Üçüncü Sektör Sosyal Ekonomi Dergisi
Third Sector Social Economic Review
55(2) 2020 772-783
doi: 10.15659/3.sektor-sosyal-ekonomi.20.04.1308

Research Article

Intuitive and Reliable Estimates of Output Gap and Real Exchange Rate Cycles for Turkey

Türkiye Ekonomisi Için Mantikli ve Güvenilir Çikti Açiği ve Reel Döviz Kuru Çevrimleri Tahminleri

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Makale Gönderme Tarihi	Revizyon Tarihi	Kabul Tarihi
04.02.2020	19.03.2020	15.04.2020

Abstract

Extracting cyclical components from time series data is among the priorities for policy maker institutions. Comparing with the unrestricted Beveridge-Nelson decomposition and Hodrick-Prescott filter, we implement a restricted Beveridge-Nelson filter developed by Kamber et. al. (2018) which limits the volatility of trend component. Utilizing the quarterly real GDP series, we find that restricted Beveridge-Nelson filter provides more persistent and larger cyclical values than Beveridge-Nelson decomposition. Taking the output gap estimates of Central Bank of Turkey as a benchmark, our results indicate that Beveridge-Nelson filter yields more sensible results. We also develop a measure to make an assessment on the end-point bias. Our results show that restricted Beveridge-Nelson filter performs better than Hodrick-Prescott filter regarding the magnitude of end point bias. When we compare the alternative methods by using the monthly real exchange rate series for Turkey, our findings are consistent with the results obtained with GDP data. Restricted Beveridge-Nelson filter produces persistent and large real exchange rate cycles than Beveridge-Nelson decomposition estimates. We find that restricted Beveridge-Nelson filter dominates Hodrick-Prescott filter in terms of the magnitude of end point bias.

JEL Classification*: C22, E17, E32, F31.*

Keywords*: Beveridge-Nelson decomposition, Beveridge-Nelson filter, Hodrick-Prescott filter, output gap, real exchange rate cycles, signal-to-noise ratio.*

Öz

Zaman serisi verilerinin çevrimsel bileşenlerinin elde edilmesi, politika yapıcı kurumlar için öncelikler arasındadır. Bu çalışmada, kısıtlanmamış Beveridge-Nelson ayrışması ve Hodrick-Prescott filtresi ile karşılaştırarak, Kamber ve diğ. (2018) tarafında geliştirilen sınırlanmış Beveridge-Nelson filtresi uygulanmaktadır. Türkiye ekonomisi için çeyreklik reel GSYİH verileri kullanıldığında sınırlanmış Beveridge-Nelson filtresinin Beveridge-Nelson ayrıştırma yönteminden daha kalıcı ve daha büyük döngüsel değerler sağladığı görülmektedir. Türkiye Cumhuriyet Merkez Bankası'nın çıktı açığı tahminlerini referans olarak aldığımızda, Beveridge-Nelson filtre yönteminin daha mantıklı sonuçlar verdiği tespit edilmektedir. Ayrıca, sonuçlarımız kısıtlı Beveridge-Nelson filtresinin, uç nokta yanlılığının büyüklüğü ile ilgili olarak Hodrick-Prescott filtresinden daha iyi performansa sahip olduğunu göstermektedir. Türkiye için aylık reel

Önerilen Atıf /Suggested Citation
Ekinci, M. F. 2020. Intuitive And Reliable Estimates Of Output Gap And Real Exchange Rate Cycles For Turkey, *Üçüncü Sektör Sosyal Ekonomi Dergisi*, 55(2), 772-783

döviz kuru serilerini kullanarak alternatif yöntemleri karşılaştırdığımızda bulgularımız GSYİH verileri ile elde edilen sonuçlarla tutarlıdır. Sınırlanmış Beveridge-Nelson filtresi, Beveridge-Nelson ayrıştırma tahminlerine göre daha kalıcı ve daha büyük reel döviz kuru çevrimleri üretmektedir. Sınırlanmış Beveridge-Nelson filtresinin, uç nokta yanlılığının büyüklüğü açısından Hodrick-Prescott filtresinden üstün olduğu görülmektedir.

