On fractional filtering versus conventional filtering in economics

Nigmatullin, Raul R. and Omay, Tolga and Baleanu, Dumitru

Kazan State University, Çankaya University, Çankaya University

4 April 2010

On fractional filtering versus conventional filtering in economics

Raul R. Nigmatullin[1]
Tolga Omay[2]
Dumitru Baleanu[3]

Abstract

In this study, we compare the Hodrick-Prescott Filter technique concerning the Fractional filtering technique, which has recently started to be used in various applied sciences, i.e., physics, engineering, and biology. We apply these filtering techniques to the quarterly GDP data of Turkey, which span the period 1988:1 2003:2. The estimated filtered series are then compared using classical statistical tool MSE (Minimum Square Error) and with real-life evidence such as crisis periods, recessionary, or boom periods. In the second part of the study, we use generated data that exhibits the essential characteristics of economic data to see the effects of filtering on these data and trace the effects of these filtering's on decomposed series.

Keywords: Fractional Filtering, Hodrick-Prescott Filtering, MSE, Data Generation, Decomposition.
JEL Classification: C10, C15, C53

[1] Physical Faculty, Kazan State University Kremlevskaya str. 18 Kazan Russia, 420008
e-mail: nigmat@knet.ru

[2] Çankaya Vocational Training School , Çankaya University- 06530, Ankara, Turkey
e-mail: omay.tolga@gmail.com

[3] Department of Mathematics and Computer Sciences, Faculty of Arts and Sciences, Çankaya University-06530, Ankara, Turkey . and Institute of Space Sciences, P.O.BOX, MG-23, R 76900, Magurele-Bucharest, Romania
e-mail: dumitru@cankaya.edu.tr

Introduction

Filtering methods deal with the identification and extraction of certain features from time-series data; trend component that reflects the long-dated progression of the series; the cyclical component that describes the regular fluctuations caused by the economic cycle (business cycle); the seasonal component reflecting seasonal fluctuations; irregular component (or "noise") that describes random, irregular influences. This study compares the Fractional filter (F) with the HP filter. The Hodrick Prescott (1997) filter HP is designed to identify cycle C_t, S_t, and I_t) components of a macroeconomic time series from its other component trend (long-run path), and it is used widely in the economics literature. On the other hand, the HP filter is classified as a linear filter in filtering literature, where Fractional filtering is linear filtering which can identify cycle and trend components of a time series data. We compare F filtering with HP filtering for these reasons whether F filtering can be an alternative to HP filtering in economics.

In our investigation, first, we deal with the Turkish economy's quarterly GDP data, which we can classify as real data in our study. In the economics literature, a significant amount of work is dedicated to analyzing growth, business cycles, and monetary policy. Therefore, the output gap and potential output formed from GDP are important macroeconomic indicators for these issues. In particular, the increased importance of inflation in policy formulation has direct implications for the central bank's choice of indicators[4]; for the example output gap. The output gap is the difference between actual and potential output, which is the potential output obtained from the trend variable of GDP data. However, the output gap is an unobserved variable. Therefore, the output gap variable must be estimated by the filtering techniques. For the industrialized countries, the HP filter does an excellent job in measuring potential output and output gap. However, while estimating the potential output for developing countries, we meet different problems. In developing countries, excessive boom-bust cycles along with volatile output have occurred. HP filter usually cannot capture the very high volatility of macroeconomic variables in developing market economies. In this study, we are employing F filtering to capture much more of the volatility and structural change that characterize the developing market economies. For example, Harvey and Jaeger (1993) argue that the HP filter may introduce spurious features in its estimate of the trend and add that conditions required for the HP filter to serve as an optimal filter are rarely met in practice. A typical result documented like these studies is that although the potential output estimates that employ the HP filter may provide accurate results for countries like the United States, a more general and flexible procedure should be developed for other economies, where potential output does not follow a smooth trend.

We produce some theoretical data to find out the features of filtering techniques. In the data generating process (DGP), our first aim is to construct the stylized fact of GDP data to be suitable for developing countries. Therefore, we deduce the advantages or disadvantages of F filtering regarding HP filtering in filtering the developing countries' type GDP data. We obtain minimum square error (MSE) statistics to compare the efficiency of F filtering versus HP filtering.

