubt on the FRB’s estimates. The main argument rests in the fact that, the index is based on the Survey of Plant Capacity, conducted by the US Census Bureau, in which the Census asks plant managers for the ‘maximum level of production that this establishment could reasonably expect to attain under normal and realistic operating conditions fully utilizing the machinery and equipment in place’<sup>8</sup> (ibid. p. 10, emphasis added in italics). Due to the ‘ambiguous’ way in which this particular question of the survey might be designed, the author states, ‘In that sense the FRB utilisation index is a proxy for the deviation of  $u^*$  [effective utilisation] from  $u_d$  [desired utilisation] and gives us no information about  $u_d$  itself.’ (ibid. p. 11).

In a similar fashion, some authors in the past have already claimed, that, in some surveys plant managers [respondents in the McGraw-Hill utilization survey] ‘find’ capacity when output rises sharply, and ‘lose’ it when output slackens (Perry 1973, p. 711; Rost 1983, p. 521). Anticipating some results, we will show later that, in the same survey, another question is asked by the Census, which might cast doubt as to whether Nikiforos’s claims are valid.

### 2.2.2. *Shaikh's critique*

Professor Shaikh (2016)<sup>9</sup> maintains, based on Hertzberg et al. (1974), Rost (1983), Schnader (1984), Shaikh (1989) and Shapiro (1989), that ‘a second group of capacity measures tries to get around this problem [estimation of capacity utilisation] by relying on economic surveys of operating rates, as in those by the Bureau of Economic Analysis (BEA) and the Bureau of the Census. Here, firms are typically asked to indicate their current operating rate (i.e., their current rate of utilization of capacity). The difficulty with such surveys is that they do not specify any

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<sup>7</sup> Nikiforos might be labelled under a Neo-Kaleckian framework, although with Classical influences, in which the utilization rate is endogenous and responsive to demand pressures in the long-term. See Nikiforos (2013, 2016, 2018, 2019) for theoretical and empirical evidence on this issue, Girardi and Pariboni (2019) and Gahn and González (2019a) for critical remarks.

<sup>8</sup> [https://www2.census.gov/programs-surveys/qpc/technical-documentation/questionnaires/watermark\\_form.pdf?#](https://www2.census.gov/programs-surveys/qpc/technical-documentation/questionnaires/watermark_form.pdf?#)

<sup>9</sup> Shaikh might be labelled as a classical Marxist/Harrodian scholar, who argues that there is a tendency for firms to obtain a normal rate of capacity utilization in the long-run equilibrium. In this view, Keynesian results and policy conclusions apply in the short-run, but, apparently, not in the long-run.

explicit definition of what is meant by “capacity”, so that the respondents are free to choose between various measures of capacity’ (Shaikh 2016, p. 823).

Problems related to surveys have been greatly acknowledged by De Leeuw (1979). In our view, Shaikh’s argument could hardly be a concern for a survey’s analysis: Firstly, according to Phillips (1963, p. 284), while referring to McGraw-Hill surveys<sup>10</sup>, ‘the obvious advantage of the McGraw-Hill survey method is that direct questions relating to capacity are responded to by persons likely to know the answers’. Secondly, once fixed, the criteria to define capacity by the plant manager is defined at a very first time, even right or wrong; in any case if we assume that she will respond coherently using the same method of estimation through time, the error measurement of the time series remains on its level. We think this is not too strong and implausible an assumption to be made, should we prefer working on surveys, rather than on estimates of capital stock or past estimates of investment.

### **3. US Census Bureau measures of capacity utilization**

The US Census Bureau reports a variety of measures of capacity utilization from the ‘Quarterly Survey of Plant Capacity Utilization’ (QPC), previously called ‘Survey of Plant Capacity’ (SPC). Here we will present just two that will give us enough evidence to support our arguments.

#### *3.1. Full Utilization Rate and National Emergency Rate*

One of the time series calculated by the Census Bureau since 1974 is the Full Utilization Rate (FUR, hereafter) - which serves as a basis for the construction of FRB’s measure. It is a comparison of actual production and ‘full production capability’. In this case the plant managers have to ‘report market value of actual production for the quarter’ (for the numerator) and ‘estimate the market value of production of this plant as if it had been operating at full production capability for the quarter’ (for the denominator) (Survey, US Census Bureau<sup>11</sup>): For the latter, they have to assume only machinery and equipment in place and ready to operate, normal downtime, that labour, materials, utilities, etc. are fully available, the number of shifts, hours of operation and overtime pay that can be sustained under normal conditions and a

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<sup>10</sup> We are not claiming here that McGraw-Hill and FRB measures are the same, but both share a survey-based estimation method and therefore, this critique is common to both.

