

Does policy rate follow Taylor's Rule or not?

Monetary policy discussions often centre around what the factors or choice variables are that influence policy decision. To answer the same, one such simplified rule-based formula i.e. Taylor's rule is widely used to explain the dynamics of monetary policy. In simple words Taylor's rule is an algebraic formula showing the responsiveness of policy rate to deviations in inflation and output from its potential/targeted level. It has its own set of limitations, especially for India, since there are no official estimates of potential GDP and equilibrium real interest rate. However, the simple formula makes it appealing. In this exercise, we try to calculate Taylor's rule-based rate discounting the complexities of rigorous research and see how its trajectory has evolved compared to actual policy repo rate. The exercise is done post the adoption of flexible inflation targeting framework, as India adopted a formal inflation target. The results are interesting. It shows there exists directional convergence between Taylor's rule-based rate and actual policy rate. In fact, Taylor's rule-based rate is more responsive to inflationary shocks. On the other hand, actual policy rate incorporates a wider set of information in its reaction function and hence is more calibrated.

Taylor's Rule in retrospect:

In today's world of ever-changing macro and market dynamics, monetary policy rules are difficult to follow any sacrosanct algebraic formula. Policymakers deal with multiple endogeneities in a real-world scenario which is difficult to interpret in terms of policy rules or any specific equation. Taylor's Rule is a hypothetical but representative policy rule. In simple words, it shows the responsiveness of policy rate to changes in price level and real income. Taylor's rule practical application centres around two case studies- German unification and 1990 oil price shock. There also have been several instances where discretion-based policies precede rule-based policy. The example of Black Monday-stock market crash on 19 Oct 1987 and Federal Reserve pumping abundant liquidity as an immediate response, is one such instance where Taylor's rule does not fit in, as it ignores episodes of high financial volatility. Even in today's world of complexities, the rule may not strictly adhere to the decision making of global central banks. However, it can give some directional approach or a forward guidance to where policy rate is headed. The advantage of this rule was that it expressed a complicated phenomenon of monetary policy reaction function in very simple terms (McCallum, 1999).

The main assumption of Taylor's rule is that each central bank adjusts its short-term interest-rate regime in response to changes in the price level and real output from a target, under a flexible exchange rate regime. In simple form Taylor's rule is:

$$r = p + .5y + .5(p - 2) + 2$$

where r is the federal funds rate, p is the rate of inflation over the previous four quarters, y is the percent deviation of real GDP from a target. The Constant "+ 2" at the end represents the equilibrium real interest rate (r^*). The original "Discretion versus policy rules in practice, John B Taylor", paper assumes the 2% "equilibrium" real rate is close to the assumed steady-state growth rate of 2.2% and in consonance with the neutral stance of the economy. It is to be noted that the deviation of p from 2 is the deviation of inflation from the targeted 2% level, set by the Federal Reserve.

To interpret the equation, the (original) Taylor rule predicts that the FOMC will raise the Federal funds rate (tighten monetary policy) by one-half percentage point:

- (1) for each percentage point that inflation rises relative to the Fed's target (2%), or
- (2) for each percentage point that that output rises relative to its potential.

The paper also highlights that there is not a consensus about the size of the coefficients of policy rules, it is more of a representation. The simple way to read the Taylor's Rule is that Federal funds rate changes when inflation and output deviates from its targeted level. Another important thing highlighted in the original paper is that the signs of the response coefficients are more important than the magnitude. The magnitudes may vary depending on the sensitivity of aggregate demand and inflation to interest rates. Thus, different central banks can have different values of the coefficient depending on their degree of sensitivity and aversion to inflation and output or employment volatility.

Taylor's Rule in India's Context

In India's context, estimation of inflation and output gap poses significant challenge in terms of adherence to a simple rule-based policy. Inflation gap has still become clearer with the setting of monetary policy committee and adoption of the flexible inflation targeting approach in 2016. Some estimation of deviation of actual inflation from the targeted level of 4+/-2% still can be obtained. However, output gap is still a constraint with no formal targeted growth rate in place.