***JEL Sınıflaması**: C22, E17, E32, F31.*

***Anahtar Kelimeler**: Beveridge-Nelson ayrışması, Beveridge-Nelson filtresi, Hodrick-Prescott filtresi, çıktı açığı, reel döviz kuru çevrimleri, sinyal gürültü oranı.*

Introduction

Estimating a robust and stable trend is an important issue for economic analysis. Several methods have been developed to estimate the output gap[1] by central banks to make an assessment on the state of the economy. Despite the importance of output gap estimates, there are some difficulties in measuring the output gap. One obvious reason is that output gap is not directly observable. Therefore, consistency with economic theory and the size of the end-point bias have been utilized to compare alternative methods instead of forecasting performance of estimation methods.

To make an assessment about the consistency with theory, estimated cyclical component of output is expected to have a large amplitude and persistent behaviour. Along with the interpretation of business cycles, a detrending method which yields small and noisy cycles can be classified as counter-intuitive. Furthermore, if the difference between real-time estimates and estimated values with additional data points display a large difference, then estimation method can not be considered as a reliable technique to extract the cyclical component.

Since the trend component is defined by a conditional expectation of the permanent component, Beveridge-Nelson (BN) decomposition is a prominent method of estimating cyclical values for an integrated time series. Regarding these intuitiveness and reliability issues, Kamber et. al. (2018) shows that when lag structure is determined by information criteria, standard BN decomposition produces small and noisy output gap estimates. They develop a restricted version of BN decomposition with a strong prior belief that the volatility of the cyclical component is much higher than the one of the trend component. This adapted filter produces sensible estimates of the US output gap that are reliable, intuitive, subject to less revisions and which moves closely with the National Bureau of Economic Research (NBER) business cycle.

In this study, we describe unrestricted BN decomposition and the restricted BN filter developed by Kamber et. al. (2018). Using quarterly GDP data for Turkey, we implement these methods. Taking the official estimates provided by Central Bank of Turkey as a benchmark for output gap, we compare the performance of these methods. We include the popular Hodrick-Prescott (HP) filter as an alternative for this exercise. We find that BN decomposition provides small and noisy cycles. Estimates from HP filter are persistent and exhibit a larger amplitude, but suffer from a large end point bias problem. BN filter method dominates the alternatives by producing intuitive and reliable estimates of output gap. When we conduct the same exercise utilizing the monthly real exchange rate (RER) series for Turkey, our results remain intact.

The contribution of this paper is twofolds. First, we compare the BN filter method with alternative estimation techniques using data from an emerging market economy. The comparison in Kamber et. al. (2018) implements the method for industrialized economies. We show that BN filter dominates alternative methods when capturing high volatility of economic indicators in an

[1] Output gap is the difference between actual and potential level of output. Since potential output can not be directly observed, several econometric methods have been implemented to estimate of the output gap. Univariate filtering methods are the most widely used tools to extract the cyclical component of output. Despite the ease of use, this approach is criticized for being a purely statistical method that does not contain an economic structure. In this context, model-based approaches with a structural framework are also used to estimate the output gap. Öğünç and Sarıkaya (2011) is an example of this approach which uses a new keynesian model to estimate output gap for Turkish economy.

emerging market economy. Secondly, we present estimates for real exchange rate cycles which can be interpreted as real exchange rate misalignments. The analysis can be extended to make an assesment on the exchange rate policies. Furthermore, we provide a quantitative comparison with alternatives based on intuitiveness and reliability criterion, whereas many studies on Turkish economy[2] present a narrative analysis of output gap estimates based on the business cycle developments.

The paper is organized as follows. Next section describes BN decomposition, section 3 explains the BN filter developed by Kamber et. al. (2018). In section 4, we focus on the persistence and amplitude of cycles obtained by applying BN decomposition and BN filter on the real GDP data for Turkey. We compare our results with HP filter cycles and focus on the intuitiveness of BN filter cycles. Section 5 provides a dicussion on the reliability of BN filter by investigating the end-point bias observed in BN filter output gap estimates. Section 6 dscusses the RER cycles obtained with BN filter. Finally, section 7 concludes.

