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Alternative Measures of Rate of Capacity Utilization for the Turkish Economy: A Comparative Analysis in Means of Adequacy for Empirical Investigation and Growth Models

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Türkiye Ekonomisinde Kapasite Kullanım Oranlarının Alternatif Ölçüleri: Ampirik Çalışmalar ve Büyüme Modellerine Uygunluk Açısından Karşılaştırmalı Bir İnceleme

Abstract

This study aims at calculating the rate of capacity utilization for the Turkish economy with the cointegration method which is based on the relation between capital stock and the output and compare it with several other measures. The cointegration method is developed in accordance with the long run perspective of the classical/Marxian conceptualization. It also takes into account the Keynesian short-run cycles. For comparative purposes the Wharton index and the output-capital ratio measures are also calculated. These three measures as well as the available series based on the survey data are compared and contrasted to each other. The cointegration measure proves to be the most adequate measure in means of the classical/Marxian long-run as well as the Keynesian short-run theoretical considerations. Together with its technical simplicity in compilation and calculation as compared to the widely used survey based series its theoretical advantages makes it the best measure for use in empirical investigations and macroeconomic modeling.

Keywords : Capacity, Rate of Capacity Utilization, Turkish Economy, Cointegration Measure, Wharton Index, Classical Economic Theory, Post-Keynesian Economic Theory.

JEL Classification Codes : N14, E22, E32, B12, O52.

Özet

Bu çalışma Türkiye ekonomisi için kapasite kullanım oranlarının, sermaye stoku ve çıktı arasındaki ilişkiye dayalı eşbütünleşim yöntemiyle hesaplanmasını ve teorik yaklaşımlar açısından diğer ölçülerle karşılaştırılmasını amaçlamaktadır. Eşbütünleşim yöntemi klasik/Marxgil kavramsallaştırmanın uzun dönemli bakış açısıyla uyumlu olarak geliştirilmiştir. Aynı zamanda Keynesgil kısa dönemli çevrimleri hesaba katmaktadır. Çalışmada karşılaştırma amacıyla Wharton endeksi ve hâsıla-sermaye oranı ölçüsü de hesaplanmıştır. Bu üç ölçü ve mevcut anketlere dayalı seriler birbirleriyle karşılaştırılmıştır. Eşbütünleşim ölçüsü hem uzun dönemli klasik/Marxgil hem de kısa dönemli Keynesgil kuramsal yaklaşımlara en uygun davranışı sergilemektedir. Gerekli gözlenebilir verilerinin toplanması ve kapasitenin hesaplanması açısından sıklıkla kullanılan ankete dayalı serilere nazaran teknik yalınlığı ve kolaylığıyla birlikte kuramsal üstünlüğü, eşbütünleşim ölçüsünün deneysel çalışmalar ve makroekonomik modelleme için en iyi ölçü olduğunu göstermektedir.

Anahtar Sözcükler : Kapasite, Kapasite Kullanım Oranı, Türkiye Ekonomisi, Eşbütünleşim Ölçüsü, Wharton Endeksi, Klasik İktisat Kuramı, Post-Keynesgil İktisat Teorisi.

1. Introduction

From the point on, the demand is conceptualized as a macroeconomic category, the capacity utilization gains central significance for almost all lines of economic thought and investigation.[1] It is the simplest indicator of relative strength of demand vis-à-vis the market supply (Tsaliki and Tsoulfidis, 1999). In the widely accepted general setting of macroeconomic and growth modeling there are two related but somehow drifting foci. One is related to the price stability and the sensitivity of the general price level to the demand. From this perspective the capacity utilization is primarily perceived as a signal for inflationary pressures and this in turn constitutes the fundamental reason why the central banks and other regulatory financial institutions such as IMF collect, design and publish data on the rate of capacity utilization. [2] The other focus is rather older and belongs to the Keynesian and developmentalist understanding of the capitalist economies. The price mechanism, in this emphasis, is secondary if not altogether absent. Capacity utilization is simply the strength of aggregate demand and is not necessarily reflected in the price mechanism. The distinction between the two is of course related to the distinction between the underlying remedies to the different perils of capitalist accumulation: to the demand deficiency and to the inflation. Chagny and Döpke (2001: 4-5) insightfully argue that "…the criteria to evaluate estimates of the output gap differs strongly depending on the purpose of the concrete aim of the analysis and the theoretical underpinning of the discussion." Hence, there is obviously more to it than the simple necessities of economic policy design of different phases of capitalist development. With its less emphasis on prices the letter perception is more adaptable from the perspective of classical and Marxian long-run approaches. One good example of this adaption is Weisskopf's decomposition of the rate of profit (Weisskopf, 1979). The rate of capacity utilization is taken as one of many determinants and designated as the market related component.

Still, there is tension between the Keynesian and classical/Marxian conceptualizations. Lavoi et al. (2004) empirically investigates the distinction between the Post-Keynesian and the Marxian approaches. Their focus lies on the distinction between the short, medium and long run analysis and investment behavior. Shaikh (2007 and 2009) proposes a model, synthesis of Keynesian and Classical type theories of growth, which vividly reveals the distinction between the two. He retains to the classical profit driven accumulation, which necessitates the gravitational behavior of rate of capacity utilization

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[1] *Maybe except for the Austrian tradition, the central focus of which is deliberately placed in the insistent refusal of macroeconomic inquiry and dogmatic reliance on the microeconomic boundaries.*

[2] *The fitted production function method is usually used in line with this emphasis. Also see Dergiades and Tsoulfidis (2007) for an alternative method of estimating rate of capacity utilization with special reference to the inflation, which is based on structural vector autoregressive system of equations.*

around its normal level without resorting only to the savings-driven accumulation (as the Harrodian type models do).[3] In line with the classical/Marxian theoretical underpinnings and revealed contrast with the Keynesian conceptualization, Shaikh and Moudud (2004) proposes a shortcut method of measuring capacity utilization based on the cointegrated behavior of the capital stock and the output.

This study aims at calculating the capacity utilization rates of the Turkish industries in line with the proposed method. However, for the purpose of comparing and contrasting, the rate of capacity utilization for the whole economy from 1924 to 2008 is calculated in line with the widely used Wharton (or trend-through-peaks) method. Also the output-capital ratio measure, a simpler version of the cointegration measure, as well as the Wharton index is calculated for the manufacturing industries for the years from 1968 to 2008. Also the official figures based on survey data, which are compiled and published by the Turkish Statistical Institute and the Central Bank of Republic of Turkey (CBRT) is used for comparison.

The next section briefly presents and discusses the different measurement methods. The following section presents the results of calculations.

2. Definition and Measurement Methods

The definition of capacity utilization involves one directly observed and one definition-sensitive unobserved variable: Actual output and capacity output, respectively. The definition of capacity is somehow ambiguous. There is, first, the distinction between the economic and engineering definitions of capacity. Engineering capacity refers to the maximum possible amount of output attainable given the level of factors of production. Economic capacity, on the other hand involves, on behalf of the firm, which is supposed to maximize the profit, a desired level of output (Klein, 1960; Klein, et al., 1973, Tsaliki and Tsoulfidis, 1999; Shaikh and Moudud, 2004). This first distinction lies in the determination of the "maximum amount attainable" and certainly involves the cost minimization.