So, here we use the concept of **potential GDP**, which is not directly observable, to calculate the deviation of actual output from the targeted/potential level. To elaborate on potential GDP, it is the level of output that an economy can produce sustainably over the medium term. It also coincides with stable inflation. Secondly, the degree of uncertainty surrounding the estimates of the output gap and their robustness to new information determines the credibility of the estimate (Alberoa et al., 2013). There are different econometric methods to determine the output gap using simple trend method, Hodrick-Prescott filter, band-pass filter, Kalman filter and the moving average method. However, all these are mere statistical techniques that is directly applied on the GDP series without accounting for any causal relationship or endogeneity of other variables. There are challenges to the same. Data revisions also make estimates of potential GDP unreliable. Especially in today's world, potential growth is likely to change with shifting contours of productivity with AI-led growth, hence the estimates have its own set of limitations. However, for the purpose of our study, we will limit our exercise using the estimates of potential GDP using the HP filter. There have been research papers that showed broad based similarity of estimates of potential GDP based on various filtering methods, providing marginal differences in the scales. Hence, we limit our exercise to HP filter for estimating potential GDP.

Hodrick Prescott (HP) filter is a smoothing technique often used to decompose a time series data into its trend and cyclical component. The trend component may not be stationary. However, the cyclical component is stationary. The cyclical component in other words is the output gap i.e. the difference between actual output and trend component. Applying the HP filter for both quarterly and annual data separately, potential output has been in the range of 7.5-8%. (**Appendix: Details of the breakdown of the series into trend and cyclical component**). The trend is computed by minimising the variance of actual output (y_t) around trend component (τ_t)

$$\min_{\tau} \left(\sum_{t=1}^T (y_t - \tau_t)^2 + \lambda \sum_{t=2}^{T-1} [(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1})]^2 \right).$$

The first component is the distance of trend from data, and the second component represents smoothness of the trend. The values of λ are taken as 1600 for quarterly data and 100 for yearly data.

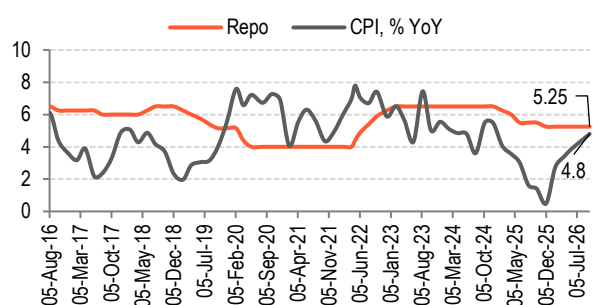
Using the HP filter, the potential growth rate of output is in the range of 7.5-8%. This also aligns with a 3-year moving average of 7.7% and a 10 Year average (excluding Covid years) of 7.4%.

Apart from the problems in estimation of potential output for India, it is also difficult to get an estimate of real equilibrium interest rate as for India, as no concrete information is available. The natural rate has emerged as a benchmark for assessing the policy stance. Recent MPC minutes have also emphasised the importance of real interest rate, with two of the MPC members (Prof Ram Singh and Shri Saugata Bhattacharya) stressing on real rates warranting attention in the current scenario.

In literary terms, when the real policy rate is at or close to the natural rate, monetary policy is neutral. This situation persists when inflation is well aligned to the target level and there is no divergence of actual output from its potential level. Natural rate is also contingent on time horizon and nature of shocks. For India, several research papers have provided different estimates of equilibrium real rate. The Report of the Expert Committee to Review and Strengthen the Monetary Policy Framework has recommended adoption of a real policy rate which should be positive, on average, when inflation exceeds the inflation target. RBI's article titled "Revisiting India's Natural Rate of Interest" has computed equilibrium interest rate in the range of 0.8-1.0% for Q3 of 2021-22. The same paper has pointed out a range of 1.6 -1.8% for Q4 2014-15. An alternative model that takes into account both financial cycles and business cycles to generate the equilibrium real interest rate again shows a higher level at 2.0 -2.1 per cent for Q3 of 2021 22. The paper itself points out that "the natural rate are notoriously imprecise".