Beveridge-Nelson (BN) decomposition

Following Beveridge and Nelson (1981), we express an integrated time series as follows,

$$y_t = \tau_t + c_t \tag{1}$$

where τ_t represents the long-run trend which is a random walk with a drift, and c_t denotes the cyclical component. Trend component in BN decomposition is the infinite horizon expectation: $\$\tau_t \equiv \lim_{h\to\infty} E_t(y_t - h\,\mu)$ where μ is the drift term. Since y_t is an I(1) process, the first difference of the series is stationary. We define the deviation from the unconditional mean as $\Delta\tilde{y}_t \equiv (\Delta y_t - \mu)$. To illustrate the BN decomposition for a simple case, suppose that the first difference can be expressed as an AR(1) process given by,

$$\Delta\tilde{y}_t = \Phi_1 \Delta\tilde{y}_{t-1} + e_t \tag{2}$$

where $|\Phi_1|$ <1 and $e_t \sim i.i.d.\ N(0,\sigma^2)$. For this process, the trend component is,

$$\tau_t = y_t + \frac{\Phi_1}{1-\Phi_1}\Delta\tilde{y}_t \tag{3}$$

Given the trend, cyclical component is

$$c_t = -\frac{\Phi_1}{1-\Phi_1}\Delta\tilde{y}_t \tag{4}$$

Considering the generalized case, suppose that the first difference of data series is characterized by an ARMA(p,q) process described as,

$$\Phi(L)\Delta\tilde{y}_t = \theta(L)e_t \tag{5}$$

where Φ and θ are autoregressive and moving-average polynomials in the lag operator L, respectively. We can write this model in the state space form to calculate the cyclical component. Defining the state vector as $X_t \equiv (\Delta\tilde{y}_t \quad \Delta\tilde{y}_{t-1} \quad \Delta\tilde{y}_{t-2} \ldots \Delta\tilde{y}_{t-p+1} \quad e_t \quad e_{t-1}\, e_{t-2} \cdots \quad e_{t-q+1})'$, transition equation is

$$X_t = F X_{t-1} + \nu_t \tag{6}$$

where $\nu_t \sim i.i.d.\ N(0,\Omega)$.

Measurement equation is

$$\Delta\tilde{y}_t = H\, X_t \tag{7}$$

[2] See Alp et. al. (2012), Ece and Öğünç (2004), Özbek and Özlale (2005) and Üngör (2012) for efforts to estimate Turkish output gap.

Minimum MSE j-period ahead forecast is given by

$$E_t[\Delta\tilde{y}_{t+j}] = H\ F^j\ E_t[X_t] \tag{8}$$

The state vector contains some unobserved elements, and Kalman filter provides this expectation under a normality assumption. Following Morley (2002), Beveridge-Nelson cycle can be calculated as

$$c_t = -HF(I - F)^j\ X_{t|t} \tag{9}$$

To analyze the share of cyclical fluctuations in the series, we define a signal to noise ratio. To express this ratio, a Wold representation of the underlying ARMA(p,q) process is more useful

$$\Delta y_t = \mu + \varphi(L)e_t \tag{10}$$

In this case, trend component can be expressed as,

$$\tau_t = \mu\ t + \varphi^*(1)\sum_{s=1}^{t} e_s \tag{11}$$

where long-run multiplier for our ARMA(p,q) process is

$$\varphi^*(1) = \frac{1 + \theta_1 + \theta_2 + \cdots + \theta_q}{1 - \phi_1 - \phi_2 - \cdots - -\phi_p} \tag{12}$$

Signal to noise ratio for BN decomposition is defined as the variance of trend shocks as a fraction of overall forecast error variance,

$$\varphi^*(1) = \frac{\sigma^2_{\Delta\tau}}{\sigma^2_e} \tag{13}$$

Using the results from the Wold representation above, signal to noise ratio is,

$$\delta \equiv \varphi^*(1)^2 \tag{14}$$

which indicates that signal to noise ratio is the square of the long run multiplier obtained from Wold representation.

BN filter

Different approaches to estimate output gap yield different results which might potentially have conflicting policy implications. A popular method developed by Hodrick and Prescott (1980) produces large and highly persistent cycles. However, HP filter estimates suffer from end-point bias and updated estimates after data revisions cast doubt on the reliability of this method. On the other hand, BN decomposition typically gives small and noisy cycles.

To reconcile these differences, Kamber et. al. (2018) investigate how one can generate large cyclical components using the BN decomposition. They find that by setting the noise-to-signal ratio to be large, instead of estimating it from the data, the cycles obtained are large and the timing of troughs matches the chronology dated by NBER.

