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Is there a decreasing trend in capacity utilisation in the US economy? Some new evidence*

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Abstract

Recent contributions have mentioned the possibility of a decreasing trend in capacity utilisation in the US since the 70's. However, no consensus has emerged on the empirical evidence. Comparing the rate of capacity utilisation of the Federal Reserve Board [FRB] with the Full Utilisation Rate [FUR] and the National Emergency Rate [NER] of the Census Bureau, new empirical evidence is shown confirming that there exists such a decreasing trend in capacity utilisation in the US economy, at least since 1989.

JEL classification: D24, E22.

Keywords: Capacity utilisation, growth.

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1. Introduction

Many authors have mentioned the possibility of a decreasing trend in capacity utilisation's level since the 70's for the US economy. The discussion might be divided into two different spheres: First, the empirical one - whether there is (or not) a decreasing trend in capacity utilisation and its alternative measures - and, second, the causes, in case it exists, of the latter trend. We will try to put some light only on the first one. The aim of this paper is to identify if there exists such a decreasing trend in capacity utilisation for the US economy.

On the one hand, Skott & Zipperer (2012), Duménil & Lévy (2012, 2014), Kiefer & Rada (2015), Blecker (2016), Setterfield (2018), Pierce & Wisniewksi (2018), Fiebiger (2018), Nersisyan & Wray (2019) and Setterfield & Avritzer (2019) agree that there is a decreasing trend in capacity utilisation in the US: They all rely for this on Federal Reserve Board (FRB, hereafter) estimates. On the other hand, Shaikh (1987, 1989, 1992, 1999, 2016) and Nikiforos (2016, 2018) disagree with this based on a measurement error argument, it means that the FRB estimates do not capture correctly the true value of capacity utilisation. First, we will analyse empirically the FRB time series and its critiques. After that, we will analyse different estimates of capacity utilisation for the US in order to response to our inquiry. Some conclusions will close.

2. Federal Reserve Board measures of capacity utilisation and its critiques

2.1. Federal Reserve Board measures of capacity utilisation

If we take as valid the FRB[1] measurement of capacity utilisation, we might find a decreasing trend[2] as can be seen in Figure 1. The FRB measure of capacity utilisation is built in a very particular way and this is why some authors become skeptical of this estimate.

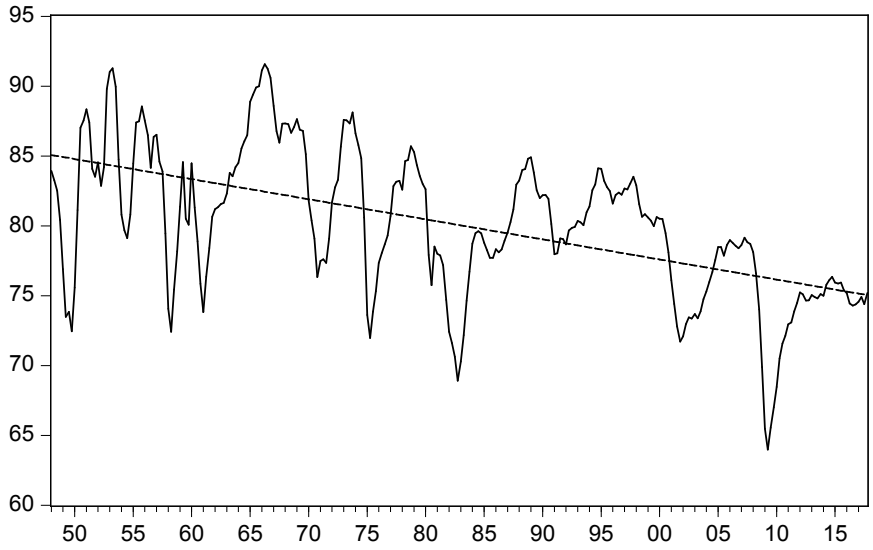
According to the Board of Governors of the Federal Reserve System[3]. (Gilbert et al., 2000 and private communication), initially a survey of firms by McGraw-Hill, which started in

[1]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

[2]In Appendix A.1. some econometric tests are presented to prove this claim.

[3]Source:https://www.federalreserve.gov/Releases/g17/Meth/MethCap.htm and https://www.federalreserve.gov/pubs/Bulletin/2000/0300secnd.pdf

Fig. 1. Federal Reserve Board Utilisation Rate (1948Q1 – 2017Q4)



Note: Utilisation rate (solid line) - Trend (dashed line).

the mid-1950s, was the primary determinant of the level of utilisation in manufacturing. The US Census Bureau survey - analysed later - was started in the mid-1970s and became the only source of utilisation 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 for 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 did 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 utilisation - 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.