<sup>11</sup> [https://www2.census.gov/programs-surveys/qpc/technical-documentation/questionnaires/watermark\\_form.pdf?#](https://www2.census.gov/programs-surveys/qpc/technical-documentation/questionnaires/watermark_form.pdf?#)

realistic work schedule in the long run, as well as the same product mix as the actual production (see Figure 2).<sup>12</sup>

Figure 2. Quarterly Survey of Plant Capacity (p. 2) - Full Utilization Rate

**Item 2 VALUE OF PRODUCTION**

**A.** Report market value of **actual production** for the quarter.

**ACTUAL PRODUCTION** ..... 

\$Bil.	Mil.	Thou.
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>

**B.** Estimate the market value of production of this plant as if it had been operating at **full production capability** for the quarter.

Assume:

- only machinery and equipment **in place and ready to operate**.
- normal downtime.
- labor, materials, utilities, etc. **ARE FULLY AVAILABLE**.
- the number of shifts, hours of operation and overtime pay that can be **sustained** under **normal** conditions and a **realistic** work schedule in the long run.
- the **same product mix** as the actual production.

**FULL PRODUCTION CAPABILITY** ..... 

\$Bil.	Mil.	Thou.
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>

**C.** Divide your **actual production** estimate by your **full production estimate**. Multiply this ratio by 100 to get a percentage. .... 

Capacity Utilization		
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>

Is this a reasonable estimate of your utilization rate for this quarter?  Yes  No — Review item 2A and 2B

Source: US Census Bureau. Link in Footnote 11.

The fact that plant managers have to assume equipment in place, ready to operate, normal downtime and a realistic work schedule might cast some doubts about the reliability of these estimates. However, the Census also presents another measure of utilization, called the National Emergency Rate (NER), again a ratio between actual production and ‘national emergency production’. Here the plant manager must ‘estimate the market value of production for this plant, as if it had been operating under national emergency conditions for the quarter’ (for the denominator) (Survey, US Census Bureau<sup>13</sup>): They also have to assume full use of all their machinery and equipment, including that requiring reconditioning, plant production as

<sup>12</sup> The question of the survey has been changing through time (see Doyle 2000; Morin and Stevens 2004; Nikiforos 2016 and Fiebiger 2018).

<sup>13</sup> [https://www2.census.gov/programs-surveys/qpc/technical-documentation/questionnaires/watermark\\_form.pdf?#](https://www2.census.gov/programs-surveys/qpc/technical-documentation/questionnaires/watermark_form.pdf?#)

close to 168 hours per week as possible, including extra shifts, minimal downtime, supposing that funding, labour, materials, components, utilities, etc. are fully available to them and their suppliers, their product mix is permitted to change and finally, that they can sell all of their output (see Figure 3).

Figure 3. Quarterly Survey of Plant Capacity (p. 3) - National Emergency Rate

**Item 5 NATIONAL EMERGENCY PRODUCTION**

**A.** Estimate the market value of production for this plant as if it had been operating under **national emergency** conditions for the quarter. ....

\$Bil.	Mil.	Thou.
□ □ □	□ □ □ □	□ □ □ □ □
□ □ □ □ □		

Assume:

- **full** use of **all** your machinery and equipment, including that requiring reconditioning.
- plant production **as close to 168 hours per week as possible**, including extra shifts
- **minimal** downtime.
- funding, labor, materials, components, utilities, etc. **are fully available to you and your suppliers.**
- your product mix **is** permitted to change.
- you can sell **all** of your output.