Secondly, the Keynesian approach certainly distinguishes between the optimal and the desired levels of output. In other words, the equilibrium between the demand and supply does not necessarily mean full employment in means of factors of production. This distinction in turn enforces a logical distinction between the "potential and preferred (planned) capacity" (Tsaliki and Tsoulfidis, 1999: 128) and also involves the cost

[3] *He does so by introducing the 'business retention ratio' as a variable responding to the gap between the normal and the actual capacity utilization.*

structures. The potential or optimal capacity would refer to the minimum point on the firm's average cost curve. The imperfect competition on the other hand suggests that the long run cost curve may not have a global minimum.[4] Moving away from the significantly challenged microeconomic conceptualization that identifies the desired level with the optimum level, the macroeconomic meaning of capacity rests heavily on the theory of business cycle.

There are a number of methods for the measurement of the capacity and the rate of capacity utilization: the Wharton or trend-through-peaks method, output-capital ratio method, survey method, fitted production function method and the cointegration method, which constitutes the central focus and contribution of this study. For the purpose of comparison we calculated the capacity by the Wharton, output-capital ratio methods as well. The following is a brief discussion about each method.[5]

2.1. The Wharton Method

The Wharton (or the trend-through-peaks) method defines the capacity as "the maximum sustainable level of output the industry can attain within a very short time if the demand for its product were not a constraining factor, when the industry is operating its existing stock of capital at its customary level of intensity" (Klein and Summers, 1966). The years where the output (or the production index) peaks are determined (through mere observation or through filtering the output series) and taken as the years when the industry operates at the full capacity. The linear interpolation between the peak years yields the constructed series of capacity. Comparison between the observed actual level of output and the capacity gives a measure for the rate of capacity utilization for the non-peak years. The first part of our calculations is based on this method. This method is primarily criticized for not being able to distinguish and take into account the medium and long term business cycles as well as for depending on the assumption of symmetry between each cycle (Chagny and Döpke: 2001). The Wharton method "accept[s] the widely held (neoclassical)

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[4] *A more definite critique by Piero Sraffa concludes with a straightforward choice in favor of classical linear cost curve instead of perfectly competitive short-run equilibrium which is incompatible with the constant returns to scale in the long run (Sraffa (1926)). See also Varian (1992) for an apologetic discussion.*

[5] *The other widely used measure is based on the fitted production functions. See Brendt and Morrison (1981) and Morrison (1988) for an early empirical refinement and application of this method. See Gökçekuş (1998) for an application of the generalized Leontief functional form proposed by Morrison (1988) for the Turkish rubber industry. As Shaikh and Moudud (2004: 5) argue that this method relies on "theoretical faith not only in the much criticized notion of an aggregate demand...but also in the existence of a natural rate of employment," we do not calculate this type of measure for the Turkish economy. And having no readily available calculation for comparison we leave this method out of this study.*

assumption that, except for downturns associated with the short (3-5 yr.) cycle, the capitalist economies generally operate at normal capacity" (Shaikh and Moudud, 2004: 4).

2.2. Output-Capital Ratio Method

The long run analysis of the capitalist economies reveals that there is a long run, stable and slightly declining trend of "capital productivity" whereas the labor productivity exhibits an increasing trend (Maddison, 1991: 68-72, 150 and 274; Foley and Michl, 1999:39 and Taylor, 2004: 55). This stable proportional relation between the capital stock and the output constitutes the basis for this approach. The linear trend obtained from the observed output capital ratio is scaled to intersect the observed series at its maximum level. This linear trend is taken as the capacity-capital ratio. By simply multiplying by the observed capital stock the capacity is found (Tsaliki and Tsoulfidis, 1993). Unlike the Wharton method, this method relies on the potential capacity. The advantage of this method is that it does not ignore the existence of longer cycles.

2.3. The Cointegration Method

Similar to the output-capital ratio method, the cointegration method suggested by Shaikh and Moudud (2004) is based on the historical behavior of the output-capital ratio. However, unlike the former the latter rests on a significantly more complex and realistic relation between the capital stock and the output and implicitly takes into account not only the cycles of different duration but also the external shocks such as natural disasters, wars, etc… that would destroy some of the capacity of the economy (Shaikh and Moudud, 2004). The embodied as well as disembodied (autonomous) technological change is addressed in this method. It is built on a model consisting of one identity and two behavioral stochastic equations:

$$Y \equiv \frac{Y}{Y^*} \cdot \frac{Y^*}{K} \cdot K \tag{1}$$

$$\ln Y_t = \ln K_t - \ln v_t + \ln u_t \tag{2}$$

The first equation is an identity defining the output (Y) as the product of rate of capacity utilization ($u = \frac{Y}{Y^*}$), capacity-capital ratio ($\rho^* = \frac{Y^*}{K}$) and the capital stock (K). Taking the natural logarithm of this identity produces equation (2), where

$v_t (= \frac{1}{\rho^*} = \frac{K}{Y^*})$ denotes the capital-capacity ratio.

The first behavioral equation presents the rate of capacity utilization in the long run, randomly walking (E(e_u)=0) around the normal capacity (here assumed as u_n=1):[6]

$$\ln u_t = e_{ut} \tag{3}$$

The last behavioral equation depicts the capacity-capital ratio with its growth through autonomous and the embodied technological change. It suggests that there is a linear relation between the growth rate of capital stock (g_K) and the growth rate of capacity-capital ratio (g_ρ) such as $g_\rho = \beta_0 + \beta_1 g_K$, where β_0 refers to the autonomous and β_1 to the embodied technical change. This is presented in a stochastic equation:

$$\ln v_t = \beta_0 + \beta_1 t + \beta_2 \ln K_t + e_{vt} \tag{4}$$

The equations 2, 3 and 4 constitute the model. Combining them into one equation produces the following relationship containing only the observable variables and defining a cointegration relation between ln*Y* and ln*K*:

$$\ln Y_t = \alpha_0 + \alpha_1 t + \alpha_2 \ln K_t + e_t \tag{5}$$

As can be seen, the estimated parameters of equation 5 are related to the parameters of equation 2 and there is also a relation between the disturbance terms of the three equations:

$$\begin{aligned} \alpha_0 &= -\beta_0 \\ \alpha_1 &= -\beta_1 \\ \alpha_2 &= 1 - \beta_2 \\ e_t &= e_{ut} - e_{vt} \end{aligned} \tag{6}$$

6 *The measure can be scaled according to an average normal capacity. Shaikh and Moudud (2004) suggest the average value of census-based measure as the scale for the US manufacturing.*

