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Original Article

Cyclical and seasonal patterns of India's GDP growth rate through the eyes of Hamilton and Hodrick Prescott Filter models

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Abstract

The paper endeavours to analyse the cyclical fluctuation, seasonal movement and trends of Indian GDP growth rate by applying both Hodrick-Prescott filter and Hamilton filter models taking St.Louisfred quarterly data from 2011Q4 to 2019Q4.The paper concludes that the seasonal adjustment and actual GDP growth rate of India have been merged with each other and they are identical in both the models. But the cyclical trend in H.P.Filter showed one upward humped but Hamilton filter showed cyclical fluctuations with two peaks and troughs and the seasonal variations are v shaped and highly volatile. Hamilton seasonal variations have been verified by applying residual test of correlogram which explained that autocorrelation and partial autocorrelation functions moved around both the sides significantly. Hamilton regression filter model is extended to forecasting ARIMA (1,0,0) model for 2030 which confirmed stationarity and stability. Even, the final trend cycle of GDP growth rate of India converges towards stationary process for 2025. Countercyclical fiscal and monetary policy including financial management strategies have been incorporated.

Keywords:*Cyclical trend; seasonal fluctuation; H.P.Filter; Hamilton filter; Autoregressive Integrated Moving Average*

Introduction

Now-a-days, the decomposition of time series with trend and cyclical components is commonly used in macroeconomics such as potential output, natural interest rate, share prices and inflation rate and so on. Filtering technique of a time series data either in short run or in long run trends have been applied in the econometric analysis widely. Methodology of filter can be used to decompose a time series into trend, cycles, seasonal and irregular components. There are two types of filter: symmetric or asymmetric. Robert Henderson (1916) derived moving average with filters which are of both symmetric and asymmetric.

The fixed length symmetric filter was explained by Baxter-King (1999). This model can isolate components that have a cyclical duration of no less than six quarters and of no more than 32 quarters. The model sought to fulfill their requirement in a band pass filter that should ideally have instantaneous transitions at two frequency values. Christiano-Fitzgerald (2003) explained both the symmetric and asymmetric filter with stationary and non-stationary processes. This method can fit a process embodying a first order random walk and attributable to a single unit root within an autoregressive operator. Even it may be appropriate to extrapolate the data at the levels of the end points.

The spectral density is a primary process of showing cycle under the ARMA(p,q) technique which shows the fluctuations of a series where spectra density function is expected value of a periodogram or autocovariance which means a graph of the spectra density or conversely, the periodogram can be used as an estimator of the spectra density. The spectra density function of a time series data shows amplitudes of oscillatory signals.

A multivariate filter can be developed by the Band pass filter which is an optimal approximation to the ideal filter that isolates a specified range of fluctuations in a time series. Band pass filters are useful in measuring the business cycles components of macroeconomic activities. It can eliminate quadratic deterministic trends from a time series. Both the high pass and band pass filters are easily constructed from low pass filters. The ideal high pass filter passes components of the data with periodicity less than or equal to p=32.A low pass filter removes high frequency cycles while retaining low ones. The high pass filter does the reverse task. A band pass filter can be applied through autoregressive process also. Business cycles volatility can be easily measured by band pass filter with k=20.Hodrick-prescott filter (1997) with λ=1600 in quarterly data produces a reasonable approximation to a high pass filter. On the other hand, assuming λ=100, H.P.filter is considered as a band pass filter where components of data with cycles between 9 to 16 years.

The methodology of H.P.Filter (1997) has been used as a low pass smoothing filter in a numerous macroeconomic investigations setting smoothing parameter to certain arbitrary conventional values. It can decompose trend and cycles of the time series data to produce new time series such as potential GDP and output gap that are useful in macroeconomic discussions and in some recent public debates. It also useful in the technique of ARMA forecasting process that can deliver the required forecasted values that are required in H.P. algorithm. The cyclical component obtained by H.P.Filter is unpredictable which indicates that the econometrician cannot do any investigation into the cyclical component because they are independent.