The rest of the paper is organized as follows. In section 2, we introduce F filtering and HP filtering. In section 3, we apply F filtering and HP filtering to Turkish quarterly GDP and compare the results of these two filtering's techniques with real data. Section 4 generates

[4] From the Phillips curve relation, we know that inflationary pressures tend to increase as output rises and decline when output falls relative to potential. Hence, if the output gap increases, we can conclude that inflationary pressure occurs and vice versa.

theoretical data that exhibits developing countries' GDP features. To this generated data, we apply MSE statistics to compare HP filter with Fractional Filter. The final section concludes.

2. Real Data and Comparison of HP Filter versus Fractional Filter

The below graph shows the actual output and estimated potential output derived from Hodrick-Prescott(HP) and Fractional Filtering(FF), respectively. The HP filter computes the smoother potential output, and FF computes the more nonlinear. For the quarterly data, the convention in economics is to use K=1600 for the HP filter. We deduce that when we use wminx around 0.8, this is the relevant correspondence of K= 1600. Hence, we obtain the same type of output gap from this computation.

Figure 1. GDP without Seasonality HP1600 trend and F0.8 trend

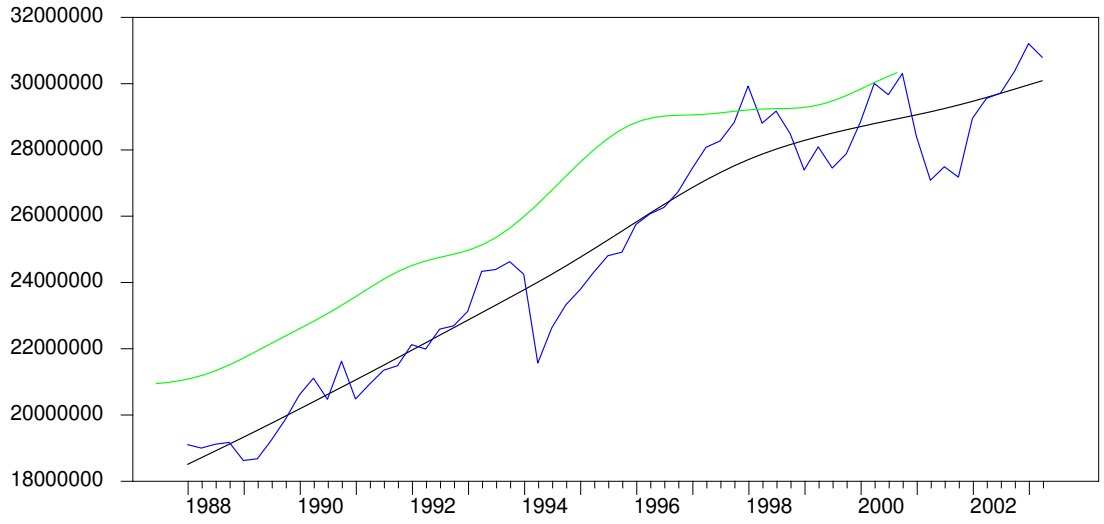
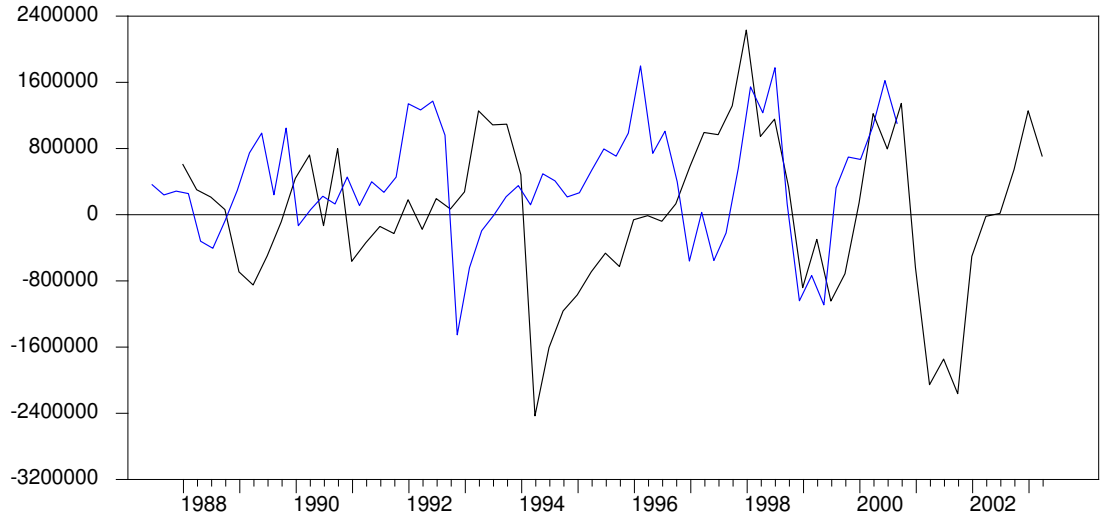