Equation 2 tells that in the long run the rate of capacity utilization is one and $\ln u_t = 0$. Plugging this long run value and equation 4 into equation 2 yields:

$$\ln Y_t^* = \alpha_0 + \alpha_1 t + \alpha_2 \ln K_t - e_t \tag{7}$$

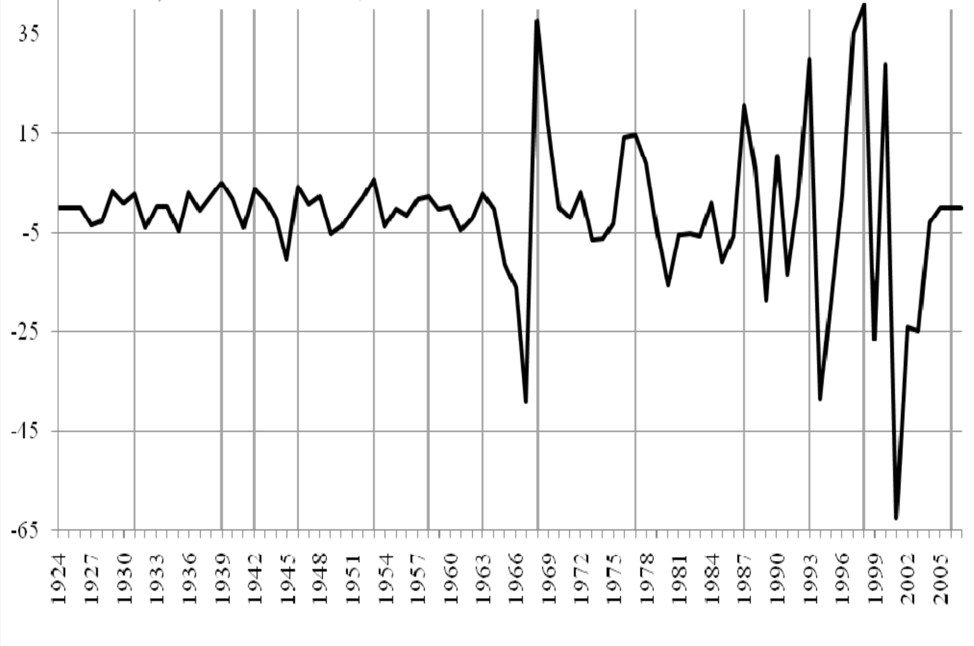
As all the variables, parameters and disturbances on the right hand side of the equation is known, form here we can calculate the capacity. Then it is trivial to find the rate of capacity utilization given the actual level of output.

3. Results

3.1. Wharton Index: Total Output, 1924-2006

The Wharton Index, as argued above is based on determining the peak years of output. This can be done by mere observation or certain knowledge of the economy, i.e. additional information on the observed cycles. In this study, we used filtering techniques only in order to determine the peak years. However, these filtering techniques are themselves are used to estimate the potential output (See Chagny and Döpke (2001) for an assessment of different filtering techniques). We only used them to produce the "additional information on the observed cycles".

Figure 1. Detrended (Baxter-King filtered) Series of Output (total output, ×100000) and the Peak Years, 1924-2006.



Output data is taken from the “total output data” column of the Gross National Product by Kind of Economic Activity tables provided by the State Institute of Statistics (SIS / DİE, 2001) for the years from 1924 to 1998. For the years from 1999 to 2006, the same tables provided for the years between 1968 and 2006 in the State Planning Organization’s (SPO) online Economic and Social Indicators Data Package.[7] The

[7] *The data is presented in Excel sheet files in the Economic and Social Indicators Data Package: http://www.dpt.gov.tr/PortalDesign/PortalControls/WebIcerikGosterim.aspx?Enc=83D5A6FF03C7B4FCA4781AFB16189036083F239D24768693A2F910AC764FA886 (as of June 2011). The latest version has the date title 1950-2010. The source of the data is given as the Turkish Statistics Institute’s (TÜİK, previously SIS) TurkSTAT database. However, the new series from 1998 to 2010 does not match the previously published data in Economic and Social Indicators 1950-2006 for the overlapping years. It is the same in the TSI’s National Accounts database. The differences between the new and the old GDP series is summarized in the TSI (2008) document, “Gayrı Safi Yurtiçi Hasıla Güncelleme Çalışmaları 1987 ve 1998 Bazlı GSYİH Serileri Arasındaki Farklar.” The differences are so ambiguous and fundamental that we did not use the new series for furthering the analysis to 2010.*

combined series are filtered by Hodrick-Prescott and Baxter-King Filters for determining the peak years.[8]

Figure 1 shows the detrended series and the peak years. It is striking to see increasing volatility of business cycles by the beginning of significant industrialization efforts in 1960s. The volatility seems to visibly increase by the introduction of massive industrialization. After a period of relatively damped oscillations, the volatility surges drastically starting with late 1980s / early 1990s. The peak years are 1931, 1939, 1942, 1946, 1953, 1958, 1963, 1968, 1977, 1987, 1993, 1998 and 2006. The peak years, as can be seen, refers to 5 to 10 years cycles. A more detailed analysis would adhere to 3 to 5 years cycles. However, since the Wharton analysis conducted here is for comparative purposes, taking 5 to 10 years cycles for an 83 year long period would not disturb the results. Furthermore, the problem of "weak peaks" of shorter cycles would be, to a great extent, eliminated through leaving some of the minor peaks out of consideration (Taylor, et al. 1970).[9]

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[8] *For the Hodrick-Prescott filter the parameter for penalizing the fluctuations in the second differences is chosen as 6,25 as suggested by Ravn and Uhlig (2002). The Baxter-King filter is both a high and a low pass filter (bandpass filter). For the Baxter-King filter the minimum and maximum periodicity is set to 2 and 8 years respectively and the lead lag length as 3 years (which means first and the last three years are not included in the detrended series), as suggested by Baxter and King (1995). The results are almost perfectly compatible.*

[9] *Still, for two non-peak years (1976 and 1997) the Wharton Index is larger than 1. Such problems are generally overcome through using the net physical investment data in order to connect the peaks with a non-linear instead of a simple linear interpolation (Klein, et al. 1973). However, we let the index exceed 1 for some years for the sake of simplicity of the analysis. The aim of this study is not producing a perfect Wharton index but to produce one to compare with the results of the cointegration method which is in line with the classical theory.*