Hamilton filter (2018) has claimed that H.P.Filter creates spurious dynamic relation and it fails to eliminate spurious predictability,produces values for the smoothing parameter vastly at odds with common practice. It is not also a sensible approach for a random walk. Therefore, Hamilton used regression variable at date t+h on the four most recent values as of date t which is a better alternative to detrend and to extract cyclical components. Hamilton also assumes random walk so that the cyclical component is estimated as y_{t+h}– $y_t$which is predictable and can perform much better than the H.P.Filter model.

In analysing the filter methodology, Pollock (2018) opined that filter should be designed with reference to their frequency responses where these filters should be implemented in the frequency domain in which data should be free of trend that will be able to alleviate the end -of-sample problems.

Therefore, the paper seeks to derive both H. P. Filter and Hamilton filter in the GDP growth rate series of India taking the quarterly data from 2011Q4 to 2019Q4 in order to decompose trend, cycle and seasonal variations to show the comparisons with each other. Moreover, the paper applies ARIMA (p, d, q) model in the Hamilton filter in order to forecast Indian GDP growth rate for the year 2030.The paper also suggests countercyclical fiscal and monetary policy in context of financial management in recessionary period.

Review of Literature:

The author studied some valuable economic literature which are closely relevant in the analysis of this paper. Batcher and Dua(1997) applied recursive Hamilton filter to determine whether and how the conference Board indexes of consumer confidence can help to predict the ends of booms and recessions. This simple version of the Hamilton filter produces better ex-ante predictions than more complex version.

Mohr (2005) studied that the trend cycle filter has better end -of-sample properties than the H.P. filter when using it in GDP of four selected eurozone countries during 1970-2002 and author concluded that trend cycle filter provides a richer and scholastic model as it explicitly accounts for the cycle and estimates better forecast.

Higgins and Ofori-Acheampong (2018) examined estimation of conditional maximum likelihood method with Hamilton filter to identify asset price bubbles in the S & P 500 index during 1888 January to 2010May and detected multiple bubbles and found the explosive bubbles which tend to immediately precede recession periods and collapsed bubbles when coincide with recession.

Schuler (2018) applied Hamilton filter in the credit to GDP gap in USA taking data of GDP from Fred during 1947Q1-2017Q1 and data of credit GDP ratio from BIS during 1952Q1-2016Q4 which produced more robust cycle estimates than H.P. filter. On the other hand, Diallo (2018) utilised Hamilton filter as an alternative to H.P. high pass-filter and remarked that it is a superior alternative.

Colak, Guney, Senol and Yilmaz (2019) applied Hamilton filter model with other filters like H.P.filter, Butterworth filter, Christiano-Fitzgerald filter to construct indicators to determine the episodes of moderate to expensive credit slowdown and expansion during 2007-2019 in Turkish banking sector.

Bosupeng (2019) applied both the H.P. Filter and Hamilton regression filter to compare the application in tourism demand and determined the variability of H.P. filter in forecasting tourism demand and studied feasibility in investigating trend analysis of tourism demand especially by Hamilton filter.

Based on Hamilton filter, Quast and Wolters (2019) found that real time output gaps are economically much more meaningful measures of the business cycle than those based on simple statistical trend cycle like H.P. Filter model.

Jonsson (2020) verified that the similar dynamics can be found in the cyclical component of H.P. Filtered and Hamilton filtered series when applied to identical time series. If the sheer magnitude of the cyclical dynamics from H.P. filter is deemed problematic than the cyclical dynamics of Hamilton filtered series, then it could be equally problematic.

Cekin, Gupta and Olson(2020) used Hamilton filter in using Taylor curve to determine deviations of monetary policy from an efficiency locus for UK, Germany, France, Italy and Spain during 2000-2018 and found that deviations in UK occurred during global financial crisis and post-Brexit period and on the other hand, eurozone members experienced more volatile deviations around 2001.

Methodology and sources of data

Assume x_t variable has T observations where Hodrick-Prescott Filter model (1997) has been applied to interpret the trend component g_t as a very smooth series that does not differ too much from the observed x_t. It is calculated by minimising the equation(g_t) from t=-1 to T given below**.**

$$1/T\{\Sigma(x_t-g_t)^2+\lambda/T\Sigma[(g_t-g_{t-1})-(g_{t-1}-g_{t-2})]^2\}$$

Where Σt=1 to T, T=observations, λ=constant.