**B.** If **actual** operations in the quarter were **less** than **national emergency production**, how quickly could the plant increase to the national emergency production level if given emergency priority by the government?  
*Mark (X) the shortest amount of time the plant would require.*

Less than 3 months    
  3 to 6 months    
  7 to 12 months    
  More than one year

Remarks

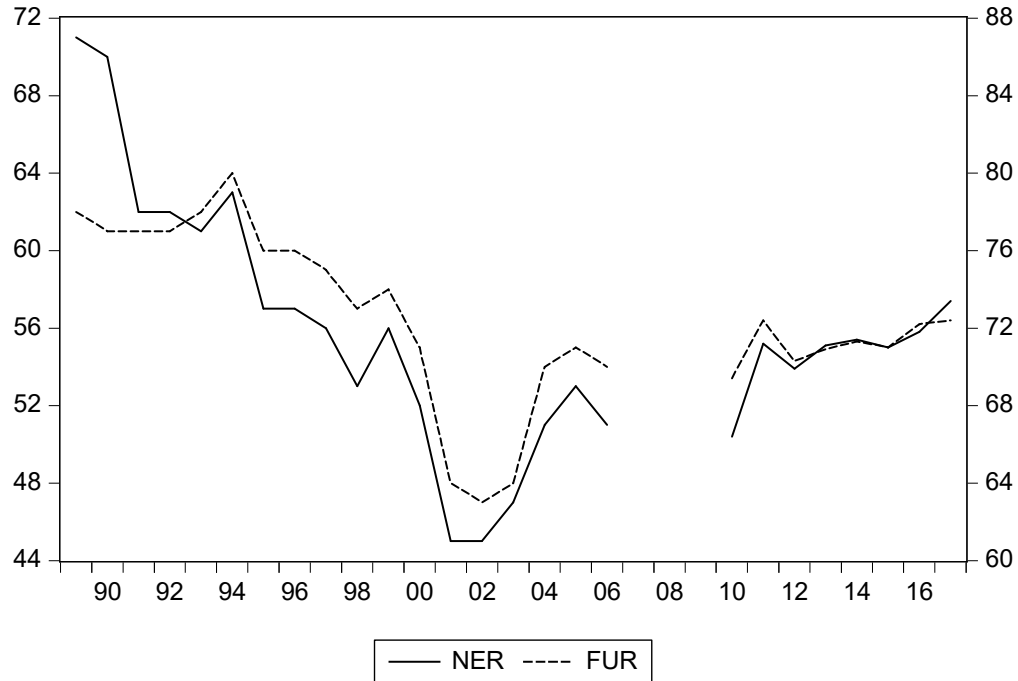
Source: US Census Bureau. Link in Footnote 13.

The FUR could represent an ‘economic’ estimate of capacity utilization, while the NER is similar to the ‘engineer’ concept.<sup>14</sup> The NER database is publicly available at an aggregate level and for more than 500 industries from 1989Q4 to 2006Q4 - only for the last quarter of each year and for 93 industries from 2010Q1 to 2017Q4 - quarterly - not seasonally adjusted, therefore, in the first stage, we will try to compare visually this aggregate time series with the aggregate FUR in order to see if there is any compatibility.

Figure 4. Full Utilization and National Emergency Rates (1989Q4–2017Q4)

<sup>14</sup> On the one hand, the ‘engineer’ concept of capacity utilization  $Y/Y^*$  implies a notion in which the denominator expresses the maximum technical possibilities of the plant or firm, even if this is not profitable.





Note: NER (left axis) - FUR (right axis). Only last quarter. 2007, 2008 and 2009 values are missing.

Source: own elaboration based on US Census Bureau. See Appendix A.3.

In Figure 4, the aggregate NER and the aggregate FUR, directly retrieved from the US Census Bureau Survey<sup>15</sup>, are shown; hence without any adjustment performed by the Federal Reserve Board (FRB). Even considering the missing values for 2007, 2008 and 2009, it can be seen that the pattern of both variables is quite similar.<sup>16</sup> Few comments should be made regarding this. Firstly, it is clear that, as previously stated, the pattern is similar and what is different is the level of the variables: The NER is at any time lower, as might be expected, given the denominator is the maximum that can be technically produced. Secondly, if we consider that the NER is the closest variable to the measurement of ‘engineering’ utilization capacity<sup>17</sup> and

<sup>15</sup> <https://www.census.gov/programs-surveys/qpc/data/tables.html>

<sup>16</sup> In Appendix A.2., we show that we cannot reject the null hypothesis of both series being equal (different only in levels).

<sup>17</sup> Even better than the Average Workweek of Capital (Foss 1963; Taubman and Gottschalk 1971; Foss 1981a; Foss 1981b; Foss 1984; Foss 1985; Shapiro 1986; Orr 1989; Mayshar and Solon 1993; Shapiro 1996; Foss 1997; Beaulieu and Matthey 1998; Gorodnichenko and Shapiro 2011) because NER takes into account, at least partially, the speed of operation.

given that FUR's behaviour through time is very similar, then it could also validate the idea that the latter could be a proxy of the correct 'economic' measure of capacity utilization, at least to analyse its behaviour through time, if not its level.