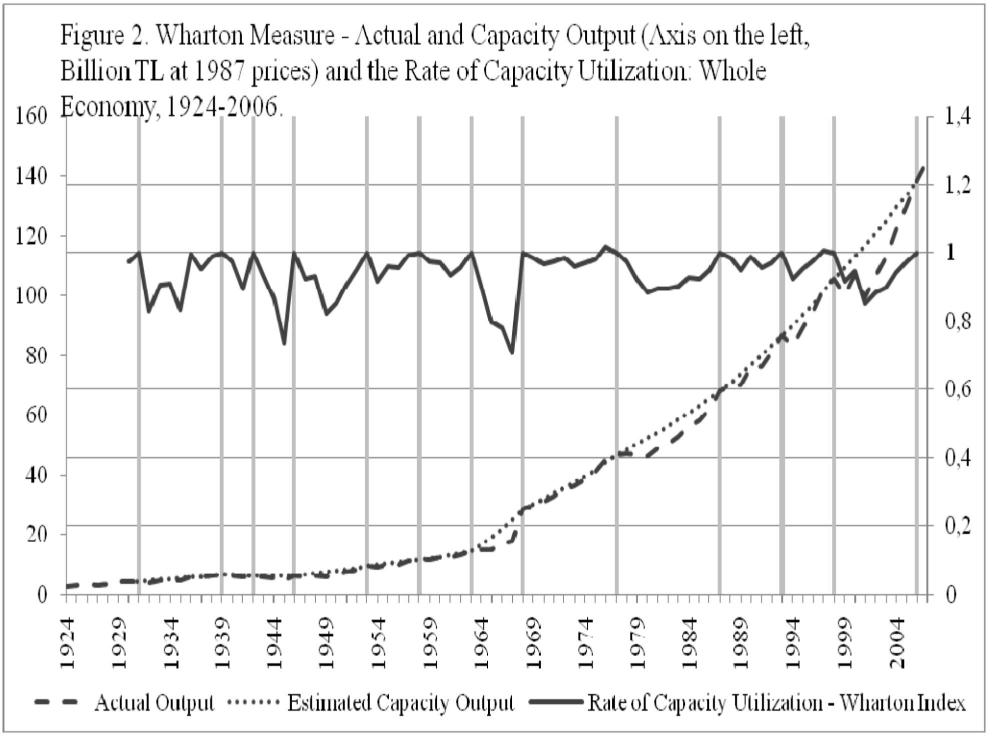
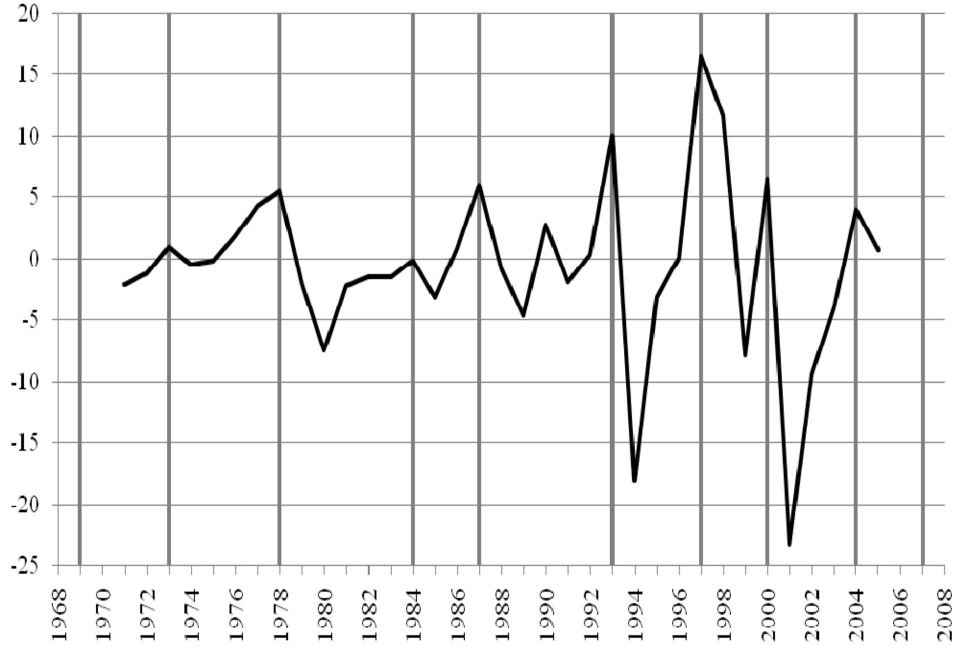


Figure 2 summarizes the results of the calculations and Table A.1. in appendix provides the estimated figures. Since the method is based on predetermined peak years a brief discussion on the low levels may be more meaningful. The lowest level of capacity utilization is attained in 1967 with a rate of 70,6 %. The other years with the lowest utilization rates are 1932, 1935, 1945, 1980 and 2001. The years 1930 and 1935 obviously refers to the world economic depression. Even the low level of capital stock supply as compared to the demand to even the most fundamental commodities seem not to be enough to keep the economy close to capacity. 1945 refers to the retransforming the economy from war mobilization efforts back to the normal production. 1967 may refer to rapid capital stock buildup throughout the early years of the planning period, which may not be immediately met by sufficient demand (and hence probably not due to a decline in effective demand). Another explanation may be the existence of idle capacity due to not yet operational physical capital buildup, which can be observed by sudden increase in output in the year 1969. The year 1980 is the peak of the foreign exchange shortage crisis of the late 1970s compounded with the oil price shock. Hence it is not surprising at all to have a trough in that year. The following gradual recovery is usually attributed both to broken resistance of the working class and the foreign exchange ease through trade liberalization and devaluation up until 1988. The rate declines also in 1994, but not as drastically as it does in 2001, the year of financial crisis.

3.2. Wharton Index: Manufacturing Industry, 1968-2008

Figure 3. Detrended (Baxter-King filtered) Series of Output (manufacturing, ×100000) and the Peak Years, 1968-2008.



The same procedures, described in the previous section are applied to the output of the manufacturing industry. The years before 1968 are not taken into account (from SIS (2001)) in order to conduct a more compact analysis. The series are extrapolated from 2006 to 2008 by making use of the growth rates of output provided in the latest new series of GDP (TSI).[10] Figure 3 shows the detrended series and the peak years for the manufacturing industry. The first thing to observe is the increased volatility starting in

[10] *The only reason for this extension is to be able to make comparisons with cointegration method results which cover the years from 1972 to 2008.*

early 1990s The peak years are 1969, 1973, 1978, 1984, 1987, 1993, 1997, 2000, 2004 and 2007.[11]

Figure 4 shows the results for the manufacturing sector and Table A.2. provides the estimated series. There are four apparent troughs: 1970, 1980, 1994 and 2001, recognized years of economic crisis. Throughout the relatively stable and damped oscillation between 1980 and 1994, the year 1989 shows the lowest level of capacity utilization. The year 1988 is often mentioned as the point of exhaustion of early export-led boom of the post 1980 era and the results are in line with this argument. After 1993, the manufacturing sector seems to enter a relatively turbulent phase where the oscillations in the rate of capacity utilization become more apparent.