When the smoothness penalty λ tends to zero, then g_t will be just the series x_t itself, whereas when λ tends to infinity, the procedure amounts to a regression on a linear time trend (that is, produces a series whose second difference is exactly zero).The common practice is to use a value of λ=14400 for monthly data series and λ=1600 for quarterly data series.

The solution is obtained by

$$g^*=(H'H+\lambda Q'Q)^{-1}H'x=A^*x$$

The inferred trend g_t^* for any date t is thus a linear function of the full set of observations on x_t for all dates.

Where the vector $H(TXT)=[I_T(TXT) \quad 0(TX2)]$

And the matrix Q(TXT)=

$$\begin{matrix} 1\ -2\ 1\ 0 \ldots\ldots 0\ 0\ 0 \\ 0\ 1\ -2\ 1 \ldots\ldots 0\ 0\ 0 \\ \ldots\ldots\ldots\ldots \\ \ldots\ldots\ldots\ldots \\ 0\ 0\ 0\ 0 \ldots\ldots -2\ 1\ 0 \\ 0\ 0\ 0\ 0 \ldots\ldots 1\ -2\ 1 \end{matrix}$$

Hamilton (2018) regression filter model is expressed in the following manner when the data are quarterly.

$y_{t+8}=\alpha_0+\alpha_1 y_t+\alpha_2 y_{t-1+}\alpha_3 y_{t-2}+\alpha_4 y_{t-3}+v_{t+8}$

where y=variable to be regressed.

Or, $v_{t+8}=y_{t+8}-(\acute{\alpha}_0+\acute{\alpha}_1 y_t+\acute{\alpha}_2 y_{t-1}+\acute{\alpha}_3 y_{t-2}+\acute{\alpha}_4 y_{t-3})$

So, $y_t=\alpha_0+\alpha_1 y_{t-8}+\alpha_2 y_{t-9+}\alpha_3 y_{t-10}+\alpha_4 y_{t-11}+v_t$

Therefore,$v_t= y_t-(\acute{\alpha}_0+\acute{\alpha}_1 y_{t-8}+\acute{\alpha}_2 y_{t-9}+\acute{\alpha}_3 y_{t-10}+\acute{\alpha}_4 y_{t-11})$ where $\acute{\alpha}_i$ are estimated.

$v_{t+h}=y_{t+h}-y_t$ is the difference i.e. how the series changes over h periods. For h=8, the filter $1-L^h$ wipes out any cycle with frequencies exactly one year and thus taking out both long run trend as well as any strictly seasonal components.

It also applies random walk: $y_t=y_{t-1}-\varepsilon_t$ where d=1 and $\omega_t^h=\varepsilon_{t+h}+\varepsilon_{t+h-1}+\ldots\ldots\ldots\ldots+\varepsilon_{t+1}$

Regression filter reduces to a difference filter when applied to a random walk. Hamilton suggested h=8 for business cycles and h=20 for studies in financial cycles. Regression v_t converges in large samples to $\alpha_1=1$ and all other $\alpha_j=0$. Thus, the forecast error is $v_{t+h}=y_{t+h}-y_t$.

The residual equation v_t can be decomposed into trend, cycle and seasonally adjusted through SEATS/TRAMO or STL or census X-13 packages. The Hamilton regression filter residual is passed through ARIMA (p, d, q) model for forecasting at date using Box and Jenkins (1976) model.

Box and Jenkins (1976) methodology of ARIMA (p, d, q) can be estimated as below.

$x_t= a+ b_i x_{t-i}+ \varepsilon_t+ b_{oi}\varepsilon_{t-i}+ \grave{e}_t$wherex$_t$ is the variable, a is constant, b_i are the coefficients of AR process and b_{oi} are the co-efficients of MA process and $\grave{e}_t$ is residual and i=1,2,…….n, and t= time. If b_i and b_{oi} are less than zero and significant at 5% level, then the model is convergent and significant. If the roots of AR and MA are less than one, then the model is stable and stationary.

Quarterly data of India's GDP growth rate per cent per quarter from 2011Q4 to 2019Q4 at constant prices have been collected from the Federal Reserve Bank of St.Louis which is available from https://www.fred.stlouisfed.org.