The fact that the FUR estimates follow the NER estimates - as can be seen in Figure 4 - is proof that what can be considered for some authors an 'ambiguous' question asked by the Census - although without being error-free as any survey-based method - it is not necessarily the case with regard to plant managers.

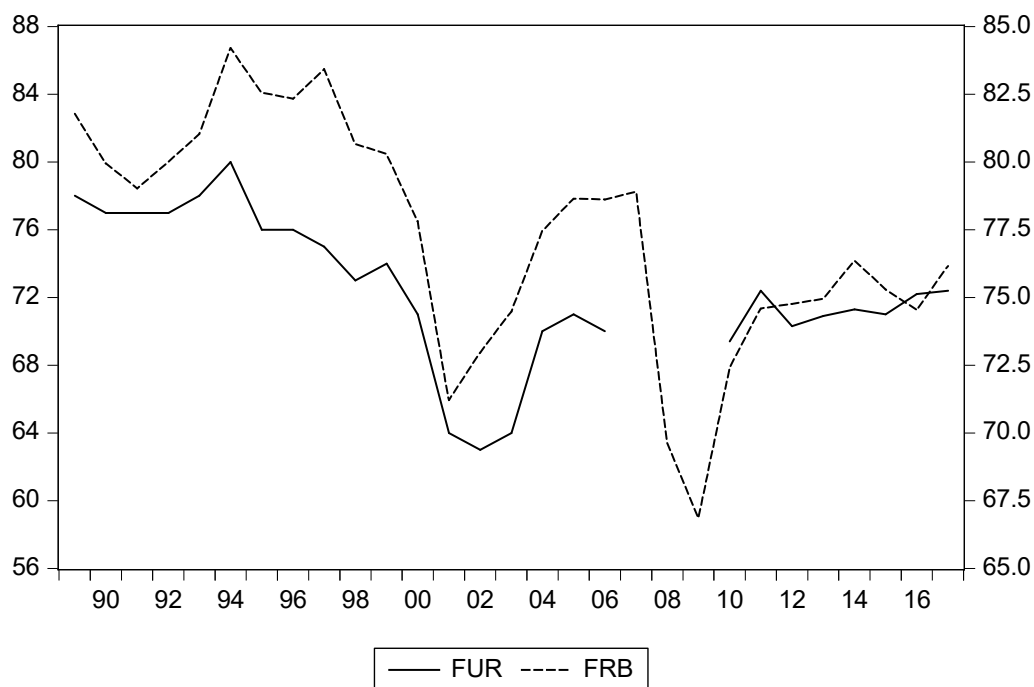
#### **4. Comparing the Federal Reserve Board and the Census Bureau time series**

As we have mentioned previously, the FRB makes some adjustments to the US Census Bureau's FUR, so we must also compare these variables. Unfortunately, the FRB time series is seasonally adjusted by default while the FUR is not; therefore, we applied X-13ARIMASeats seasonal adjustment for the period 2010Q1-2017Q4.<sup>18</sup>

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<sup>18</sup> This adjustment is also performed by the US Census using the same methodology.

Figure 5. Full Utilization and Federal Reserve Board Utilization Rates and (1989Q4-2017Q4)



Note: FUR (left axis) - FRB (right axis). Only last quarter, seasonally adjusted since 2010. 2007, 2008 and 2009 values are missing for FUR. Source: own elaboration based on US Census Bureau and Federal Reserve Board. See Appendix A.3.

As we can see from Figure 4, the behaviour of both series through time is not the same but quite similar. The level of the FRB’s measure might be greater, as expected, because of the adjustment of the FRB in relation to McGraw-Hill’s estimates (see 2.1). At least from a simple visual analysis<sup>19</sup> it could be inaccurate to claim that the adjustment made by the FRB radically changes the behaviour through time of the Census Bureau time series, the latter can be considered an even more accurate proxy of ‘economic’ capacity utilization.

## 5. A summing up

Recent contributions have mentioned the possibility of a declining trend in capacity utilization in the US since the 1970s. However, no consensus has emerged on the empirical evidence: Some authors severely criticized FRB’s measure of capacity utilization (Nikiforos 2016, 2018, 2019b; Shaikh 1987, 1989, 1992, 1999, 2016), on the basis that they consider the estimate of capacity utilization of the Federal Reserve Board not to be appropriate.