[11] *Again, both the Hodrick-Prescott and the Baxter-King filters are used to determine the peak years with the same defined parameters of periodicity, etc… (See footnote 6). Due to the lead-lag length of three, the peaks for the first and last three years are picked according to the Hodrick-Prescott filter (1969 and 2007). Both filters almost perfectly fit onto each other and point out exactly the same peaks for the common years.*

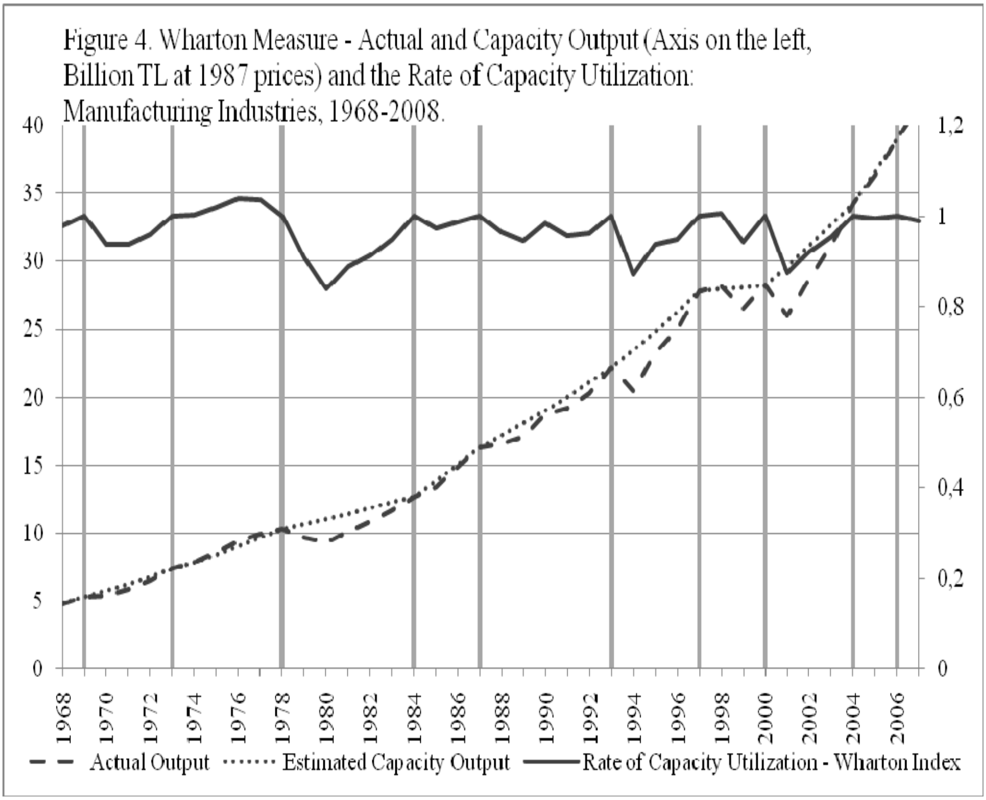


Figure 4. Wharton Measure - Actual and Capacity Output (Axis on the left, Billion TL at 1987 prices) and the Rate of Capacity Utilization: Manufacturing Industries, 1968-2008.

Now we turn to the results of the cointegration method.

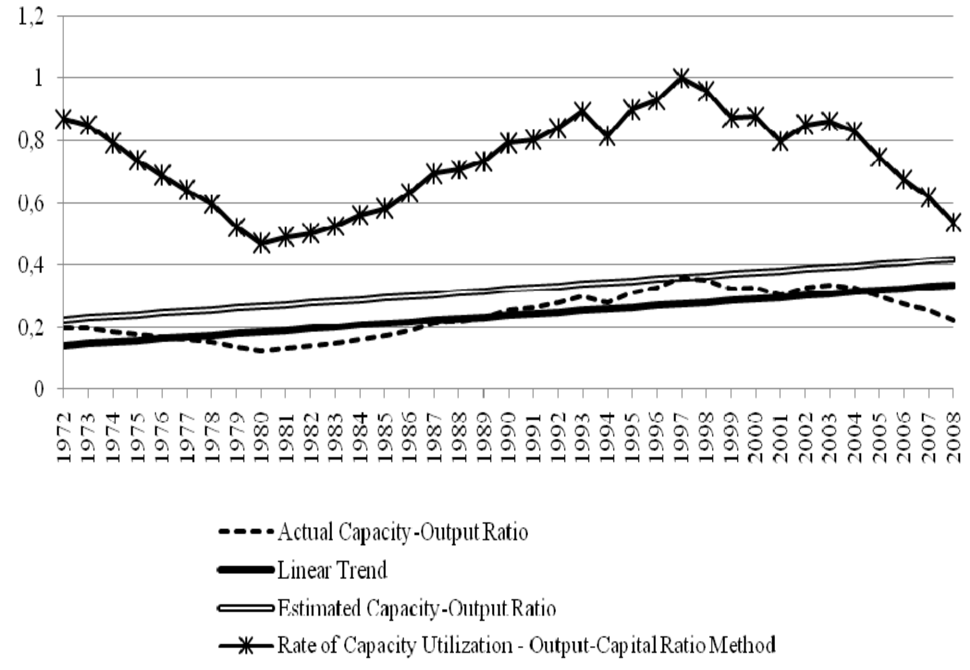
3.3. Output-Capital Ratio Method: Manufacturing Industries, 1972-2008

Output-capital ratio method makes use of the linear trend of the actual output-capital ratio ($Y/K = 1/\rho$). The capital stock data is taken from Ünlü (2010), which provides an extended series of Cihan, et al. (2005). The series is for the main sectors of the economy and covers the years from 1972 to 2008. Its calculation is based on the perpetual inventory method. There is no other reliable series available for the Turkish economy. The output-capital ratio method requires the capital stock data. Hence, the scope of the analysis is strictly limited to the years for which this data is available. The output series is again from the SPO's online Economic and Social Indicators Data Package.[12] The OLS results are as follows (figures in parenthesis are the standard errors):

$$\frac{1}{\rho} = \underset{(0,01463)}{0,143215} + \underset{(0,00069)}{0,0053t}$$

Adjusted $R^2 = 0,6141$

Figure 5. Rate of Capacity Utilization – Output-Capital Ratio Method. Manufacturing Industry 1972- 2008.



Scaling up this trend line so that it touches only the maximum level of output-capital ratio (adding the highest level of difference between the trend and the actual levels

[12] *See footnote 5.*

to the intercept[13]) gives the capacity-output level. Figure 5 presents the actual output-capital ratio, its linear trend and the scaled version of the trend line as well as the rate of capacity utilization calculated by making use of this capacity-capital ratio level. Table A.2. in the appendix provides the estimated figures of rate of capacity utilization.

3.4. Cointagration Measure of Capacity: Manufacturing Industries, 1972-2008

As discussed above cointegration measure is based on the stable long run relation between the capital stock and the output. The capital stock and the output series are the same for the output-capital ratio method.