Figure 2. The Computed Output Gap from HP1600 and F0.8 Filter



As can be seen in the output gap series, which are driven from HP and F filters (1988 recession), the two major financial crises in April 1994 and February 2001 are nicely captured along with the negative impact of the Russian crisis and the devastating earthquake in August

1999. The HP filter can be viewed as a two-sided moving average filter, where its moving average coefficients are functions of a "smoothness" parameter for the trend component. Although it is widely used in obtaining potential output estimates, it has also been subject to severe criticisms. As an example, Harvey and Jaeger (1993) argue that the HP filter may introduce spurious features in its estimate of the trend and add that conditions required for the HP filter to serve as an optimal filter are rarely met in practice. A typical result documented like these studies is that although the potential output estimates that employ the HP filter may provide accurate results for countries like the United States, a more general and flexible procedure should be developed for other economies, where potential output does not follow a smooth trend. From figure 1, we can see that the HP filter has a smoother trend than the F Filter. In this respect, the F filter improves the quality of the HP filter's trend component.

3 Generated Data and Comparison of HP Filter versus Fractional filter.

In this part, we generate data that exhibit the essential characteristics of economic data. The generated data is:

$$\text{Trend:} \quad T_t = 1 + 0.1t$$
$$\text{Seasonal:} \quad S_t = 1.6\sin(t\pi/2)$$
$$\text{Irregular:} \quad I_t = 0.7I_{t-1} + \varepsilon_t$$

Where T_t = value of the trend component in period t

S_t = value of seasonal component in t

I_t = the value of the irregular component in t

ε_t = a pure random disturbance in t

Thus, the irregular disturbance in t is 70% of the previous period's irregular disturbance plus a random disturbance term. In our study, we generated 150 random disturbances to generate the generated data. In the first computation, we deal with the seasonal data in figure 3