From a technical perspective, BN filter relies on the insight that signal to noise ratio depends on the autoregressive coefficients of an AR(p) model. This result yields the conclusion that we can fix the signal to noise ratio by restricting the autoregressive coefficients. Considering an AR(p) model given by

$$\Delta\tilde{y}_t = \Phi_1\Delta\tilde{y}_{t-1} + \Phi_1\Delta\tilde{y}_{t-2} + \cdots + \Phi_1\Delta\tilde{y}_{t-p} + e_t \tag{15}$$

which can be rearranged as follows,

$$\Delta\tilde{y}_t = \rho\Delta\tilde{y}_{t-1} + \sum_{j=1}^{p-1} \phi_j^* \Delta\tilde{y}_{t-j} + e_t \tag{16}$$

where $\rho \equiv \phi_1 + \phi_2 + \cdots + \phi_p = 1 - \phi(1)$. and $\phi_j^* \equiv -(\phi_{j+1} + \cdots + \phi_p)$. Then, AR(p) model given above can be estimated by restricting signal to noise ratio $\bar{\delta}$ as follows,

$$\bar{\rho} = 1 - 1/\sqrt{\delta} \tag{17}$$

Value for AR(p) coefficients are fitted by utilizing a "Minnesota" type shrinkage prior on the higher lags of the model where

$$\phi_j^* \sim N(0, \frac{0.5}{j^2}) \tag{18}$$

Conditional on σ_e^2, the posterior distribution for $\{\phi_j^*\}_{j=1}^{p-1}$ has a closed-form solution and can be calculated without the need for posterior simulation. In practice, number of lags is set to 12, p=12. Defining the implied amplitude to noise ratio,

$$\alpha(\delta) \equiv \frac{\sigma_c^2(\delta)}{\sigma_e^2(\delta)} \tag{19}$$

$\bar{\delta}$ is chosen to maximize this ratio as follows,

$$\bar{\delta} \equiv \inf\{\delta > 0 : \alpha'(\delta) > 0, \alpha''^{(\delta)} < 0\} \tag{20}$$

The procedure can be summarized in 3 steps as follows,

Set a low $\bar{\delta}$. Repeat step 2 and 3 for incremental increases in $\bar{\delta}$ from an initial increment just above zero until the estimated $\alpha(\bar{\delta})$ decreases.

Given $\bar{\delta}$, estimate the AR(p) model by imposing a "Minnesota" type shrinkage prior for $\{\phi_j^*\}_{j=1}^{p-1}$ by setting p = 12.

Given $\bar{\delta}$ and estimates of for $\{\phi_j^*\}_{j=1}^{p-1}$, solve for restricted estimates of $\{\phi_j\}_{j=1}^{p-1}$ by applying the BN decomposition.

To apply the BN decomposition and BN filter, we document the results from augmented Dickey-Fuller tests on the output and real exchange rate series in Table 1. Unit root hypothesis is not rejected for output and real exchange rate series for Turkey. Thus, we conclude that presence of stochastic trends in the data series motivate the application of Beveridge Nelson decomposition and BN filter.

Table 1: Unit Root Tests

Intercept only	ADF statistic	p-values	Lags	unit root
GDP	-0.654	0.855	0	YES
RER	-2.402	0.142	2	YES
Intercept and Trend				
GDP	-2.634	0.266	0	YES
RER	-2.064	0.563	2	YES

Note: GDP is the seasonally adjusted annual levels of quarterly series by OECD in 2010 TL prices. GDP series cover the period between 1960Q1 and 2018Q4. RER is the trade weighted real effective exchange rate index for Turkey. RER is calculated by Bank for International Settlements and covers the period between January 1994 and December 2018. Top panel reports the unit root tests with an intercept term, and bottom panel includes a time trend. Natural logarithms of series are used in the regressions. Lag lengths are chosen by Schwarz information criteria (SIC).

Persistence and amplitude of output gap for Turkey

In order to make an assessment on the performance of BN filter, we present the output gap estimates of Central Bank of Turkey (CBRT) in figure 1 as a benchmark[3]. The sample of official estimates covers the period between 2008Q1 and 2018Q4. We observe that output gap exhibits a persistent behaviour. Amplitude of the estimates is quite large, reaching a trough around 9 percent in 2009Q1 during the global economic crisis.

Output gap is estimated by using BN decomposition, BN filter and HP filter utilizing the quarterly GDP data[4] for Turkey between 1960Q1 and 2018Q4. We compare our results with the CBRT estimates in order to understand whether these methods provide sensible and intuitive results. For BN decomposition, we select a lag length based on Schwartz Information Criteria (SIC) which suggests an AR(1) model. When BN filter is utilized, estimated signal to noise ratio for GDP series is 0.14.