Result & Discussion:

India's GDP growth rate has been declining at the rate of 0.47% per quarter during 2011Q4 - 2019Q4 which is derived from semi-log linear trend model which is not significant at 5% level.

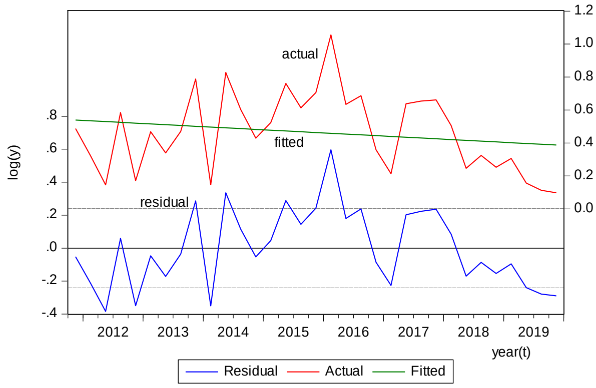
Log(y)=0.544147-0.004749t

(6.34)* (-1.07)

R^2=0.036, F=1.16, DW=1.35, where y= growth rate of GDP at constant price. *=significant at 5% level.

In Figure 1, the declining estimated trend line along with actual and residual series have been given.

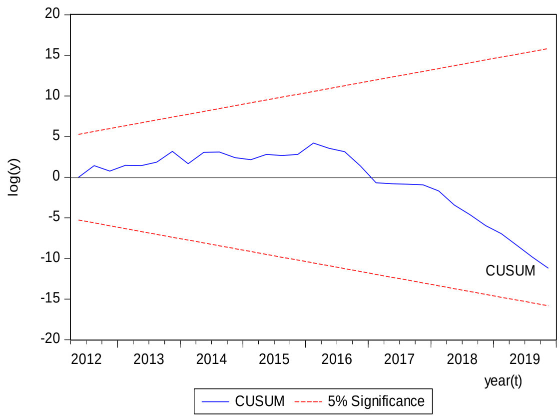
Figure 1: *Linear Trend line*



Source- Plotted by author

The stability test of residuals of the estimated trend line through CUSUM of squares test is significant at 5% level which is shown below.

Figure2: *Stability test*



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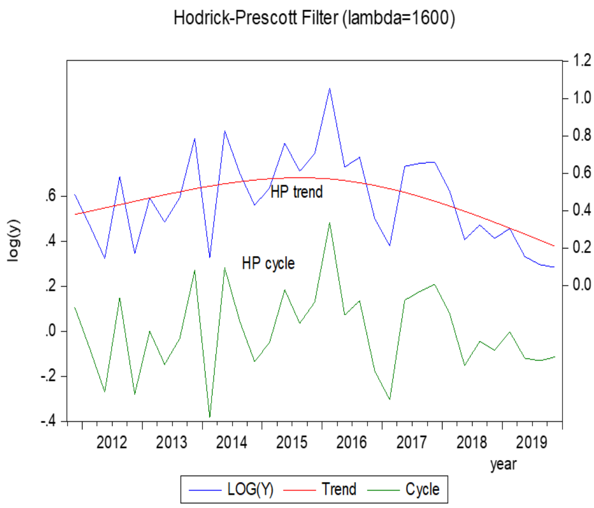
In order to applying H.P. Filter model to get smoothness of trend and cyclical pattern of the quarterly data of India's GDP growth rate assuming λ=1600, the paper found that the trend pattern is smoothly cubic with rising and then falling gradually having only one hump.

Figure 3: *H.P. Filter model*



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But the cyclical path of the GDP growth rate consists of 10 peaks and 11 troughs showing extremely volatile with declining pattern. Most of the cases, the duration of revivals is longer than the duration of recessions but in post $2017Q_2$ period, the duration of recessionary trend is very strong.

The regression model of Hamilton is not a good fit with a very low R^2 and F value. All the t statistic of lag 8 to lag 11 showed insignificant.

$Log(y)= 0.6823-0.024log(y)_{t-8}+0.0284log(y)_{t-9}$

(2.94)* (-0.089) (0.115)

$-0.2337log(y)_{t-10}-0.16105log(y)_{t-11}+v_t$

(-0.958) (-0.648)

R^2=0.0826, F=0.382, DW=0.682, AIC=0.366, SC=0.614, *=significant at 5% level.