Figure 3. Seasonal Data HP filter and Fractional Filter

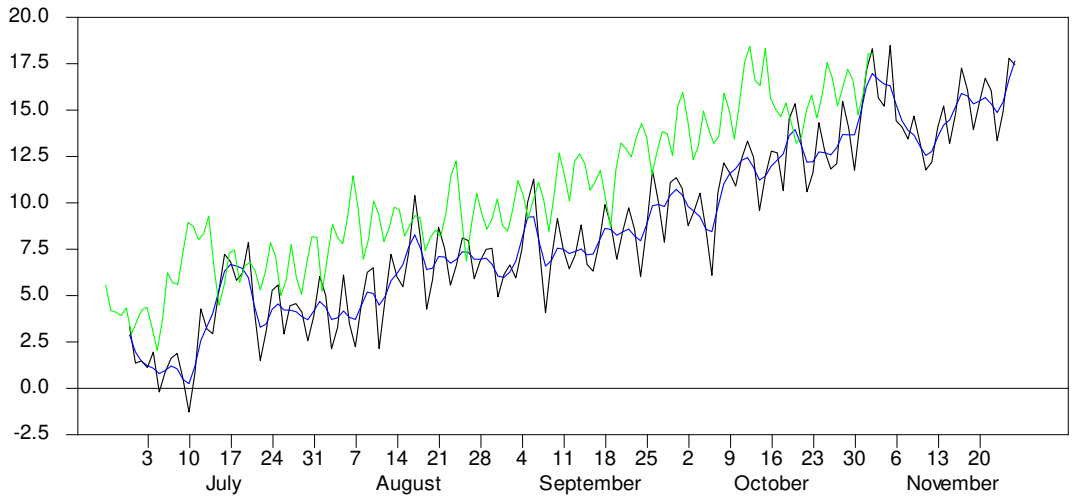


Figure 4. Original Noise Term From Seasonal Data and HP1600 Filter's Cycle Component

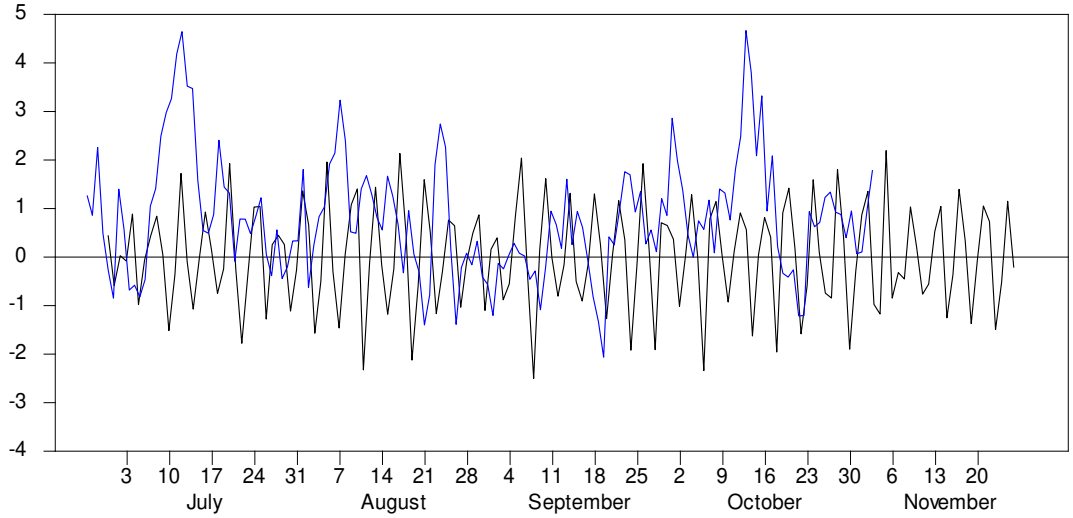
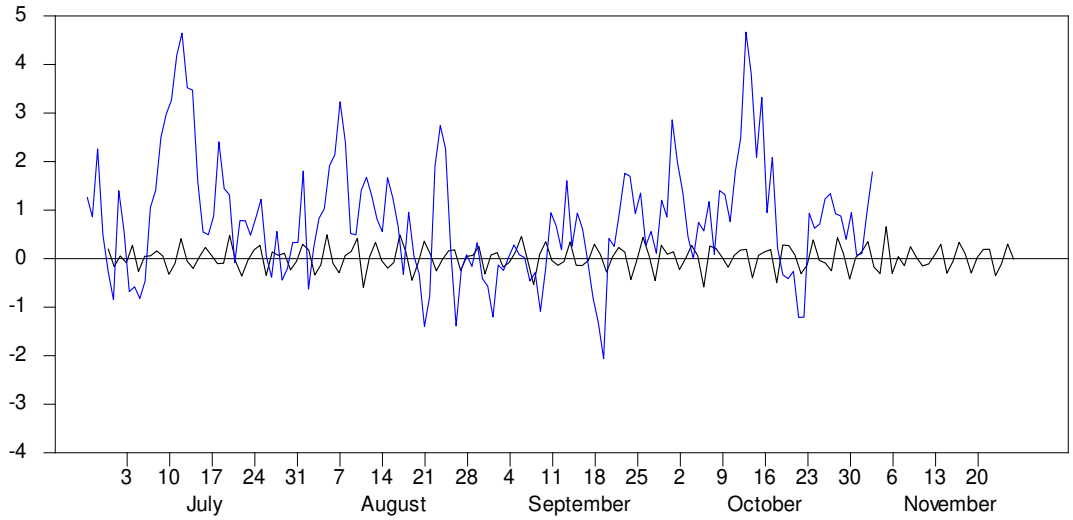