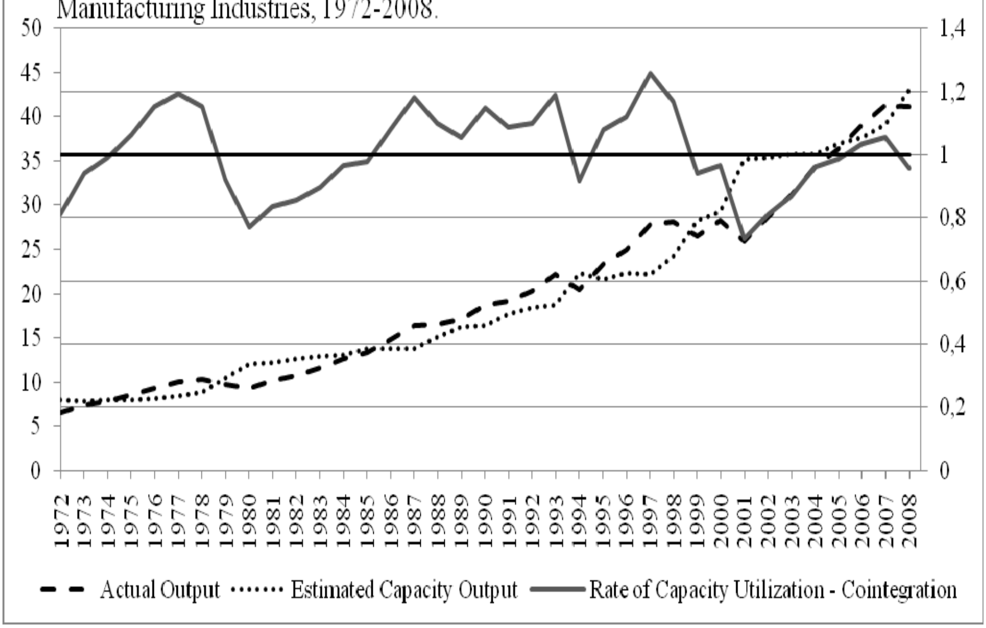


Figure 6. Cointegration Measure - Actual and Capacity Output (Axis on the left, Billion TL at 1987 prices) and the Rate of Capacity Utilization: Manufacturing Industries, 1972-2008.

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[13] $\max\left\{\frac{1}{\rho}-\widehat{\left(\frac{1}{\rho}\right)};t=1972,...,2008\right\}=0,082596$.

The method relies on the estimated parameters and the disturbance term of equation 5. This equation indicates that the logarithms of *Y* and *K* are cointegrated. Therefore, it is necessary to check if both series are integrated in the same order for avoiding the possibility of spurious regression. For the manufacturing industry, the ln*Y* series are integrated in the first order (I(1)) at 1% significance level.[14] The first difference of ln*K* series are, on the other hand, stationary (I(1)) at 5% significance level with no constant and two lags.[15] However, for the mining industry and the electricity, gas and water industries the order of integration does not match. Hence, we leave these industries out and limit the analysis to manufacturing industry. The Durbin-Watson test for the regression in equation 5 suggests that the disturbance term is autocorrelated for the manufacturing industry.[16] The estimated coefficient of the regression of the first difference of the disturbance terms on the one lagged disturbances of equation 5 is statistically significant at 1% level, which signifies that ln*Y* and ln*K* are cointegrated.[17] The figure 6 shows the actual and capacity output and the rate of capacity utilization for the manufacturing industry, calculated accordingly with the cointegration method. Table A.2. in the appendix gives the estimated series of rate of capacity utilization. The following section presents a brief comparison of the three measures of rate of capacity utilization as well as the survey data on the rate provided by the TSI.

3.5. A Comparative Look: Manufacturing Industry

Figure 7 shows three different measures of rate of capacity utilization discussed above and the survey data. The appendix of the article also provides the series of different measures.

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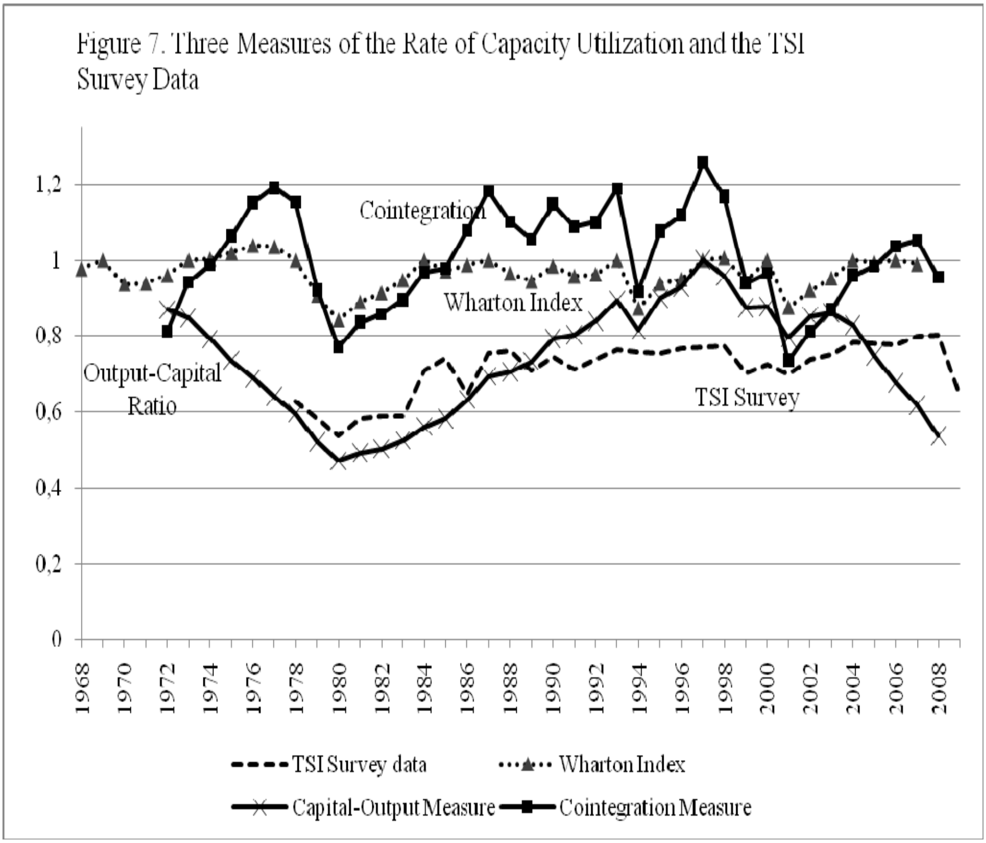
[14] *The test statistics is -5,974 and the critical value for the 1% significance level is -3,682.*

[15] *The test statistics is -1,991 and the critical value for the 5% significance level is -1,95.*

[16] *d(3, 37) = 0,6927426. The lower and upper bounds for the test is 1,112 and 1,446 respectively at 1% significance level.*

[17] *For the manufacturing industry the constant is 0,002499 and the coefficient is -0,3797737 with a t-statistics of -2,99. The Johansen Maximum Likelihood test also confirms this result: The null hypothesis that the (cointegration) rank is one cannot be rejected with the trace statistics value of 1,2023 and the critical value of 3,76 at 5% significance level.*



It can be seen that there are apparent differences in the levels among these measures. The Wharton index and the cointegration measure seem to have the closest levels as contrasted to the others. The cointegration measure is gravitating around the rate of capacity utilization level of 1 (100%), which is imposed into the model by the equation 3 and the Wharton index exhibits the upper bound of 1, a condition which is similarly imposed by this method's assumptions.[18] The former's behavior is in line with the classical/Marxian conceptualization of the long run behavior of the capitalist economies. The cointegration measure and the Wharton Index move on a very similar path. However, the cointegration measure exhibits significantly higher volatility with stronger rise and falls. This feature is in line with Post-Keynesian and classical/Marxian analysis which emphasize the turbulence and inherent instability of capitalist economies. The output-capital ratio measure follows a different path as compared to the others. It presents longer

[18] *See footnote 7.*

cycles. During the whole period we can observe a downfall of 8 years followed by a nearly complete cycle of 20 years (1980-2008).