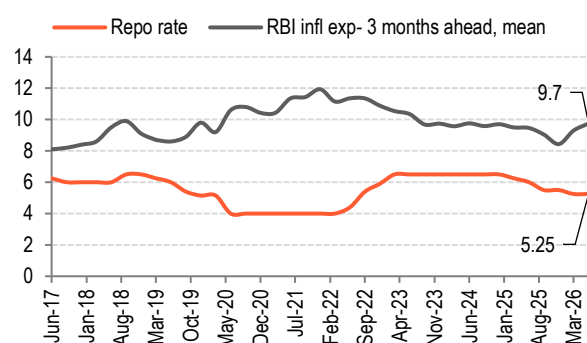
So, the real question is how to arrive at the equilibrium real rates. For the purpose of our analysis, we have assumed real equilibrium rate in the range of 1-1.5%. This range also broadly aligns with the differential between repo and actual CPI in CY26, on average, till date. The average 91-day Tbill rate and CPI differential also is around 1.5% in CY26, till date. If we take the differential between 10Y Gsec and CPI on average for CY26, it turns out to be far higher at 3.1%. Since the volatility of 10Y Gsec has been substantial during the recent episodes, hence we discount this differential from the purpose of our analysis. Another angle that we have looked on is the differential between repo and 3-month ahead inflation expectations (mean). However, the differential is on the far higher side. Hence, we rule out the same in our calculation as inflation expectations are more of a signalling indicator.

Figure 1: Repo-CPI trajectory



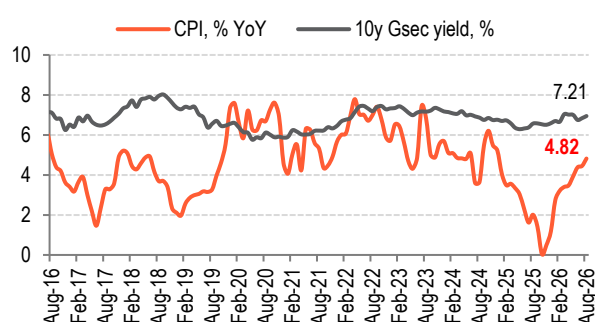
Source: Bloomberg, Bank of Baroda Research

Figure 2: Repo-3 month ahead inflation expectation



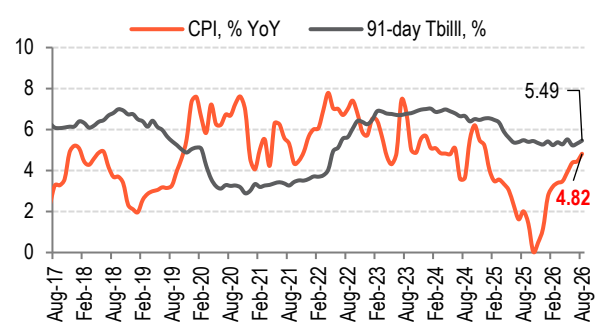
Source: Bloomberg, Bank of Baroda Research

Figure 3: 10Y GSec and Inflation



Source: Bloomberg, Bank of Baroda Research, Note: For 10Y Gsec yield, the last data point is the latest reading

Figure 4: Inflation and -91-day TBill



Source: Bloomberg, Bank of Baroda Research, Note: For 91-day TBill, the last data point is the latest reading

Other rigidities associated with using Taylor's Rule in India's context entail around 1) availability of different policy variables with a lag while decision making 2) different measures of inflation. With flexible inflation targeting in picture, the targeted variable is headline CPI. Hence there is less of ambiguity on at least choice of variable of inflation. However, for India, there has been considerable divergence of different measures of inflation. GDP deflator is not easy to interpret with the complexities of new base year (2022-23). Under the new WPI series, we have also the PPI data, so these are adding new dimensions to India's inflation picture.