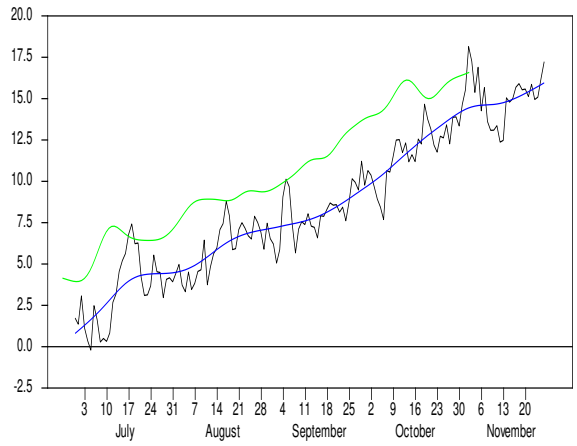
Figure 5. Original Noise Term From Seasonal Data and F0.8 Filter's Cycle Component



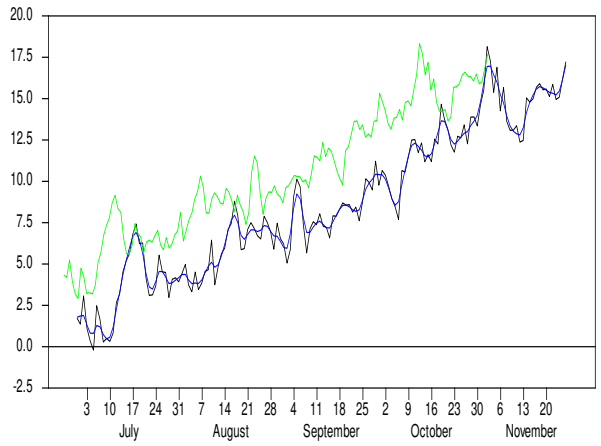
In economic analysis, we are using data to remove seasonality; hence, we employ the seasonality removing technique to analyze the data. In the below Figure, we use HP1600 and F=0.8 and HP1 and F0.1

Figure 6. Seasonally Removed Generated Data original noise HP(1600, 1) and F(0.8, 0.1)

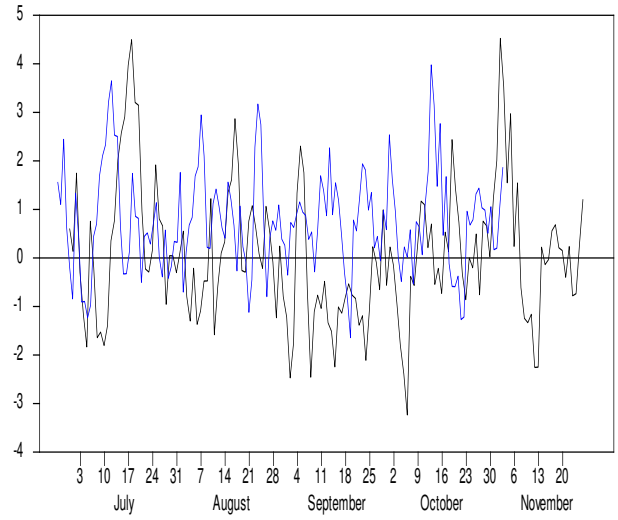
Seasonally Filtered Data HP1600 and F0.8