Therefore, residual $v_t=logy_t-[0.6823-0.024log(y)_{t-8}+0.0284log(y)_{t-9}-0.2337log(y)_{t-10}-0.16105log(y)_{t-11}]$

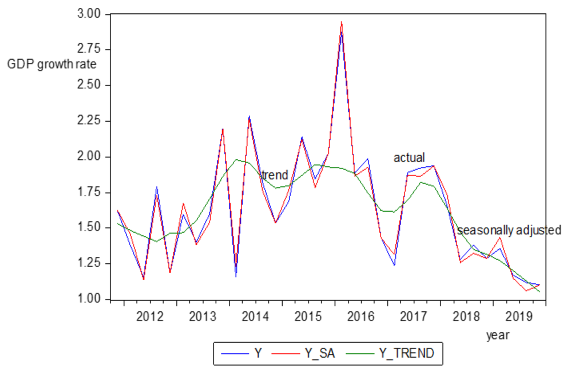
The Hamilton regression filter model is depicted in Figure 4 where the residual and fitted series of GDP growth rate during 2011Q4-2019Q4 are irregular and multiple trending. The estimated trend line of the growth rate of India flattens with a sign of rising after 2018Q3 but the residual series which explains the Hamilton model contains one spike of expansion with small 6 peaks and 5 troughs, but it steadily fell down since 2017Q4.

Figure 4: *The residual and fitted series of Hamilton regression*

Source-Plotted by author

The residual series v_t of Hamilton filter has been seasonally adjusted with a cyclical trend line through the STL method and found in a grouped figure where it was found that cyclical trend of Hamilton filter is more smoother than the H.P.Filter since it consists of only 3 peaks and 3 troughs where duration of expansion and recessions are long. The seasonal adjusted series and actual series of GDP growth rate of India have been nearly merged with each other because the Fred quarterly data of India's GDP growth rate are already seasonally adjusted.

Figure 5: *Trend and seasonal series of Hamilton*



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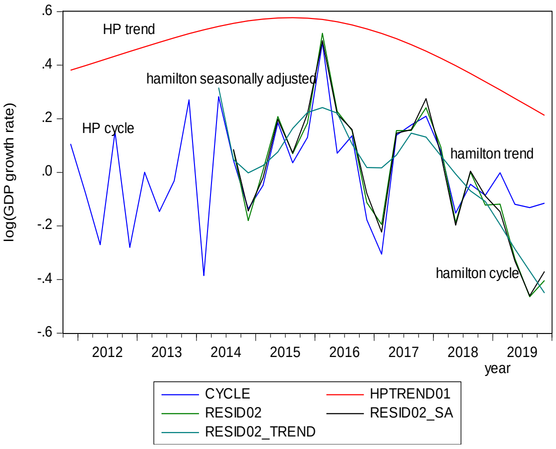
In the Figure 6, the combined results of both H.P. Filter and Hamilton Filter of GDP growth rate of India in a single figure has been compared. The cyclical trend of H.P. Filter has one upward hump, but the cyclical trend of Hamilton filter showed 2 peaks and 2 troughs with clear cyclical trend of quarterly data which declines steadily. In both the cases, the declining trend is permanent and clear. But the seasonally adjusted series of both H.P. Filter and Hamilton filter are more or less identical and similar to their actual series showing many peaks and troughs. Since lag 8 is included in Hamilton method therefore the seasonal adjusted series starts from 2014 onward.

Figure 6: *Hamilton and H.P. filter compared*.



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Hamilton regression filter of India's GDP growth rate during 2011Q4 -2019Q4 has been decomposed into residual, trend, seasonal variation and seasonally adjusted series in a composite Figure 7 with 5 panels of figures. Panel 1 describes the residual series of Hamilton filter model which showed 6 peaks and troughs having declined in patterns. Panel 2 explains that the smooth cyclical trend line of Hamilton filter showed downward trend with two peaks and troughs which explained slow revival and steady declines. Panel 3 explains the seasonality in which high volatility with seasonal fluctuations in every year were observed. The seasonal variations are v shaped. Panel 5 described seasonally adjusted line of Hamilton filter of India's GDP growth rates where two peaks were seen during revival from 2014 to 2016 and seasonality declines steadily up to 2017 and then from 2018Q3 to 2019Q3 respectively.