Figure 1: Central Bank of Turkey Output Gap Estimates

Persistence and standard deviation of the output gap estimates are reported in table 2. Cyclical component obtained with BN decomposition exhibits a smaller amplitude and weaker persistence. HP filter and BN filter both produce persistent output gap estimates with a larger amplitude compared to the BN decomposition. Figure 2 plots the output gap estimates obtained with these alternative methods. BN filter and HP filter cycles move closely for most of the sample with a correlation of 0.70. We observe that the dates of negative values roughly coincide with the

[3] Figure 1 presents a range of estimates obtained with different methods to estimate output gap. See Central Bank of the Republic of Turkey (2017) for a detailed description of methods implemented and additional references on the methodology.

[4] Data source is OECD. Next, we use monthly real exchange rate (RER) series provided by Bank for International settlements. RER data spans from January 1994 to December 2018. Results with RER data are reported in section 6.

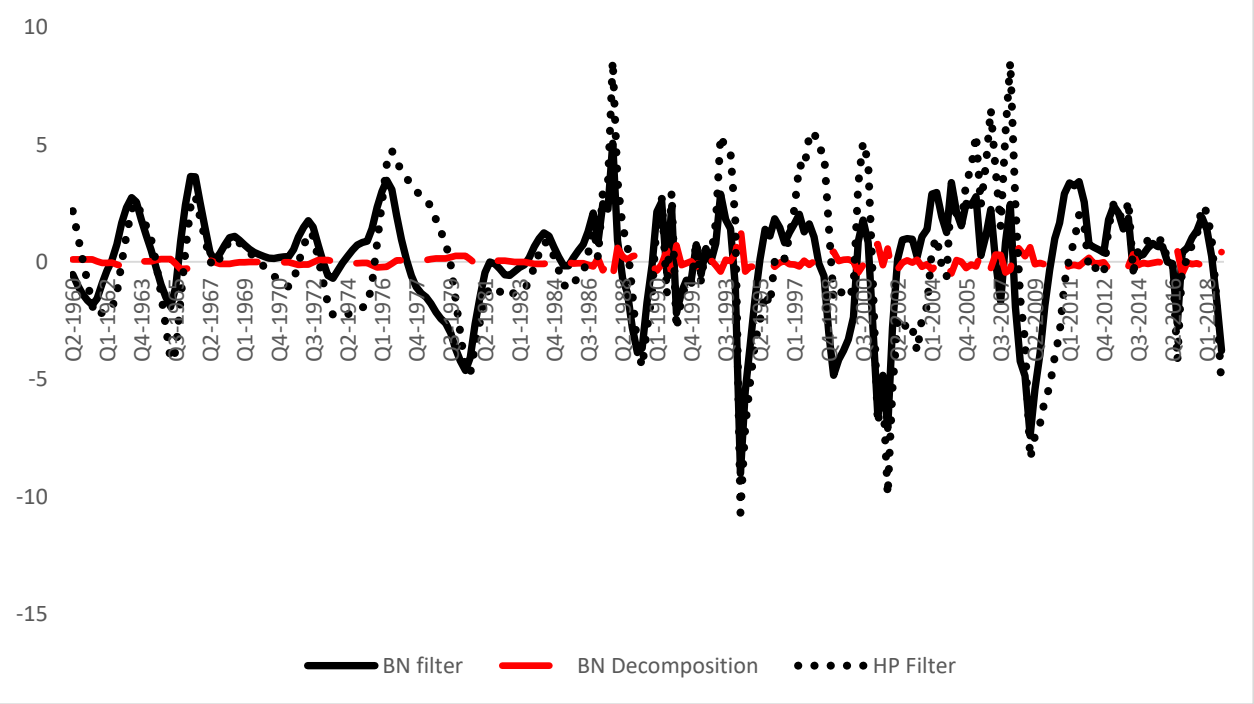
estimates published by Central Bank of the Republic of Turkey (2019) for both methods. The size of the trough in 2009Q1 is quite close to the official estimates for BN filter (7.41 percent) and HP filter (8.40 percent). Sign and direction of the estimated cycles are consistent with the official estimates.

Table 2: Persistence and Amplitude of Output Gap Series

	Autocorrelation	Standard deviation
BN AR(1)	0.106	0.236
BN Filter	0.803	2.171
HP Filter	0.783	2.921

Note: Autocorrelation and standard deviation for estimated cyclical values are reported for different estimation methods.