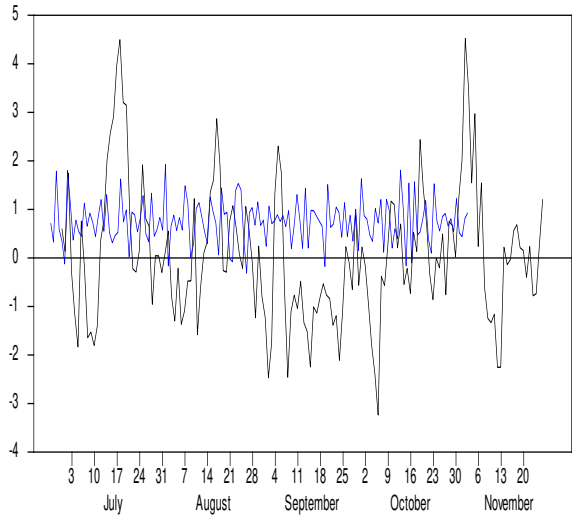
Seasonally Filtered Data HP1 and F0.1



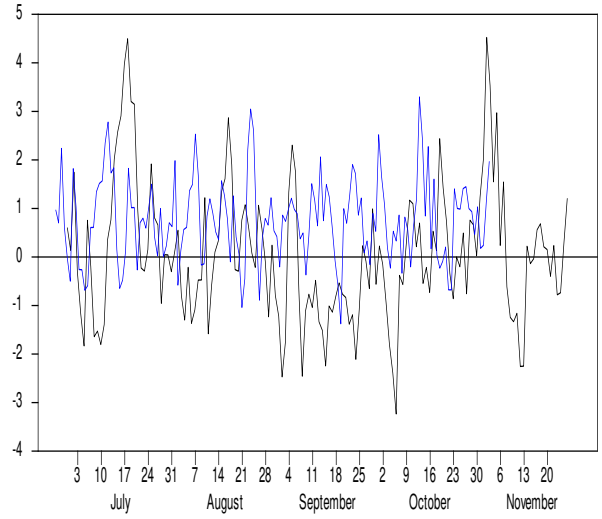
Noise and Filtered Noise from HP1600



Noise and Filtered Noise from HP1600



Noise and Filtered Noise from F0.8



Noise and Filtered Noise from F0.8

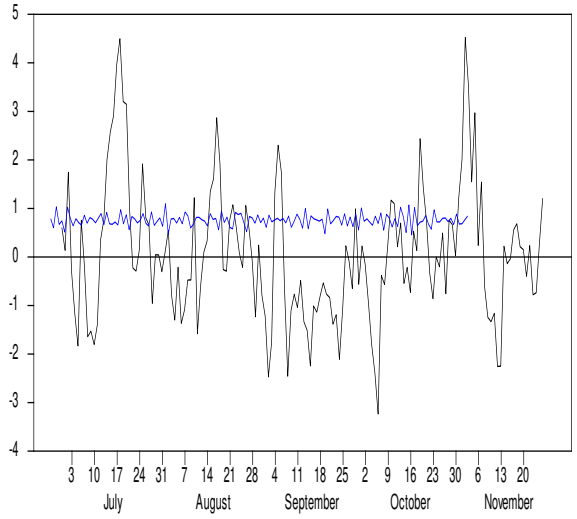
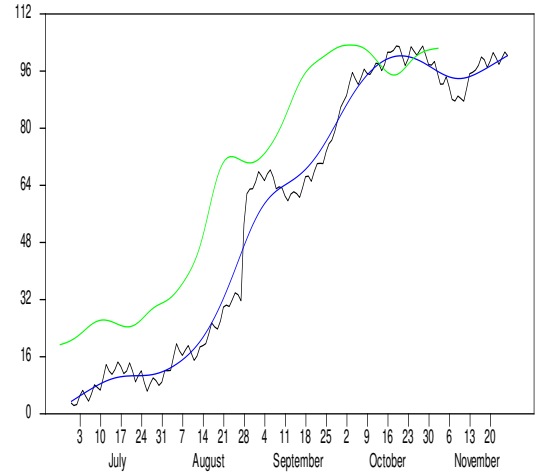
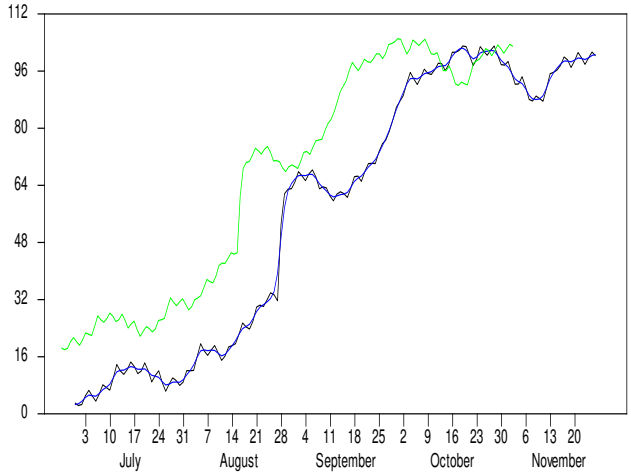