Residual series of Hamilton's filter of GDP growth rate of India during 2011Q4 to 2019Q4 has been tested through correlogram where autocorrelation and partial autocorrelation functions satisfy the properties of seasonality patterns of filters, but the probabilities of Q-stat are accepted for autocorrelation problems. The positive and negative autocorrelations and partial autocorrelations have been ranging within 5% significant level. In the Figure 8 the values have proved the patterns.

Figure 7: *Decomposition of Hamilton filter*

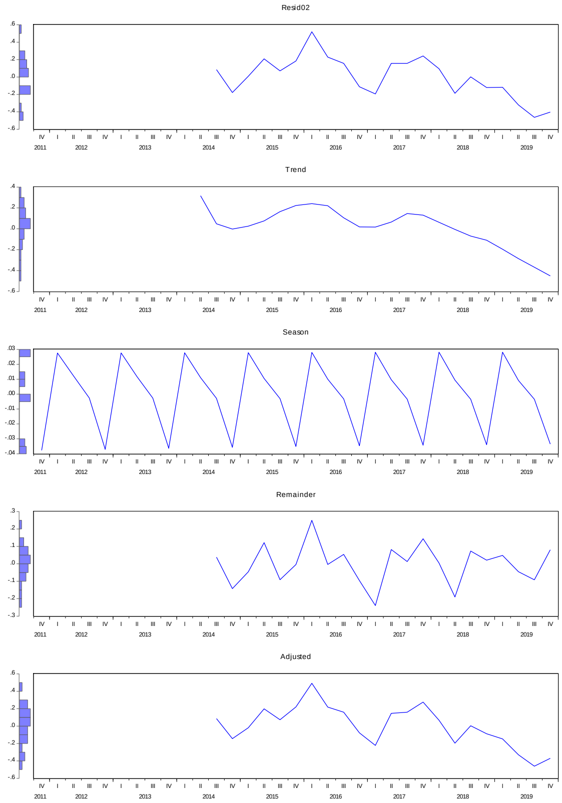

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Figure 8: *Residual test for correlogram of Hamilton filter.*

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.264	0.264	1.1973	0.274
		2	-0.326	-0.425	3.1798	0.204
		3	-0.423	-0.247	6.8187	0.078
		4	-0.176	-0.146	7.5101	0.111
		5	0.027	-0.174	7.5284	0.184
		6	-0.017	-0.294	7.5367	0.274
		7	-0.050	-0.245	7.6158	0.368
		8	0.119	-0.071	8.1425	0.420
		9	0.181	-0.130	9.6069	0.383
		10	-0.039	-0.322	9.6930	0.468
		11	-0.001	0.035	9.6931	0.558
		12	-0.061	-0.258	10.107	0.607

Source- Plotted and calculated by author

Residual test for heteroscedasticity of the Hamilton filter model in case of GDP growthrate is estimated below where t values of all the coefficients have been found insignificant and R^2 and F are also low and insignificant. Observed R squared is accepted for heteroscedasticity through ARCH(4) model which is given below.

$$\varepsilon_t^2 = 0.0331 + 0.3963\varepsilon_{t-1}^2 - 0.5667\varepsilon_{t-2}^2 + 0.3061\varepsilon_{t-3}^2 - 0.2347\varepsilon_{t-4}^2$$

(1.09) (0.78) (-1.30) (0.61) (-0.405)

R^2 =0.28, F=0.486, AIC=-3.08, SC=-2.93, DW=1.69

nR^2 =2.8019 where probability of $\chi^2(4)$=0.59

To check ARIMA forecasting model, Hamilton filtered residual series of GDP growth rate of India during $2014Q_3$-$2019Q_4$, the paper selected AR(1) of the level series of residual from the 25 best models whose ARMA maximum likelihood estimate is shown below.

$$(Residual)_t = -0.023255+0.6514\,(Residual)_{t-1}+0.0320\sigma^2_t$$

$$(-0.20) \quad (3.0430^* \quad (2.41)^*$$

$$R^2=0.402,\ F=6.39^*,\ DW=1.86,\ AIC=-0.305(min),\ SC=-1.56,\ n=22,\ AR\ root=0.65$$

This ARMA forecasting model is a good fit with high R^2 and significant σ^2 and AR(1) and the root of AR(1) is less than one which implies that the model is stable, stationary and convergent.