2.2. Recent main critiques to FRB's measure

2.2.1. Nikiforos' critique

Nikiforos (2016, 2018), on the Federal Reserve Board estimates, claims that are 'stationary by construction and they represent how much capacity is utilised compared with the *desired* rate of utilisation' (Nikiforos, 2016, p. 2), putting in doubt the FRB's estimates. The main argument is rest on the fact that the index is based on the Survey of Plant Capacity, conducted by the US Census Bureau, in which the Census asks to 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*'[4] (ibid., p. 10). Because of the 'ambiguous' way in which this particular question of the survey *might be* designed, the author claims that 'In that sense the FRB utilisation index is a proxy for the deviation of u^* from u_d and gives us no information about u_d itself.' (ibid., p. 11).

In a similar fashion, some authors in the past had 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 shed a mantle of doubt as to whether it is as Nikiforos claims.

2.2.2. Shaikh's critique

Professor Shaikh (2016) assures, 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 explicit definition of what is meant by "capacity", so that the respondents are free to choose between various measures of capacity' (2016, p. 823).

Problems related to surveys have been greatly acknowledge by De Leeuw (1979). In our view, Shaikh's argument could be hardly a concern for survey's analysis: First, according to

[4] `https://www2.census.gov/programs-surveys/qpc/technical-documentation/questionnaires/watermark_form.pdf?#`

Phillips (1963, p. 284), while refering to McGraw-Hill surveys[5], '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' and, second, once fixed the criteria to define capacity by the plant manager 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 a too strong and implausible assumption that could be done if we prefer working on surveys rather than in estimates of capital stock or past estimates of investment.

3. US Census Bureau measures of capacity utilisation

The US Census Bureau reports a variety of measures of capacity utilisation from the 'Quarterly Survey of Plant Capacity Utilisation' (QPC) previously called 'Survey of Plant Capacity' (SPC). Here we will present only two that will give us enough evidence to support our arguments.

3.1. Full Utilisation Rate and National Emergency Rate

One of the time series calculated by the Census Bureau since 1974 is the Full Utilisation Rate (FUR, hereafter) - that one that serves as a basis for the construction of FRB's measure. It is a fraction between 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[6]): For the latter, they have to assume only machinery and equipment *in place* and *ready to operate*, *normal* downtime, that 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, also the same product mix as the actual production.[7]

The fact that plant managers have to assume equipment *in place*, *ready to operate*, *normal* downtime and *realistic* work schedule might cast some doubts about the reliability of

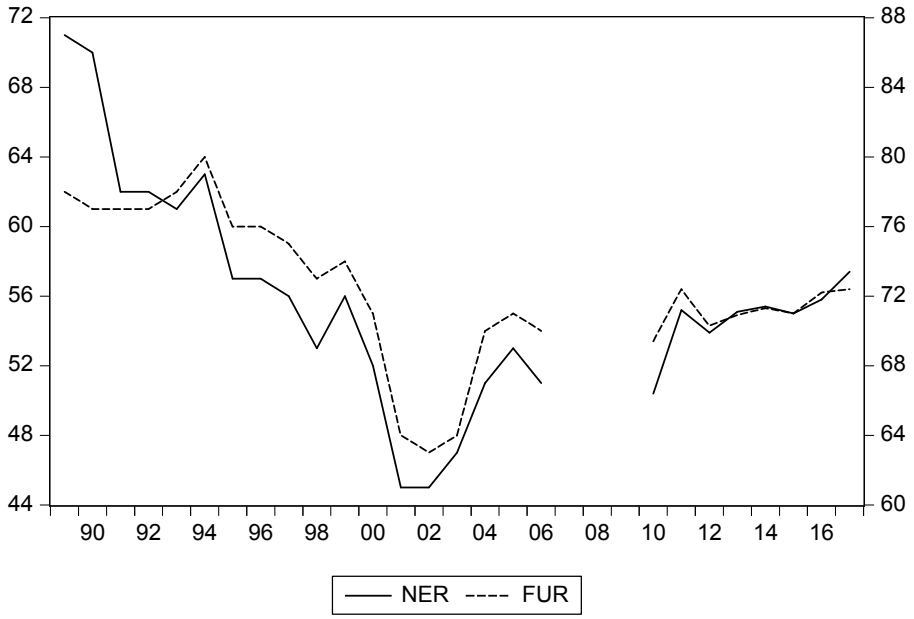
[5]We are not here claiming that McGraw-Hill and FRB measures are the same, but both share a survey-based estimation method and therefore this critique is common to both.

[6]`https://www2.census.gov/programs-surveys/qpc/technical-documentation/questionnaires/watermark_form.pdf?#`

[7]The question of the survey has been changing through time (see Doyle, 2000; Morin & Stevens, 2004; Nikiforos, 2016; Fiebiger, 2018 on this issue.)

these estimates. However, the Census also presents another measure of utilisation, called the National Emergency Rate (NER), also 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[8]): They also have to assume *full* use of *all* their machinery and equipment, *including that requiring reconditioning*, *plant production as close to 168 hours per week as possible*, *including extra shifts*, *minimal* downtime, supposing that funding, labor, 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.