Fig.5 shows how historically there has been significant divergence between WPI and CPI basket primarily on account of the difference in composition and weightage of the two separate baskets. Within CPI as well, stripping out volatile components of CPI gives a different picture altogether. The abridged core (core excl. pan tobacco gold and silver and precious metals) is just at 2.8%. However, with the flexible inflation targeting and clear communication of headline CPI as the target variable, this removes a lot of uncertainty at least from the point of calculating inflation differential from the targeted level.

Another problem is associated with the revision in base year for different macro variables. Hence application of Taylor's rule may provide inconsistent results. However, we put aside, these complexities, for the purpose of our analysis as our primary objective is to look for directional coherence between policy repo rate and Taylor's rule-based rate.

Figure 5: CPI-WPI divergence

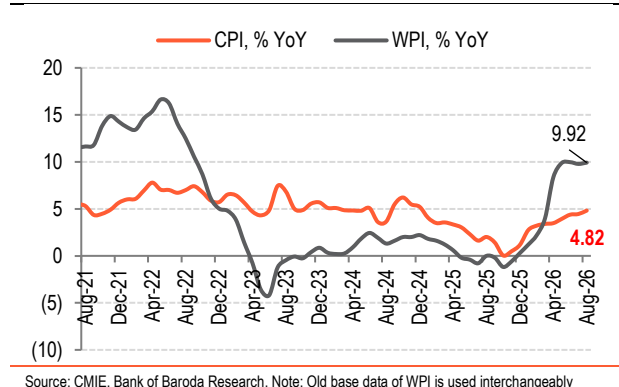
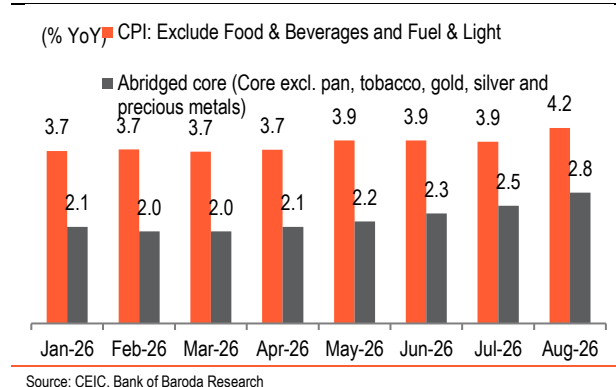


Figure 6: Trajectory of core and abridged core



To sum up the variables of Taylor's rule in India's context:

For the simplification of our analysis, we have considered the equilibrium real interest rate in the range of 1-1.5%. The potential GDP has been taken in the range of 7.5-8%. Annualised GDP is accounted to smooth out the quarterly volatility. Quarterly average of Headline CPI is taken for actual inflation. Targeted inflation is taken at 4%, as set under the flexible inflation targeting framework.

Repo versus the Taylor's Rule rate:

So where does the actual policy repo rate stand in comparison to the Taylor's rule-based rate. The computation of Taylor's rule-based rate is done from Jun'17 onwards since from that time we had the adoption of the flexible inflation targeting framework. Before discussing the Taylor's rule and repo, let us discuss about the different monetary policy cycles that India experienced post the adoption of flexible inflation targeting framework.

Table1. shows that India went through easing phase for majority of the period. The duration of easing cycle has also been higher compared to the tightening cycles. However, the May'22 to Feb-25 tightening cycle was an elaborate one. The quantum of hike in that cycle was also higher at 250bps. So, this can give a historical perspective to how much the potential of hike remains. Now, it will be interesting to see whether Taylor's rule-based rate also suggest similar rates or not?