In Figure 9, the stable and stationary ARIMA (1,0,0) forecasting model for $2030Q_1$ is seen clearly where the forecasting line moves towards equilibrium. The forecasting period is significant at 5% level which is marked by green vertical lines.

Figure 9: *Forecasting Hamilton residual*

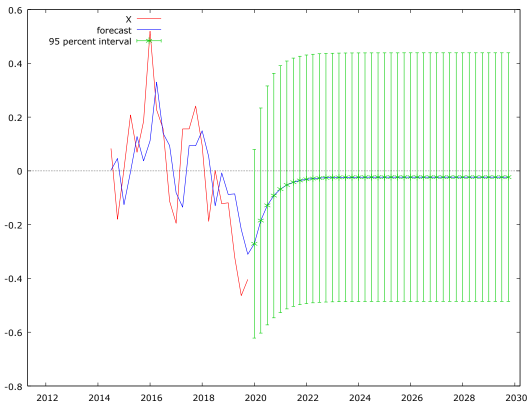

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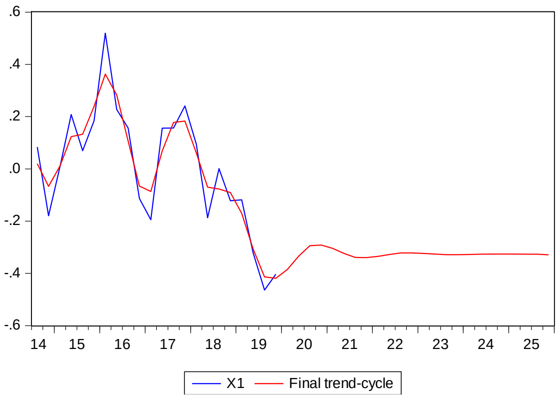
Figure 10: *Final trend-cycle till 2025Q4.*



Finally, the residual series of Hamilton's filter model has transferred to seasonal adjustment through TRAMO/SEATS method and it was found that the final trend-cycle of the series up to $2025Q_4$ stabilizes without seasonal fluctuations which was depicted in Figure 10 showing a signal of upward trend of GDP growth rate in India after 2019Q4 and then stabilizes.

Policy Framework and Financial Management

Since 2017Q3, India's GDP growth rate have been shown as overall downward trend which can be considered as recessionary trend for which the model is needed for countercyclical fiscal and monetary policy. As regards, countercyclical fiscal policy, increase in government spending to enhance effective demand is popular where new tax reform policy like progressive and proportional taxes can be implemented for creating additional government revenue. Countercyclical discretionary fiscal policy will also affect economic activities. Government fiscal deficit plan and targeted expenditure on consumption spending should be short and medium term in order to revive recovery trend.

In pursuing countercyclical monetary policy, government money supply should be increased in the form of new credit flows with low interest rate so that additional investment can create new employment generation in firms which will be able to produce increased national income. Government can encourage new small and medium industries to spare cheap credit flows through banks to enhance transitory demand for labour. Volatility of share market indices should be well managed fashion so that liquidity demand may not short fall and financial crises may not break out. Because, fiscal balances are positively related with the growth of asset prices and also related with openness so that control of international share prices and international trade increase during the recovery. Security and protection of financial institutions with implementing strong managerial skill and efficiency providing training to learn necessary financial management regulations, monitoring in credit flows and repayment structures must be conducted through central regulatory authority. Employment potentiality can be judged through human resource management programme in all firms and sectors. Short term and medium terms credit should be carefully granted in proper channels in stipulating demand for employment and output. Monetary policy in course of changes in output gap as well as inflation as a counter cyclical policy must have positive coefficients. So, growth of the cycle depends on speed of transmission mechanism and strength of the monetary policy. Increasing capital flows and foreign direct investment during recession is an important mechanism in controlling exchange rate and international financial integration where product market regulation, price wage rigidities are the structural reform policies. Greater financial integration and cross border capital flows can influence interest rate and transmit exchange rate and produce wealth effect which can offset policy impulse. So, asset price bubble that spur inflation should be driven by a credit boom and prudential regulation.