Figure 2: Output Gap Estimates



Reliability of output gap estimates

Our analysis suggests that BN filter and HP filter methods provide large and persistent output gap estimates. We can consider that implementing these methods yield intuitive estimates of output gap. Another important aspect of extracting a robust and stable trend is the difference between the estimated values when additional data points are available and the real-time estimates. Choosing the appropriate decomposition method is particularly important in this case where some information is missing when the policy decisions are made. Value of trend in the last period is based on the information available up to and including the last observed period[5]. Therefore, significant changes might be observed with new data arrivals.

[5] Canova (1998) reports that stylized facts about the US economy vary widely across different detrending methods.

We estimate the cyclical component for the last decade of our sample[6] recursively by using the full sample and cutting the sample at the data point. We define the measure of end-point bias as follows,

$$endpointbias_t = c_{t|t} - c_{t|T}$$

where $c_{t|t}$ is the real time estimate of cyclical component and $c_{t|T}$ is the output gap obtained by using full sample. Table 3 reports the standard deviation and average of the absolute value of the bias. The magnitude of end-point bias is quite large for HP filter. The results indicate that BN filter dominates HP filter in terms of providing a reliable estimate of Turkish output gap.

Table 3: End-Point Bias for Output Gap Estimates

	BN Filter	HP Filter
Standard deviation	0.108	2.937
Average Abs. Value	0.081	2.255

Note: End point bias is defined as the difference between real time estimates and cyclical values when full sample is utilized. Standard deviations and average absolute values for 2008Q1-2017Q4 period are reported.

Real exchange rate (RER) cycles for Turkey

Our exercise using quarterly real GDP series shows that BN filter dominates HP filter and BN decomposition in terms of providing intuitive and reliable output gap estimates. We extend our analysis by utilizing monthly real exchange rate series to compare these alternative methods to estimate cyclical values[7]. This exercise also relates to the permanent equilibrium exchange rate (PEER) literature. In this literature, trend values of the real exchange rate are defined to be a long-run equilibrium value and the value of cyclical component is referred as real exchange rate misalignments.

In this case, information criteria suggests an AR(2) model for BN decomposition. Estimated signal to noise ratio for RER series is 0.16 with BN filter. Cyclical values estimated with alternative methods are plotted in figure 3. Persistence and standard deviations are reported in table 4. Our results show that BN decomposition yields counter-intuitive cyclical values in this case as well. BN filter and HP filter provides persistent and large RER cycles. The estimates obtained from these methods move closely with a correlation coefficient of 0.71. When we compare these two methods in terms of the magnitude[8] of the end-point bias, BN filter dominates HP filter in terms of reliability. Standard deviations and average absolute values of bias are reported in table 5.

[6] End-point bias is calculated for the period between 2008Q1 and 2017Q4. An alternative approach is to keep the number of additional data points constant and compare these estimates with real time output gap. Our results are qualitatively similar when this approach is followed.

[7] See Ekinci et. al. (2013) for an application of alternative filtering methods on the Turkish RER data.

[8] End-point bias is calculated for the period between 2008 January and 2017 December.

Table 4: Persistence and Amplitude of RER Cycles

	Autocorrelation	Standard deviation
BN AR(2)	-0.200	1.209
BN Filter	0.833	5.165
HP Filter	0.792	6.661

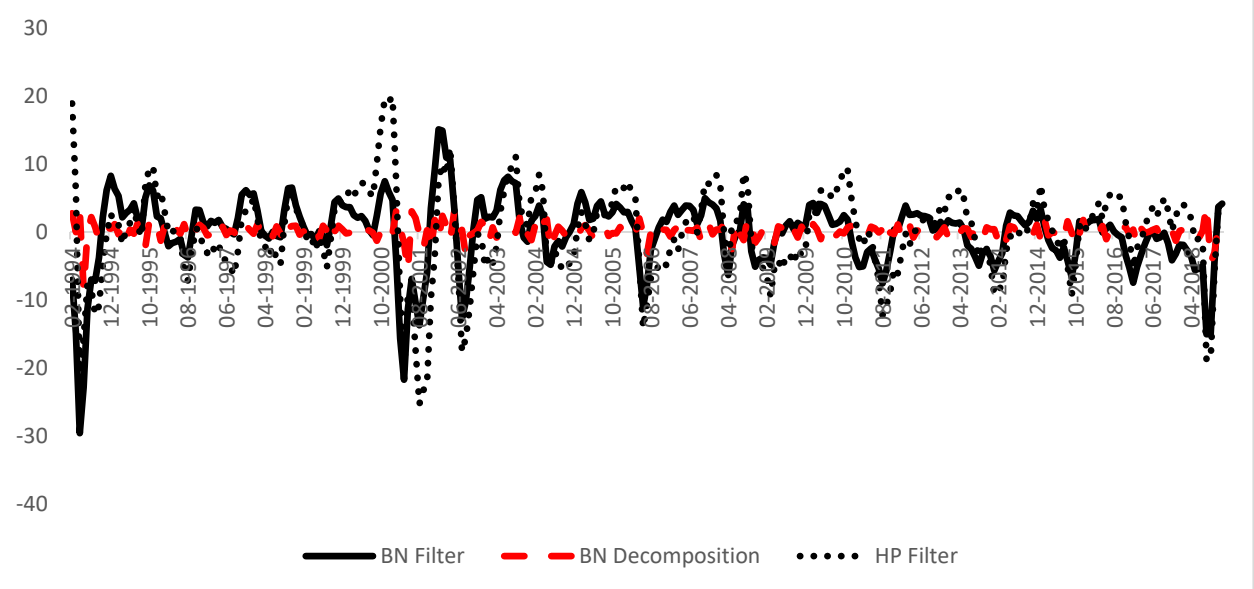
Note: Autocorrelation and standard deviation for estimated cyclical values are reported for different estimation methods.