Fig. 2. Full Utilisation and National Emergency Rates (1989Q4–2017Q4)



Note: NER (left axis) - FUR (right axis). Only last quarter. 2007, 2008 and 2009 values are missing. Source: own elaboration. See Appendix A.3.

The FUR could represent an 'economic' estimate of capacity utilisation, while the NER is similar to the 'engineer' concept.[9] The NER database is publicly available at an aggregate level and for more than 500 industries from 1989Q4 to 2006Q4 - only last quarter per year -

[8] `https://www2.census.gov/programs-surveys/qpc/technical-documentation/questionnaires/watermark_form.pdf?#`

[9] On the one hand, the 'engineer' concept of capacity utilisation 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.

and for 93 industries from 2010Q1 to 2017Q4 - quarterly - not seasonally adjusted, therefore in the first step we will try to compare visually this aggregate time series with the aggregate FUR in order to see if there is any compatibility.

In Figure 2 the aggregate NER and the aggregate FUR, directly retrieved from the US Census Bureau Survey[10], are shown; hence without any adjustment performed by the Federal Reserve Board (FRB). Even taking into account the missing values for 2007, 2008 and 2009, it can be seen that the pattern of both variables is quite similar.[11] Few comments on this must be done. First, it is clear that, as we have said, the pattern is similar and what is different is the *level* of the variables: The NER is at any time lower as it might be expected, given the denominator is the maximum that can be technically produced. Second, if we consider that the NER is the closest variable to the measurement of 'engineering' utilisation capacity[12] and given FUR's behaviour through time is very similar, then it could also valid the idea that the latter could be a *proxy* of the correct 'economic' measure of capacity utilisation; at the minimum to analyse its behaviour through time if not its *level*.

The fact that the FUR estimates follows the NER estimates - as can be seen in Figure 2 - is a 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 neccesarily for 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 FUR so we have to compare also these variables. Unfortunately, the FRB time series is seasonally adjusted by default while the FUR is not; therefore, we applied X-13ARIMA-Seats seasonal adjustment for the period 2010Q1-2017Q4.[13]

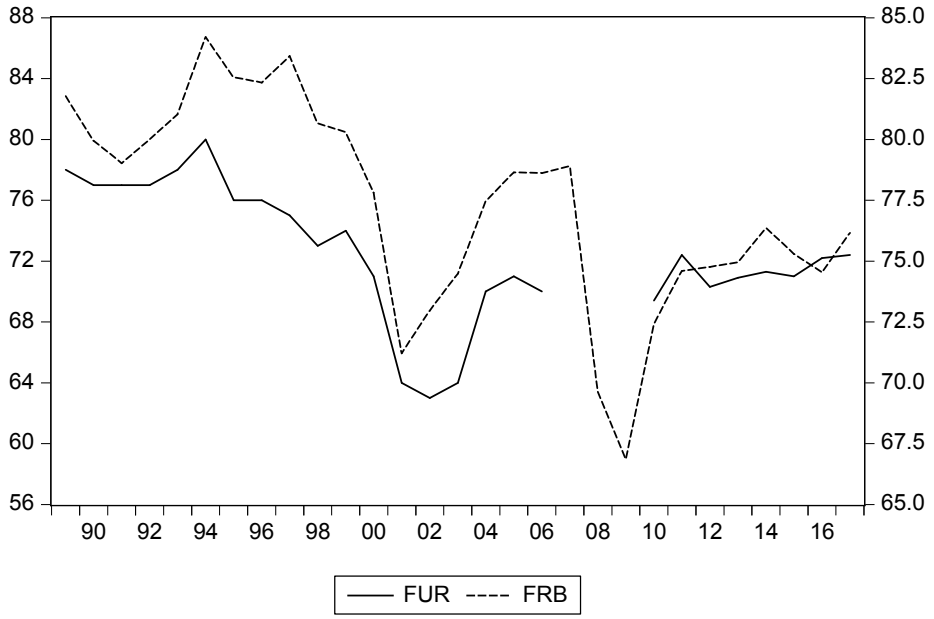
[10] `https://www.census.gov/programs-surveys/qpc/data/tables.html`

[11] In Appendix A.2. we show that we cannot reject the null hypothesis of both series being equal (different only in levels).

[12] Even better than the Average Workweek of Capital (Foss, 1963; Taubman & Gottschalk, 1971; Foss, 1981a; Foss, 1981b; Foss, 1984; Foss, 1985; Shapiro, 1986; Orr, 1989; Shapiro, 1996; Foss, 1997; Bueaulieu & Mattey, 1998; Gorodnichenko & Shapiro, 2011; Nikiforos, 2016) because NER takes at least *partially* into account the speed of operation.