Table 1: Different monetary policy cycles post FIT regime

Monetary policy cycles	Phases	Quantum of cut/hike, bps	Duration, months
Jan-15 to Jun-18	Easing	200	42
Jun-18 to Feb-19	Tighten	50	9
Feb-19 to May-22	Easing	-250	40
May-22 to Feb-25	Tightening	250	34
Feb-25 till date	Easing	-125	20

Source: Bloomberg, Bank of Baroda Research, Note: Status Quo is also counted as part of the cycles, negative stands for rate cut and + for rate hike

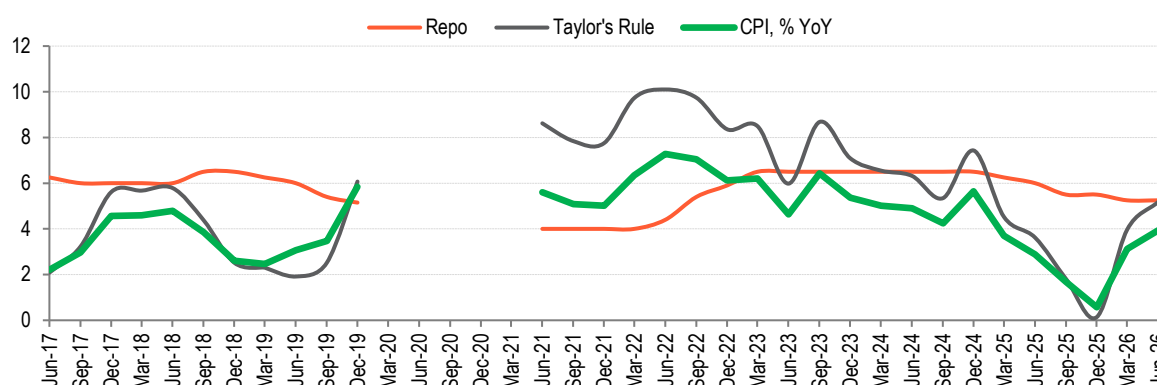
An evaluation of the historical data shows that Taylor's rule has been more sensitive to inflation showing steep increase/decrease with movement in CPI trajectory. Between Sep-17 to Jun-18, when inflation rose persistently, policy repo rate was broadly stable at 6% whereas Taylor's rule-based rate rose from 3.2% in Sep'17 to 5.8% in Jun'18. Policy repo responded with a lag in the next quarter, from

Sep-18 onwards. Hence directionally there is convergence between policy repo rate and Taylor's rule-based rate. However, magnitude differs as policy repo seems to have captured a larger set of information including inflation and output expectations while setting interest rates.

The downward correction of the Taylor's rule in the next easing cycle of Feb-19 to May'22 also happened faster since inflation continued to tread downwards from Dec-18 quarter itself. Hence Taylor's policy rate was much lower at 2.5% compared to repo rate of 6.5%. Here also the response on repo was felt from the immediate next quarter from Mar'19, where it embarked on an easing cycle. So, from the trajectory of actual policy repo and Taylor, it can be seen that policy move is much calibrated and not a knee-jerk response to actual inflation data.

The Covid period data for Taylor's rule should be read carefully on account of the significant volatility in the gap between actual and potential output and it is better to exclude this period as an outlier since HP filter data also showed significant deviation of actual GDP from trend component.

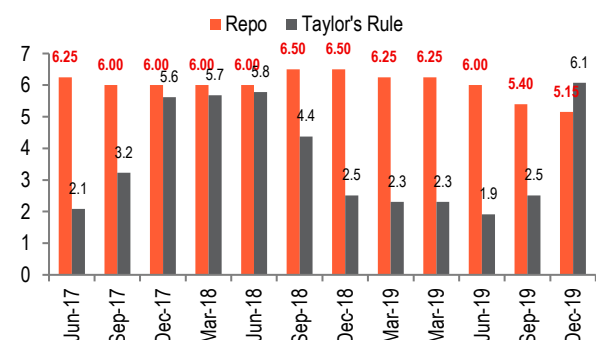
Fig 7: Taylor's rule and repo showing convergence from Jun'26 onwards



Source: Bloomberg, Bank of Baroda Research, Note: Status Quo is also counted part of the cycles