Figure 7. Seasonally Removed and Threshold Generated Data Original Noise HP(1600, 1) and F(0.8, 0.1) Filtered series Cycle Component

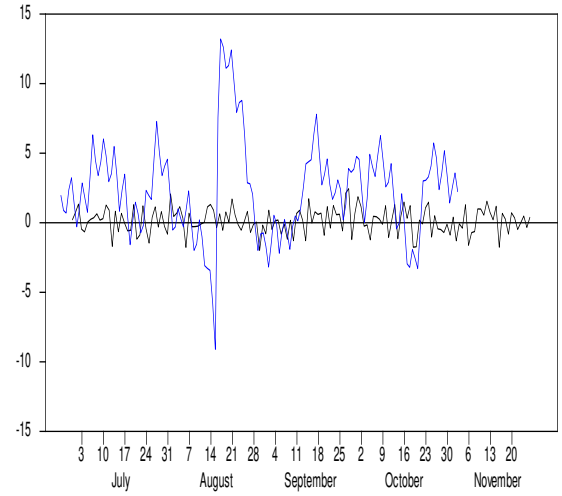
Generated Threshold Data HP1600 and F 0.8



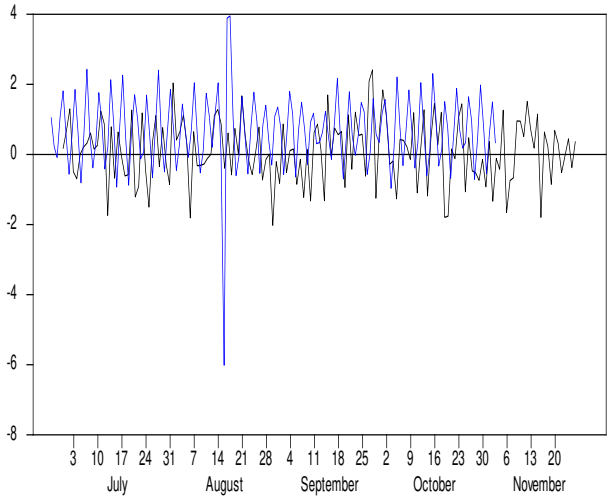
Generated Threshold Data HP1 and F 0.1



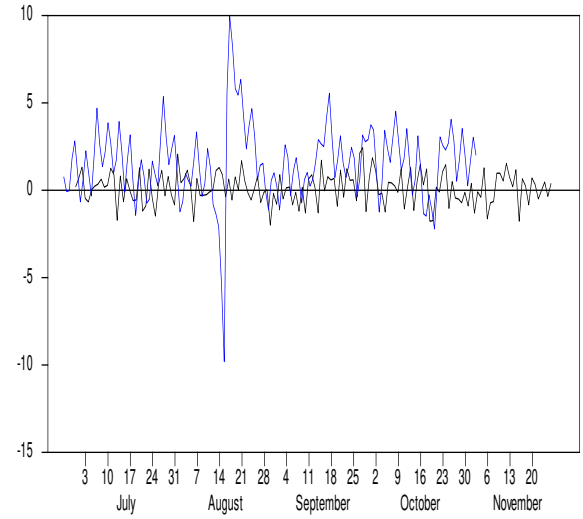
Noise and Filtered Noise from HP1600



Noise and Filtered Noise from HP1



Noise and Filtered Noise from F0.8



Noise and Filtered Noise from F0.1

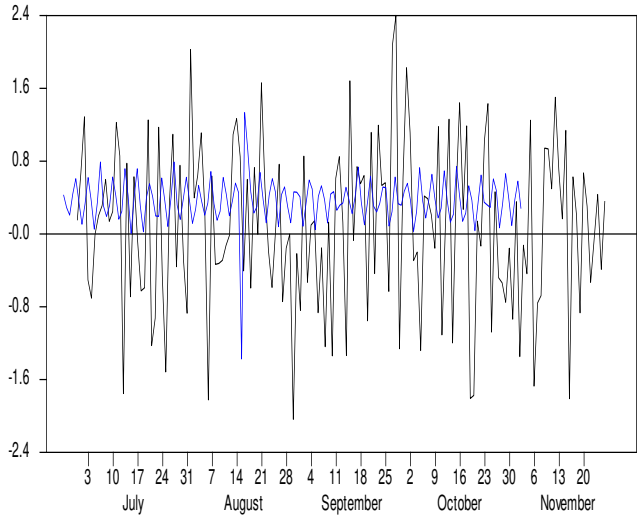


Table 1. The Summary Results of the Generated Data

	Seasonal Data	Non Seasonal Data	Threshold Data
MSE HP1600	2.271	0.328	17.735
MSE F0.8	1.835	0.578	7.704
MSE HP1	-	1.459	2.094
MSE F0.1	-	1.797	0.830

From Table 1, we can see that Fractional filtering has an advantage over HP filtering in seasonal data and the seasonally removed data with a threshold in it. These two data exhibit some kind of non-smooth trend concerning seasonally removed data. Hence we have reached this conclusion both from actual data and generated data.

Conclusion

Several different shortcomings of the HP filter have been indicated in the literature. This paper discussed whether fractional filtering could improve the economic analysis of real-time data. Our results suggest that fractional filtering has an advantage over HP in seasonal data and deseasonalized data with structural breaks. Thus, in these cases, using Fractional filtering instead of HP filtering can obtain better estimates of the trend component of macroeconomic series. Further avenues for research might include the application of F filtering to other macroeconomic series, i.e., stock market index, exchange rate, and price level, and improve the accuracy of forecasts which are crucial for policymakers.