Table: 1 gives the summary statistics of different measures. The differences in means reflect the level differences. The coefficient of variation shows the overall volatility of the series. The output-capital ratio measure has the highest volatility, followed by the cointegration measure. The Wharton index shows the lowest volatility.

Table: 1
Summary Statistics for Different Measures of Rate of Capacity Utilization

	Mean	Standard Deviation	Coefficient of Variation	ADF
Survey Data	0,7124	0,0728034	0,102195	-2,755[a]
Wharton Index	0,9573	0,0455107	0,047541	-3,694[b]
O-C Ratio Measure	0,7358	0,1544475	0,209904	-2,733[c]
Coint. Measure	1,0071	0,1339969	0,133052	-2,661[d]

[a] 10% significance level with 3 lags.
[b] 1% significance level.
[c] 10% significance level with 7 lags.
[d] 10% significance level.

Table: 2 provides the correlation coefficients on the lower part of the diagonal (lower triangular) and the concordance correlation coefficients on the upper part of the diagonal (upper triangular). Both produce almost exactly the same results. The latter is based on the measurement of 'reproducibility' (Lin, 1989).

Table: 2
Correlations and Concordance Statistics for Different Measures of Rate of Capacity Utilization

	Survey Data	Wharton Index	C-O Ratio Measure	Coint. Measure
Survey Data	1,0	0,570	0,720	0,498
Wharton Index	0,5699	1,0	0,305	0,734
O-C Ratio Measure	0,7204	0,3054	1,0	0,418
Coint. Measure	0,4977	0,7343	0,4176	1,0

The figures show that the coefficients between the capital-output ratio measure and both the Wharton index and the cointegration measure are very low, indicating that they do not agree with each other in measuring the rate of capacity utilization. Interestingly, the highest coefficients are between the survey data and the capital-output ratio measure. The concordance coefficients higher than 0,5 tell that there is not major disagreement between the corresponding measures.

All the measures point out the year 1980 as a trough. The output-capital ratio measure shows a steady increase from 1980 onwards until the peak of 1997, with a single exception of 1994. The peak year of 1997 is also the year when the positive deviation of the series from its trend reaches its maximum level during the whole period (a little less than 8,26 points difference. See footnote 12). From 1997 onwards the steady decline follows, only to be disturbed by an increase in 2002 that can be attributed to the level effect of the severe crisis of 2000-2001. This post-crisis recovery can be observed in all of the measures. However, unlike the output-capital ratio measure, it lasts longer up until late 2000s in other measures. Interesting enough, all the measures including the TSI survey data shows a declining trend starting from 1997 before the 2000-2001 crisis. It tentatively suggests an alternative real sector explanation to the crisis as contrasted to the sudden "surprise" of financial crisis.[19] Moreover, the cointegration and the output-capital ratio measures, both relying on the relationship between the capital stock and the output, reveal a relatively more drastic decline for this period.

The only series that does not present a significant cyclical behavior is the TSI survey series. All the other measures, one way or another, points out the existence of business cycles (of different durations) and exhibits a gravitational behavior. Furthermore, the sensitivity of TSI survey series to the crisis years of 1980, 1989, 1994 and 2000-2001 is unreasonably weak and it exhibits an overall stable and slightly increasing trend (the series is stationary with only seven lags).

3.6. Cointegration Measure and the Survey Data

In economic research and macroeconomic empirical investigation regarding the Turkish economy, the most widely used measure is the survey based series. There are a number of theoretical shortcomings of such series. Firstly, the survey questions usually do not explain in detail the meaning of economic capacity. Hence the answers to the surveys do not differentiate between the engineering and the economic capacity. Obviously, the surveys also do not take into account the optimal and desired levels of capacity, as discussed above. For the Turkish manufacturing industry, the TSI used to compile the rate of capacity utilization data based on the Tendencies in Manufacturing Industry Surveys (TMI) between the years 1991 and 2009. The Central Bank (CBRT) also conducts a survey under the title monthly Business Tendency Survey (BTS) since 1987.[20] Although the

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[19] *So it reminds the insightful warning that "[a]t* first glance*, therefore the entire crisis presents itself as simply a credit and monetary crisis" (Marx, [1894]1991: 621; emphasis added).*

[20] *Detailed information can be found on the CBRT's online document: <http://www.tcmb.gov.tr/ikt-yonelim/BTS-Methodology.pdf>. The TSI and CBRT announced that the data on the rate of capacity utilization will be compiled only by CBRT, starting with January 2010 (TSI, 2010 and CBRT, 2010). The*

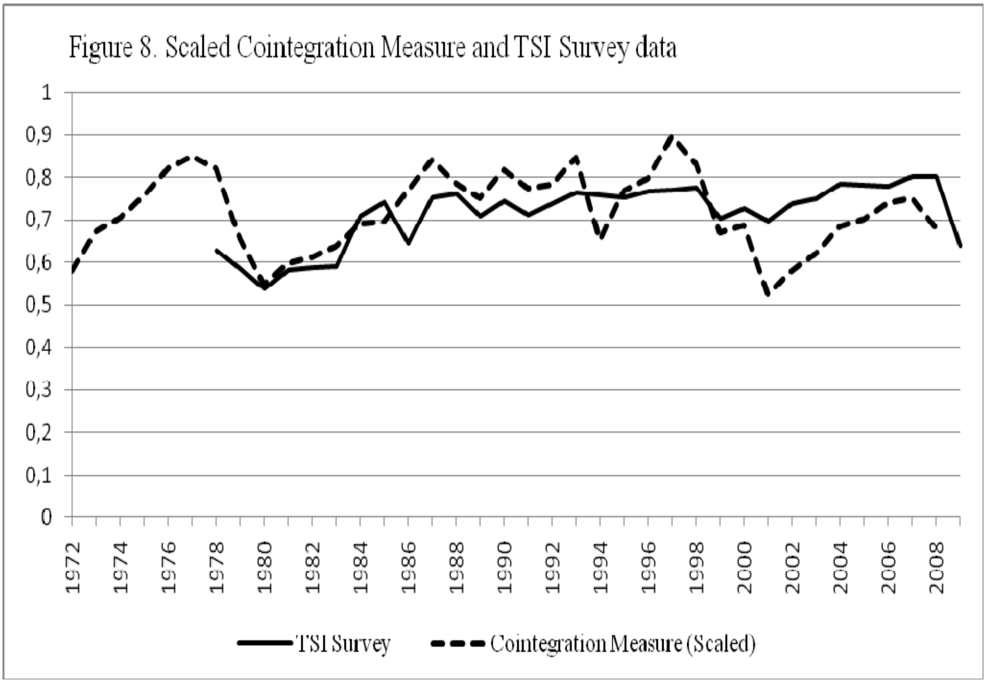
starting dates are given as 1987 and 1991, SPO's online Economic and Social Indicators 1950-2010 Data Package provides a longer series from 1978 to 2009, the source of which is reported as the TSI. For the overlapping years the CBRT and SPO's TSI based series coincide, meaning that both are based on the TSI's TMI surveys. For a longer comparative analysis we used the series provided by the SPO. Figure 8 presents the cointegration measure and the TSI survey data on the rate of capacity utilization. The cointegration measure is scaled down with the revision of the equation 3, so that the normal rate of capacity utilization is not 1 but equal to the average of the survey series:

$$\ln u_t = (-0,33822) + e_{ut} \tag{8}$$

The comparison of the two clearly shows that the cointegration measure has qualities that are more adequate for the classical/Marxian[21] conceptualization as well as the actual process of the capitalist economy: turbulent gravitation around a long run normal rate. For the analysis of business cycles the fluctuations in the capacity utilization is expected to be persistent and the "cyclical component of overall output should be stationary" (Chagny and Döpke, 2001: 4). Although the cointegration measure does not share the theoretically unreasonable overall increasing trend with the survey data, it has the same short-run fluctuations. The fluctuations in the survey data is also unrealistically damped (especially for the crisis years of 1994 and 2000-2001), whereas the cointegration measure presents higher volatility. In other words the cointegration measure adequately represents the cyclical character of the capitalist accumulation process. These suggest that the cointegration measure has superiority for use in macroeconomic modeling. Furthermore, it gets around the theoretical problems associated with the survey based series discussed above, and extremely easy to compile as compared to the survey based series.

Istanbul Chamber of Commerce also compiles survey data on the rate of capacity utilization, which can also be reached through CBRT's web site.

21 *The scaled version is also in line with the Keynesian approach since it is permanently under full capacity. However, this rule is externally imposed by substituting equation 8 for equation 3 and hence that is not an inherent property of the cointegration measure, i.e. due to the implied relationship between capital stock and output.*



Conclusion

This study calculated three different measures of rate of capacity utilization for the Turkish economy (and especially for the manufacturing industries). The central measure for the study is the cointegration measure. It has theoretical superiority over other measures in means of classical/Marxian and Keynesian empirical investigations and modeling. The calculations for the Turkish economy and comparison with other measures also supports this theoretical superiority in means of behavioral adequacy of the series for the basic tenets of long-run gravitational pace around the normal level and the short-run volatile nature.

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Appendix

Table: A1
Rate of Capacity Utilization – Wharton Measure – Total Output, 1924-2007†

1924	0,88	1952	0,95	1980	0,88
1925	0,91	1953	1,00	1981	0,89
1926	1,03	1954	0,92	1982	0,89
1927	0,84	1955	0,96	1983	0,90
1928	0,88	1956	0,96	1984	0,93
1929	1,03	1957	0,99	1985	0,92
1930	0,98	1958	1,00	1986	0,95
1931	1,00	1959	0,97	1987	1,00
1932	0,83	1960	0,97	1988	0,99
1933	0,91	1961	0,94	1989	0,95
1934	0,91	1962	0,96	1990	0,99
1935	0,83	1963	1,00	1991	0,96
1936	1,00	1964	0,90	1992	0,97
1937	0,95	1965	0,80	1993	1,00
1938	0,99	1966	0,78	1994	0,92
1939	1,00	1967	0,71	1995	0,95
1940	0,98	1968	1,00	1996	0,98
1941	0,89	1969	0,99	1997	1,01
1942	1,00	1970	0,97	1998	1,00
1943	0,93	1971	0,97	1999	0,92
1944	0,87	1972	0,98	2000	0,95
1945	0,74	1973	0,96	2001	0,85
1946	1,00	1974	0,97	2002	0,89
1947	0,92	1975	0,98	2003	0,90
1948	0,93	1976	1,02	2004	0,94
1949	0,82	1977	1,00	2005	0,98
1950	0,85	1978	0,97	2006	1,00
1951	0,91	1979	0,92	2007	1,01

† for the years 1924-1930 and 2007 the series is simply extrapolated backwards and forwards by making use of the following and the preceding annual compound rates of growth respectively. The other years are calculated as peak-to-peak annual compound growth rate.

Table: A.2.
Mesures of Rate of Capacity Utilization and the Survey Data, Manufacturing Sector

Year	Wharton Measure	Capital-Output Ratio Measure	Cointegration Measure	Cointegration Measure (Scaled)	TSI Survey Data
1968	0,98	.	.	.	.
1969	1,00	.	.	.	.
1970	0,94	.	.	.	.
1971	0,94	.	.	.	.
1972	0,96	0,87	0,81	0,58	.
1973	1,00	0,85	0,94	0,67	.
1974	1,00	0,79	0,99	0,70	.
1975	1,02	0,74	1,06	0,76	.
1976	1,04	0,69	1,15	0,82	.
1977	1,04	0,64	1,19	0,85	.
1978	1,00	0,60	1,15	0,82	0,63
1979	0,91	0,52	0,92	0,66	0,58
1980	0,84	0,47	0,77	0,55	0,54
1981	0,89	0,49	0,84	0,60	0,58
1982	0,91	0,50	0,86	0,61	0,59
1983	0,95	0,53	0,90	0,64	0,59
1984	1,00	0,56	0,97	0,69	0,71
1985	0,97	0,58	0,98	0,70	0,74
1986	0,99	0,63	1,08	0,77	0,65
1987	1,00	0,69	1,18	0,84	0,75
1988	0,97	0,71	1,10	0,78	0,76
1989	0,94	0,73	1,06	0,75	0,71
1990	0,98	0,79	1,15	0,82	0,74
1991	0,96	0,80	1,09	0,78	0,71
1992	0,96	0,84	1,10	0,78	0,74
1993	1,00	0,89	1,19	0,85	0,77
1994	0,87	0,81	0,92	0,65	0,76
1995	0,94	0,90	1,08	0,77	0,75
1996	0,95	0,93	1,12	0,80	0,77
1997	1,00	1,00	1,26	0,90	0,77
1998	1,01	0,96	1,17	0,83	0,78
1999	0,94	0,87	0,94	0,67	0,70
2000	1,00	0,88	0,97	0,69	0,73
2001	0,88	0,80	0,74	0,53	0,70
2002	0,92	0,85	0,81	0,58	0,74
2003	0,95	0,86	0,87	0,62	0,75
2004	1,00	0,83	0,96	0,68	0,78
2005	0,99	0,75	0,98	0,70	0,78
2006	1,00	0,68	1,04	0,74	0,78
2007	0,99	0,62	1,05	0,75	0,80
2008	.	0,54	0,96	0,68	0,80
2009	.	.	.	.	0,64