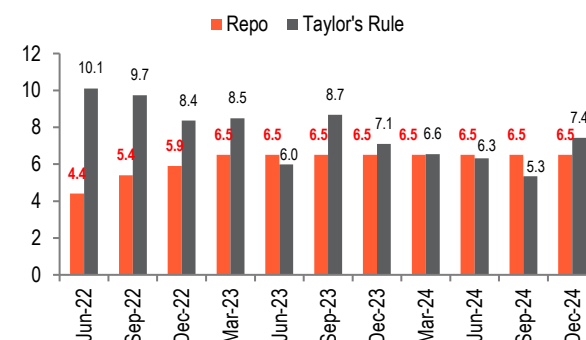
Between 2017-2019 (pre covid period), Taylor's rule estimated a much lower policy rate. However, considering the buoyancy in India's GDP, the policy rate seemed feasible. The next period post Covid especially the tightening phase of May'22 to Feb'25 showed a much higher Taylor's rule-based rate ranging between 5.5-10%. This period also saw a steeper rate hike cycle for repo. Thus, one to one directional convergence between repo and Taylor's rule-based rate, is clearly established in this cycle as well.

Figure 5: Pre Covid Taylor and policy repo rate response



Source: RBI, Bloomberg, CEIC, Bank of Baroda Research

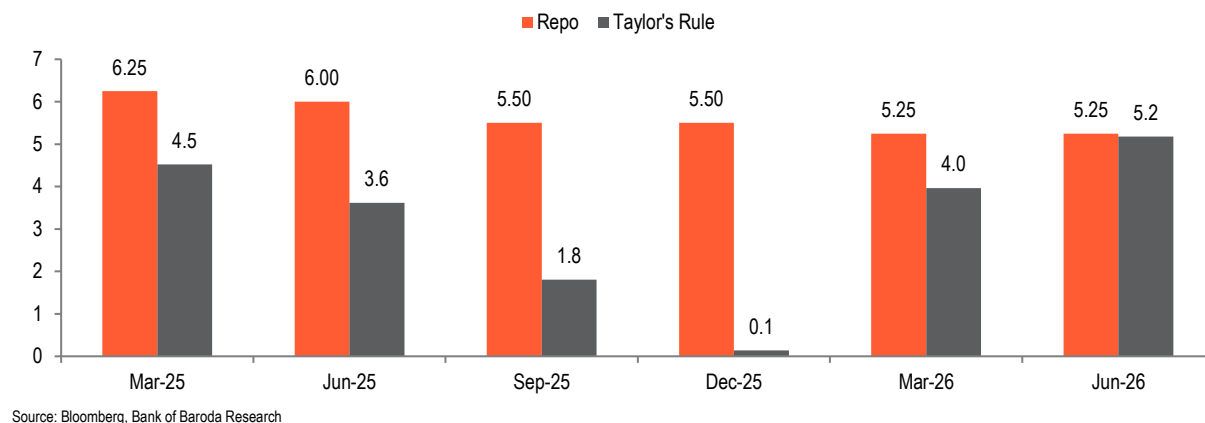
Figure 6: Post Covid tightening cycle, Taylor and policy repo rate response



Source: RBI, Bloomberg, CEIC, Bank of Baroda Research

For the current cycle, Taylor's rule is well aligned to repo, especially since Jun'26 onwards. Using the current run rate of inflation and growth, it shows a rule-based rate of 6.0-6.25% in the current cycle. So it will be interesting to see whether repo will follow the Taylor's rule-based path or not?

Fig 7: Taylor's rule and repo showing convergence in recent times



Conclusion:

1. A theoretical exercise is done to see the trajectory of repo compared to Taylor's rule-based rate, in India's context.
2. Taylor's Rule is a hypothetical but representative policy rule showing the responsiveness of policy rate to changes in price level and real income.
3. In an ever-changing macro dynamic, it has its own set of limitations, however, the purpose of this exercise is to find some directional convergence between policy repo rate and Taylor's rule-based rate.
4. For the purpose of computation of Taylor's rule, India's potential GDP has been taken as 7.5-8% using results of HP Filter. Equilibrium real rate is taken at 1-1.5%, using the rationale of different research papers and computing interest rate (Repo/91-day TBill) and inflation differential. For inflation, quarterly average headline CPI is used and annualised GDP growth data is taken for actual output.
5. The results show that Taylor's rule-based rate is more responsive to inflation trajectory compared to actual policy repo rate.
6. Policy repo rate encompasses a wider set of information. Hence the response is more calibrated.
7. Interestingly, all the easing and tightening cycles of repo coincided with the fall/increase in Taylor's rule-based rate, thus establishing one to one directional convergence.
8. For repo, usually the response time is a one-quarter lag compared to the immediate response of Taylor's rule-based rate to inflationary shocks.
9. The current period data shows repo is well aligned to Taylor's rule-based rate. Going by the current run rate of inflation and real GDP data, Taylor's rule-based rate is likely to be in the range of 6.0-6.25% in the current cycle.