Some important financial management decisions should be carefully noted such as:

[i]Invest in well-managed companies which have low debt, enough cash flow and strong balance sheet,[ii]In recession, counter cyclical stocks do well,[iii]Utilities, consumer staples and discount retailers have more recessionary resistant,[iv]create new investment plan during recovery from taking advice from advisory board,[v] take advantage from the strategy of shifting from active fixed income to passive fixed income to face less risk in recession,[vi]A good investment advisor can coach risk tolerance and financial goal to ensure appropriate investment strategy during recession.

As policy targets in financial management in recessionary phases the following are the keys for an individual or a firm or a financial institution:

[i]Switch to less volatile funds,[ii]check home price change,[iii]diversify the portfolio to reduce risk,[iv]provide larger funds for emergency(i.e., a combination of ultra-short term debt funds and flexi-fixed deposits is good for emergency),[v]reduce discretionary spending, [vi]keep medical insurance safe,[vii] plan to formulate debt strategies,[viii] calculate a debt pay strategies,[ix] boost emergency saving,[x]create monthly budget,[xi]identify risk tolerance,[xii]stop high risk investment plan,[xiii] create low risk investment plan.

For improvement of human resource development in recession, the following are key targets of policy issues.

[i] Conduct long term plan also,[ii]conduct regular check up your business,[iii] attentively listen to your employees,[iv]build a lean and efficient team,[v] think always for betterment, [vi] be positive attitude towards business on consistency and review the situations.

Since the first quarter of 2020 in India, the covid-19 has been disrupted the recessionary trend of GDP growth rate abruptly where growth rate may be turn to zero or negative along with other developed nations when India's international trade shares will fall, national production and employment will decline steeply and sectoral GDP shares will decrease sharply along with other sectors. Government fiscal stimulus package is so insufficient to uplift the economy from recession to recovery that duration of recovery must be longer than predicted. In this context, renovation of money market and product market are urgent to regenerate employment speedily.

Limitations and future scope of study

The empirical research on India's GDP growth rate through Hamilton and H.P. Filter method suffer from some issues of methodologies especially in applying ARIMA model for forecasting and on decompositions or on cyclical trending. Graphical representation of SEATS/TRAMO or seasonal variation in this paper lack some theoretical explanations. The seasonality and cyclical trend in case of GDP growth rate at current prices may slightly differ from this analysis. Lastly, long term data require for more steady findings. Taking experience from previous recessionary periods about key countercyclical policy indicators, the paper could project some of key empirical indicators of countercyclical policies for India so that paper would be enriched. There are enough scopes in these areas for future research.

Conclusion:

The paper concludes that the trend line of GDP growth rate of India during quarterly data from 2011Q4 to 2019Q4 showed a decline rate of 0.47% per quarter which is insignificant, but stability test is significant at 5% level. H.P. Filter trend is upward humped but cyclical pattern have 10 peaks and troughs. Hamilton regression filter equation is insignificant but seasonally adjustment and actual series have been merged since data are seasonally adjusted but cyclical trend is very much prominent with three peaks and troughs. There is a sharp difference of cyclical trend in H.P. filter and Hamilton filter models but seasonal adjustments are identical. TRAMO/SEATS of Hamilton filter produce clear seasonal variation showing v shaped volatility and cycles confirmed two peaks. ACF and PACF of Hamilton residual series verified the nature of seasonality. Residuals suffer from heteroscedasticity problem. ARIMA (1,0,0) process of Hamilton filter for forecasting 2030 converges to stable and stationary processes. Final trend cycle of GDP growth rate of India for 2025 of Hamilton filter converges to stability. Impact of covid-19 on Indian GDP growth rate is inverse which compelled to fall in GDP growth rate to 3.12% in 2020Q1 which is estimated by NSO. It may be negative in the next quarter. If these data are added in both the models the seasonal and cyclical fluctuations will be less deterministic and stationary property might be broken. Therefore, some important counter cyclical fiscal and monetary policies including some financial management strategies have been included for implementation.

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Conflicts of Interest:

The authors declare that the research has been conducted in the absence of any commercial or economic associations that could be construed as a potential conflict of interest.

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