<sup>19</sup> Some econometric evidence is also shown in Appendix A.2.

Through this paper, we have introduced two different measures of utilization retrieved from the US Census Bureau. One of these measures was almost ‘forgotten’ in the literature<sup>20</sup>: The National Emergency Rate of capacity utilization. This rate is built by the Census Bureau and it is the most accurate in terms of the correct measurement of ‘engineering’ utilization capacity.

Although much more work must be done on measures of capacity utilization, a simple visual and econometric analysis of the relationship between the National Emergency, the Full Utilization and the FRB rates of capacity utilization, might allow us to consider that the FRB’s measure, although with serious limitations, might still be valid as a measure of the behaviour of capacity utilization through time for the US economy. The direction and the magnitude of the adjustment of the NER, FUR and the FRB estimates coincide; although they do not coincide continuously - it cannot be denied that for some periods these measures might diverge - when the whole period of these publicly available time series is taken into account the correlation is high and we cannot reject FUR, NER and FRB being similar as shown in the Appendix. Because of this we are also in a position to answer in the affirmative to the question that gives the title to this article.

This work can be considered as a preliminary and methodological step for further research on accumulation and capacity utilization, since it aims at proving that one of the most used measures of capacity utilization (FRB) might be still a reasonable choice for empirical work and not dismissed as some authors recently have been suggesting. Up to now, this implies that past or future empirical works based on FRB’s measure might be taken into account as valid evidence.

Finally, from a theoretical point of view, the presence a deterministic trend or structural breaks in the effective rate of capacity utilization is not sufficient evidence to accept or reject any particular model, nor to claim that utilization should be exogenous or endogenous in the

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<sup>20</sup> Only mentioned in a few articles (Shapiro 1996; Morin and Stevens 2004; Bansak, Morin and Starr 2007; Shapiro and Gorodnichenko 2011) and briefly analysed in Doyle (2000) and Petri (2003, 2004). See Belzer et al. (1991, 1993) for estimations.

long-run<sup>21</sup>; to do this, the reasons behind this long-term declining trend should be analysed and these will be subject to further analysis.

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No potential conflict of interest was reported by the author.

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<sup>21</sup> One of the referees raised the issue that the presence of a declining trend in capacity utilization might imply that the latter cannot be considered an exogenous variable in the long-run, as some versions of the Neo-Kaleckian model suggest. It is not the purpose of this article to provide a thorough investigation of the theoretical implications for growth theory of the empirical findings reported here. This note is meant to provide a preliminary technical assessment on a declining trend of capacity utilization in the US economy. Nonetheless, it is interesting to notice few things: First, the fact that one variable is considered exogenous does not mean that it cannot change, but that it is relatively *persistent*; for the method to be useful it is enough that the speed of change of the endogenous variables is of a higher order than the rate of change of the exogenous magnitudes; the given variables may then be assumed to be fixed for the purpose of explaining the long-period position, even though *they may change slowly over time* (Dvoskin and Lazzarini 2013, p. 118, emphasis added in *italics*). Finally, it can be envisaged at least two scenarios in which a declining trend in utilization is compatible with its exogeneity with respect to growth: a) If the process of adjustment towards *normal* utilization is very slow and b) if any of the exogenous determinants of the *normal* rate is changing. In the end, the evidence presented in this paper it is not in itself enough to accept or reject any model.

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## Appendix A.

## Statistical evidence and data sources

### A.1. *Declining trend in capacity utilization?*

In this Appendix we perform two tests (Augmented Dickey-Fuller and Phillips Perron, using Schwarz Information Criterion) to show that there is a declining trend in capacity utilization in the FRB time series for the period 1948Q1-2017Q4. For simplicity, we perform tests which include a constant and a linear trend in the effective Hodrick-Prescott filtered ( $\lambda=1600$ ) and Hamilton filtered series. We also assume that bounds are sufficiently far away, so conventional unit root methods behave according to the standard asymptotic theory.<sup>22</sup>

Table 1: Time Series Unit Root Tests

	FRB		FRB-Hodrick Prescott		FRB-Hamilton	
	ADF	PP	ADF	PP	ADF	PP
t-Stat	-4.43***	-3.72***	-2.55	-3.06	-5.30***	-3.98**
Trend	Yes***	Yes*	Yes**	Yes***	Yes***	Yes**

Note: \*=pval<0.1, \*\*=pval<0.05, \*\*\*=pval<0.01.