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Appendix:

Using quarterly GDP data

Figure 1: HP filter trend and cycle data using quarterly GDP data

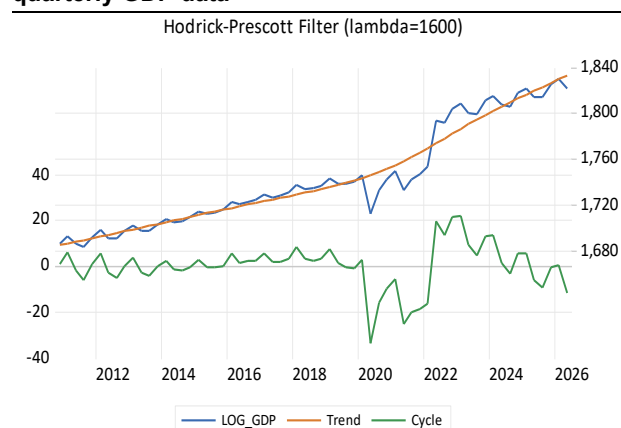


Figure 2: deviation from trend is more pronounced during COVID period

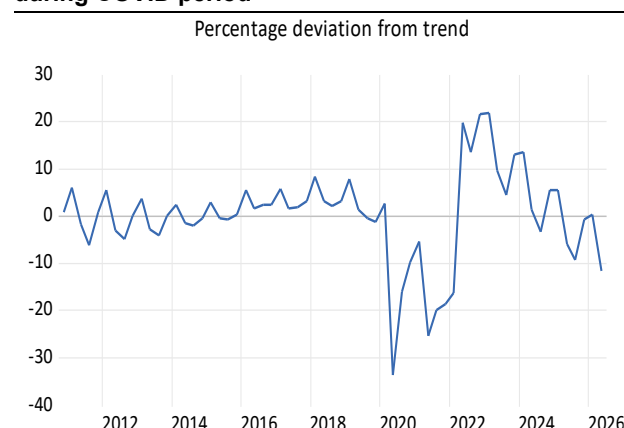
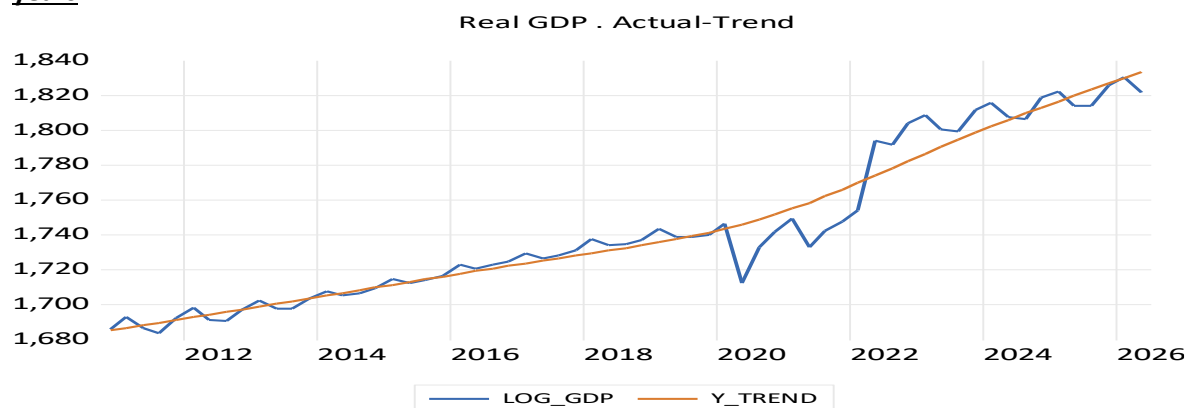