Table 5: End-Point Bias for RER Cycle Estimates

	BN Filter	HP Filter
Standard deviation	0.234	2.765
Average Abs. Value	0.359	2.571

Note: End point bias is defined as the difference between real time estimates and cyclical values when full sample is utilized. Standard deviations and average absolute values for 2008 January – 2017 December period are reported.

Figure 3: RER Cycle Estimates



Conclusion

Decomposing economic time series into trend and cyclical components is among the top priorities of economic analysis Estimating a reasonably accurate output gap is an important task for policy maker institutions, especially central banks. A particularly important task is to reconcile the differences between estimation methods. Estimates obtained from appropriate detrending methods can be useful to conduct a real time analysis if the announcement of new data is within a reasonable time frame. The results can also be utilized to conduct analysis on the economic dynamics, such as Philips curve and Okun's law.

This study describes and implements BN decomposition along with a restricted BN filter developed by Kamber et. al. (2018). We use quarterly GDP data and monthly RER series for Turkey. We take the official estimates provided by Central Bank of Turkey as a benchmark for output gap and conduct our exercises by comparing our results with HP filter estimates. Results show that BN decomposition provides small and noisy cycles for both series. Estimates from HP filter are persistent and exhibit a larger amplitude, but suffer from a large end point bias problem. BN filter method dominates these alternatives by producing intuitive and reliable estimates of output gap and RER cycles.

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Araştırma Makalesi

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Türkiye Ekonomisi Için Mantikli Ve Güvenilir Çikti Açiği Ve Reel Döviz Kuru Çevrimleri Tahminleri

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Genişletilmiş Özet

Zaman serisi verilerinin trend değerlerinin elde edilmesi ve çevrimsel bileşenlerinin incelenmesi gerek akademik araştırmalar gerekse politika yapıcı kurumlar için öncelikler arasındadır. Özellikle para politikasında sıkı bir duruş veya genişlemeci bir yaklaşımın benimsenmesi anlamında, gerçek zamanlı veriler ile çıktı açığının yönü ve büyüklüğü ile ilgili sağlıklı tahminler yapılabilmesi önem taşımaktadır. Ayrıca, reel döviz kurları hakkında yapılan bir trend-çevrim ayrıştırması ile kurların aşırı değerli olması durumu tespit edilebilmekte ve gerekli politika tedbirleri alınabilmektedir.

Çevrimsel değerleri tahmin etmek için geliştirilen yöntemlerin çoğu için bir son nokta yanlılığı probleminden bahsedilebilir. Eğer gerçek zamanlı olarak, son gözlenen değerin en önemli veri olduğu tahminler ile aradan zaman geçtikten sonra ek veri noktalarının dahil edilebilmesinden sonra yapılan tahminlerde elde edilen değerler arasında büyük bir fark oluşuyorsa, tahmin yöntemi çevrimsel bileşeni elde etmek için güvenilir bir teknik olarak kabul edilemez. Çevrimsel bileşen tahminlerinde karşılaşılan bir diğer sorun da tahminlerin mantıklı olması hususudur. Ekonomik modeller kapsamında diğer verilerle tutarlı olmayan çevrimsel bileşenler üreten yöntemlerin mantıklı sonuçlar vermediği genel olarak kabul görmektedir.