[13] This adjustment is also performed by the US Census using the same methodology.

Fig. 3. Full Utilisation and Federal Reserve Board Utilisation Rates and (1989Q4-2017Q4)



Note: FUR (left axis) - FRB (right axis). Only last quarter, seasonal adjusted since 2010. 2007, 2008 and 2009 values are missing for FUR.

As we can see from Figure 3, 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[14] 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 what can be considered an even more accurate *proxy* of 'economic' capacity utilisation.

5. A summing up

Recent contributions have mentioned the possibility of a decreasing trend in capacity utilisation in the US since the 70's. However, no consensus has emerged on the empirical evidence: Some authors severely criticised FRB's measure of capacity utilisation (Nikiforos, 2016, 2018; Shaikh, 2016) on the basis of the fact they consider the estimate of capacity utilisation of the Federal Reserve Board not appropriate.

[14]Some econometric evidence is also shown in Appendix A.2.

Through this paper, we have introduced two different measures of utilisation retrieved from the US Census Bureau. One of this measures was almost 'forgotten' in the literature[15]: The National Emergency Rate of capacity utilisation. This rate is built by the Census Bureau and it is the closest to the correct measurement of 'engineering' utilisation capacity.

Although much more work must be done on measures of capacity utilisation, a simple visual and econometric analysis of the relationship between the National Emergency, the Full Utilisation and the FRB rates of capacity utilisation 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 utilisation through time for the US economy. The economic reasons behind this long-run decreasing trend will be subject to further analysis.

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[15]Only mentioned in few articles (Shapiro, 1996; Morin & Stevens, 2004; Bansak, Morin & Starr, 2007; Shapiro & Gorodnichenko, 2011) and briefly analysed in Doyle (2000) and Petri (2003, 2004). See Belzer et al. (1991, 1993) for estimations.

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Appendix A. Statistical evidence and data sources

A.1. Decreasing trend in capacity utilisation?

In this Appendix we perform two tests (Augmented Dickey-Fuller and Phillips Perron) to show that there is a decreasing trend in capacity utilisation in the FRB time series for the period 1948Q1-2017Q4. For *simplicity*, we perform tests which include a constant and a linear trend. We also *assume* that bounds are sufficiently far away so conventional unit root methods behave according to the standard asymptotic theory.[16]

Table 1: Time Series Unit Root Tests

	ADF	PP
t-Stat	-4.43***	-3.72***
Trend	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 utilisation, sooner or later, will reach an upper or lower bound. Following this reasoning, the inclusion of breakpoints, as Nikiforos (2016) has done in his article, might be an advantage over the linear-trend *assumption*.[17] But given that the article is more focus on the *reliability* of the estimates, 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 one for the period 2010Q1-2017Q4 (quarterly, seasonally adjusted).[18] First, we present a correlation matrix for all the variables in both sub-samples.

[16] If bounds were not sufficiently far away, the analysis must consider this issue (see Cavaliere & Xu, 2014).
[17] Thanks to Alejandro González who raised this issue.
[18] 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 2nd 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 arise some complications while analysing the following time series: Even taking into account that probably we will loose important information, we will differentiate the data for the first sub-sample.[19]

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***

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

[19]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.

A.2.1. Comparing NER and FUR time series

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

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

After a simple OLS regression[20], that takes the form of an ARDL model, we run a Wald test in which we test for our null hypothesis in which $\beta_1 = 0$. 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 $\beta_1 = 1$, it means that we check if these time series are equal, with a different *level* (α). Results presented in Table 4. As we can see there, 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_0	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

In this subsection, we will compare the Federal Reserve Board Utilisation Rate (FRB) and the Full Utilisation Rate (FUR) at an aggregate level for the period 1989Q4-2006Q4[21] and for 2010Q1-2017Q4 (quarterly, s.a.). Following the same methodology explained in Appendix A.2.1, results are presented in Table 5.

[20]Given 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

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

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

[21]FUR: only last quarter, not s.a.; FRB: only last quarter, s.a.

Table 5: Wald Test - FRB and FUR comparison

Period	H_0	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 Utilisation Rate (FRB) of capacity utilisation at an aggregate level for the period 1989Q4-2006Q4[22] and for 2010Q1-2017Q4 (quarterly, s.a.). Following the same methodology explained in Appendix 2.1., results 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_0	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.

A.3. Data Sources

- FRB Capacity Utilization 1948 - 2017. Board of Governors of the Federal Reserve System (US), Capacity Utilization: Manufacturing [CAPUTLB00004SQ], quarterly, season-

[22]NER: only last quarter, not s.a.; FRB: only last quarter, s.a.

ally 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 Buurvey of Plant Capacity Utilization (QPC), https://www.census.gov/programs-surveys/qpc/data/tables.html.