Figure 3: Long term actual output broadly aligned to trend, except for some divergence in recent years



Using Annual GDP data

Figure 4: HP filter trend and cycle data using annual GDP data

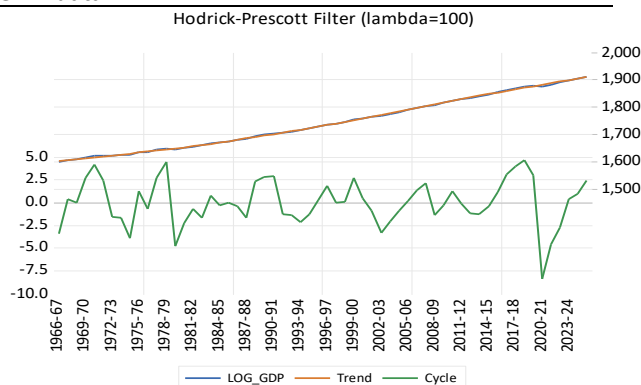


Figure 5: Annual data also shows deviation from trend is more pronounced during COVID period

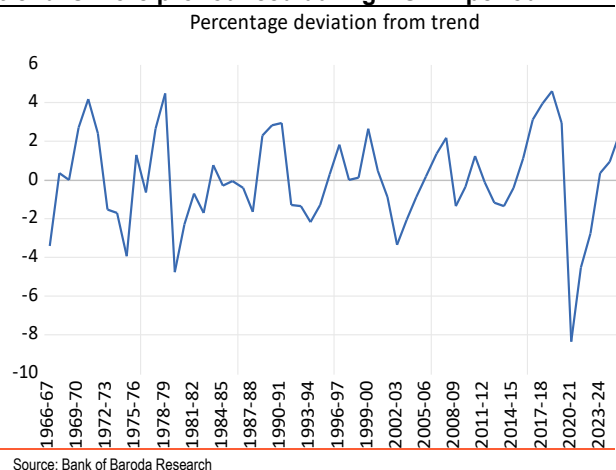
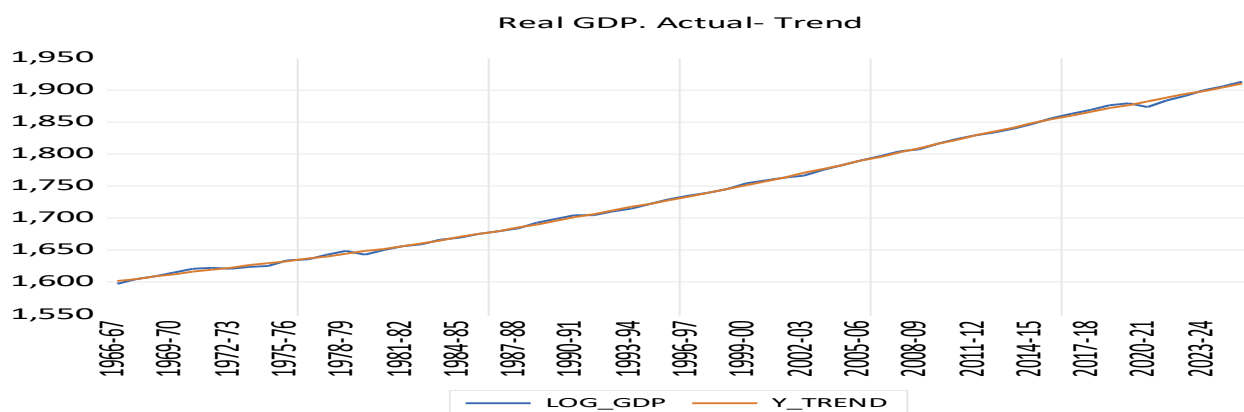


Figure 6: Long term actual output broadly aligned to trend



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