Bu çalışmada Kamber ve diğ. (2018) tarafından geliştirilen sınırlanmış Beveridge-Nelson (BN) filtresi yöntemi uygulanmaktadır. Öncelikle bu filtreleme yönteminin nasıl uygulanabileceği ve özellikleri ayrıntılı olarak tarif edilmiştir. Sıkça kullanılan BN ayrıştırması ile elde edilen tahminler çok yüksek bir sinyal-gürültü oranı ima etmektedir. Dolayısıyla iktisadi çevrimlerde oluşan hareketlerin çoğunun trend bileşeninden kaynaklandığı görülmektedir. Bu çalışmada ayrıntılı olarak tarif edilen sınırlandırılmış BN filtresi, BN ayrıştırmasında oluşan yüksek trend oynaklığının sınırlandırılması esasına dayanmaktadır.

İkinci aşamada, Türkiye ekonomisi için çeyreklik reel GSYİH serileri (1960Ç1-2018Ç4 dönemi) ve aylık döviz kuru verilerinin (Ocak 1994-Aralık 2018 dönemi) birim kök testleri yapılmıştır. Bu şekilde serilerde ayrıştırılması gereken trend bileşenlerinin varlığı bu testler ile teyit edilmiştir. Söz konusu serilere sınırlanmış BN filtresi uygulanarak çevrimsel bileşenler elde edilmiştir. Bu yöntemle bulunan çevrimsel bileşenler güvenilirlik ve mantıklılık özellikleri yönünden diğer yöntemlerden gelen değerler ile kıyaslanmaktadır.

Öncelikli olarak, reel GSYİH serileri ile çıktı açığı tahminleri alternatif yöntemler ile yapılmaktadır. Mantıklılık kriteri kapsamında, oluşturulan çıktı açığı tahminlerinin kalıcı ve büyük olması beklenmektedir. Bu kriter kapsamında, Kamber ve diğ. (2018) tarafından

geliştirilen sınırlanmış BN filtresi trenddeki hareketliliği sınırlayarak daha mantıklı tahminler üretmektedir. Türkiye Cumhuriyet Merkez Bankası'nın çıktı açığı tahminleri bu bulgumuzu teyit etmektedir. Alternatif bir tahmin yöntemi olarak benimsenen Hodrick-Prescott (HP) filtresinin de mantıklı sonuçlar ürettiği gözlenmektedir. BN ayrıştırmasının ise ürettiği çıktı açığı tahminlerinin otokorelasyon ve standart sapma değerlerinin BN ve HP filtreleri ile elde edilen değerlerin oldukça altında olduğu, dolayısıyla BN ayrıştırmasının mantıklı olarak değerlendirilemeyecek sonuçlar ürettiği görülmektedir.

Güvenilirlik kriteri olarak uç nokta yanlılığının büyüklüğü benimsenmiştir. Her bir ayrıştırma yöntemi için gerçek zamanlı veriler ve mevcut bütün verilerin kullanılması ile her dönem için çevrimsel bileşenler tahmin edilmiştir. Daha sonra oluşturulan iki çevrimsel bileşenin farkı alınarak tahmin yöntemindeki uç nokta yanlılığı hesaplanmıştır. Elde edilen uç nokta yanlılığının standart sapması yöntemlerin kıyaslanması için kullanılmıştır. Sonuçlara göre kısıtlanmış BN filtresi uç nokta yanlılığını bir güvenilirlik ölçüsü olarak benimsediğimizde HP filtresinden daha iyi bir performans göstermektedir.

Aynı yöntemler aylık frekansta reel döviz kuru serilerine de uygulanmıştır. Elde edilen sonuçlar BN filtresinin BN ayrıştırmasına göre daha mantıklı sonuçlar verdiğini ortaya koymaktadır. HP filtresi ile kıyaslandığında ise BN filtresinin daha güvenilir çevrimsel bileşen tahminleri ürettiği görülmektedir.

Sonuçlarımız Kamber ve diğ. (2018) tarafından ABD ekonomisi için elde edilen bulguları teyit etmektedir. Özellikle enflasyon ve işsizlik oranları ile ilgili yapılacak analizlerin daha sağlıklı yapılabilmesi için çevrimsel bileşenlerin tahmini için BN filtrelemesi ön plana çıkmaktadır. Yöntemin diğer teknikler ile iktisat teorisi ile uyumluluk anlamında kıyaslanması akademik çalışmalarda ve politika analizlerinde yol gösterici olacaktır.