Source: own computations, based on data provided. See Appendix A.3.

As we said, for simplicity, we have included a linear trend. From an economic point of view this does not necessarily make sense, given that, a linear trend implies that the level of utilization, sooner or later, will reach an upper or lower bound. Following this reasoning, the inclusion of breakpoints, as Nikiforos (2016) has incorporated in his article, might be an advantage over the linear-trend assumption.<sup>23</sup> But given that the article is more focused on the reliability of the estimates, the usefulness (or not) of breakpoint tests will be left for further research.

### A.2. *Comparing NER, FUR and FRB time series*

We have two sub-samples. One for the period 1989Q4-2006Q4 (only last quarter, not seasonally adjusted) and another for the period 2010Q1-2017Q4 (quarterly, seasonally adjusted).<sup>21</sup> First, we present a correlation matrix for all the variables in both sub-samples.

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<sup>22</sup> If bounds were not sufficiently far away, the analysis must consider this issue (see Cavaliere and Xu 2014).

<sup>23</sup> Thanks to Alejandro González who raised this issue.

<sup>21</sup> See Appendix A.3. for data description.

Table 2: Correlation matrix

Period		NER	FUR	FRB
1989Q4-2006Q4	NER	1	0.887	0.701
	FUR	0.887	1	0.902
	FRB	0.701	0.902	1
2010Q1-2017Q4	NER	1	0.909	0.928
	FUR	0.909	1	0.894
	FRB	0.928	0.894	1

Source: own computations, based on data provided. See Appendix A.3.

The correlation coefficient is a measure that determines the degree of association of two variables' movements. A correlation coefficient above .70 typically signals a strong positive correlation. As we can see from Table 2, correlations are between 0.701 and 0.928, higher, on average, for the second period.

On the one hand, as we can see in Table 3, a unit root process without deterministic trend cannot be discarded for variables in the first sub-sample. On the other hand, we can reject the presence of a unit root without deterministic trend for each variable of the sub-sample 2010Q1-2017Q4. This will cause some complications while analysing the following time series: Even taking into account that we will probably lose important information, we will differentiate the data for the first sub-sample.<sup>24</sup>

Table 3: Unit root tests without trends in sub-samples

Period		ADF	PP
1989Q4-2006Q4	NER	-2.02	-2.14
	FUR	-1.20	-1.20
	FRB	-1.47	-1.60
2010Q1-2017Q4	NER	-3.35**	-3.79***
	FUR	-4.62***	-4.62***
	FRB	-6.27***	-6.01***

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<sup>24</sup> These tests were performed without deterministic trends in order to be useful for the Appendix A.2.1., A.2.2. and A.2.3. Cointegration analysis was discarded because of the small number of observations.

Source: own computations, based on data provided - SIC criterion. See Appendix A.3.

### A.2.1. Comparing NER and FUR time series

Here we will compare the Full Utilization Rate (FUR) and the National Emergency Rate (NER) at an aggregate level, for the period 1989Q4-2006Q4 (only last quarter, not seasonally adjusted) and 2010Q1-2017Q4 (quarterly, seasonally adjusted). To avoid spurious regression, we introduce distributive lags under Schwarz criterion (SIC). The equation tested consists of the following:

$$NER_t = \alpha + \gamma_1 NER_{t-1} + \dots + \gamma_n NER_{t-n} + \beta_1 FUR_{t-1} + \dots + \beta_n FUR_{t-n} + \epsilon \quad (1)$$

After a simple OLS regression<sup>25</sup> that takes the form of an ARDL model, we run a Wald test in which we test for our null hypothesis where  $\beta_1 = 0$ . If we reject that  $\beta_1 = 0$  then we cannot reject the possibility of FUR and NER being similar time series. For a robustness check, we run another Wald test in which  $\beta_1 = 1$ , this means that we check if these time series are equal, with a different level ( $\alpha$ ). The results are presented in Table 4. As we can see from the table, we reject in all cases that  $\beta_1 = 0$  and we cannot reject that  $\beta_1 = 1$ .