References

Hodrick R, Prescott E. Postwar US business cycles: an empirical investigation. J Money Credit Bank 1997;2:1–16.

Nigmatulin RR, Baleanu D, Dinç E, Solak A. Characterization of a benzoic acid modified glassy carbon electrode expressed by new statistical parameters. Physica E 2009;41(4):609–16.

Harvey AC, Jaeger A. De-trending stylized facts and the business cycle. J Appl Econom 1993;8(3):231–50.

Farmer EAR. Macroeconomics of self-fulfilling prophecies. Cambridge: MIT Press; 1993.

Enders W. Applied econometric time series. John Wiley High Education; 2003.

Pershin SM, Bunkin AF, Lukyanchenko VA, Nigmatullin RR. Detection of the OH band fine structure in liquid water by means of new treatment procedure based on the statistics of the fractional moments. Laser Phys Lett 2007;4(11):808.

Nigmatullin RR. The statistics of the fractional moments: is there any quantitatively any randomness? J Signal Process 2006;86:2529–47.

Nigmatullin RR. Strongly correlated variables and existence of a universal distribution function for relative fluctuations. Phys Wave Phenomena 2008;16(2):119–45.

Nigmatullin RR, Moroz A, Smith G. Application of the generalized mean value function to the statistical detection of water in decane by near-infrared spectroscopy. Physica A Stat Mech Appl 2005;2(4):379–96.

Nigmatullin RR, Osokin SI, Nelson SO. Application of fractional-moments statistics to data for two-phase dielectric mixtures. IEEE Trans Dielectrics Electrical Insulation 2008;15(5):1385–92.

Nigmatullin RR, Baleanu D, Dinç E, Üstündag˘ Z, Solak AO, Kargin RV. Analysis of a nano-film of the mercaptophenyl diazonium modified gold electrode within new statistical parameters. J Comput Theor Nanosci, in press.