Table 4: Wald Test - NER and FUR comparison

Period	H <sub>0</sub>	Aggregate
1989Q4-2006Q4	$\beta_1 = 0$	12.76***
	$\beta_1 = 1$	0.40
2010Q1-2017Q4	$\beta_1 = 0$	6.31***
	$\beta_1 = 1$	-0.30

Note: \*=pval<0.1, \*\*=pval<0.05, \*\*\*=pval<0.01.

Source: own computations, based on data provided. See Appendix A.3.

### A.2.2. Comparing FRB and FUR time series

<sup>25</sup> Given that we cannot reject the presence of a unit root process, for the first sub-sample we differentiate the data so the equation to be tested is:

$$\Delta NER_t = \gamma_1 \Delta NER_{t-1} + \dots + \gamma_n \Delta NER_{t-n} + \beta_1 \Delta FUR_{t-1} + \dots + \beta_n \Delta FUR_{t-n} + \epsilon \quad (2)$$

The same procedure will follow for all of Appendix A.2.

In this subsection, we will compare the Federal Reserve Board Utilization Rate (FRB) and the Full Utilization Rate (FUR) at an aggregate level for the period 1989Q4-2006Q4<sup>26</sup> and for 2010Q1-2017Q4 (quarterly, seasonally adjusted). Following the same methodology explained in Appendix A.2.1, the results are presented in Table 5.

Table 5: Wald Test - FRB and FUR comparison

Period	H <sub>0</sub>	Aggregate
1989Q4-2006Q4	$\beta_1 = 0$	6.49***
	$\beta_1 = 1$	0.56
2010Q1-2017Q4	$\beta_1 = 0$	2.95***
	$\beta_1 = 1$	-0.49

Note: \*=pval<0.1, \*\*=pval<0.05, \*\*\*=pval<0.01.

Source: own computations, based on data provided. See Appendix A.3.

In this case, we also reject that  $\beta_1 = 0$  in our two sub-samples. Moreover, we cannot reject that  $\beta_1 = 1$  for both sub-samples.

### A.2.3. Comparing NER and FRB time series

Finally, we will compare the National Emergency Rate (NER) and the Federal Reserve Board Utilization Rate (FRB) of capacity utilization at an aggregate level for the period 1989Q4-2006Q4<sup>27</sup> and for 2010Q1-2017Q4 (quarterly, seasonally adjusted). Following the same methodology explained in Appendix 2.1., the results are presented in Table 6. In this case, we also reject that  $\beta_1 = 0$  in our two sub-samples and we cannot reject that  $\beta_1 = 1$ .

Table 6: Wald Test - NER and FRB comparison

Period	H <sub>0</sub>	Aggregate
1989Q4-2006Q4	$\beta_1 = 0$	4.92***
	$\beta_1 = 1$	-1.18
2010Q1-2017Q4	$\beta_1 = 0$	2.90***
	$\beta_1 = 1$	0.38

Note: \*=pval<0.1, \*\*=pval<0.05, \*\*\*=pval<0.01.

Source: own computations, based on data provided. See Appendix A.3.

<sup>26</sup> FUR: only last quarter, not s.a.; FRB: only last quarter, s.a.

<sup>27</sup> NER: only last quarter, not s.a.; FRB: only last quarter, s.a.

### A.3. *Data Sources*

- FRB Capacity Utilization 1948 - 2017. Board of Governors of the Federal Reserve System (US), Capacity Utilization: Manufacturing [CAPUTLB00004SQ], quarterly, seasonally adjusted, retrieved from FRED, Federal Reserve Bank of St. Louis; <https://fred.stlouisfed.org/series/CAPUTLB00004SQ>. For Graph 1 and Appendix A.1.
  
- FRB Capacity Utilization 1972 - 2017. Board of Governors of the Federal Reserve System (US), Capacity Utilization: Manufacturing (NAICS) [MCUMFN], retrieved from FRED, Federal Reserve Bank of St. Louis; <https://fred.stlouisfed.org/series/MCUMFN>, for aggregate comparisons.
  
- Full Utilization Rate (FUR) and National Emergency Rate (NER) 1989Q4-2006Q4, only last quarter, aggregate, Census Bureau (US), Quarterly Survey of Plant Capacity Utilization (QPC), <https://www.census.gov/programs-surveys/qpc/data/tables.html>.
  
- Full Utilization Rate (FUR) and National Emergency Rate (NER) 2010Q1-2017Q4 (quarterly) aggregate, Census Survey of Plant Capacity Utilization (QPC), <https://www.census.gov/programs-surveys/qpc/data/tables.html>.