Understanding Monetary policy Rules: Taylor Rule Revisited

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Abstract
John Taylor's seminal work on the econometric analysis of the Federal Reserve was motivated by a desire to understand how central banks can make policy decisions in the presence of incomplete information and uncertain economic relationships. Through his analysis, Taylor found that a rules-based approach to monetary policy delivers optimal outcomes in an economy with rational expectations. While it is not possible to design an algebraic rule that can be followed across different economies and monetary systems, the Taylor rule can be a useful benchmark for analysing central bank behaviour. We thus use the Taylor rule as a starting point to inform our analysis on central bank independence across different geographies with contrasting economic systems, macroeconomic fundamentals and monetary systems. We perform OLS regression for ten countries using several decades of time series data to find how central banks responded to inflation and output gaps. We then use the regression results to draw conclusions about the degree of central bank independence in these nations.

Data Description
Switzerland
The regression models below have used quarterly data from 1990 to 2023. The data was obtained from the Swiss National Bank's Data Portal.

United States of America
The regression models below have used yearly data from 1968 to 2023. The data on interest rates was obtained from the Bank of International Settlements Data Portal and data on inflation and output gap was obtained from the World Bank's Data portal.

South Africa
The regression models below have used yearly data from 1980 to 2023. The data on interest rates was obtained from the Bank of International Settlements Data Portal and data on inflation and output gap was obtained from the World Bank's Data portal.

New Zealand
The regression models below have used yearly data from 1985 to 2023. The data on interest rates was obtained from the Bank of International Settlements Data Portal and data on inflation and output gap was obtained from the World Bank's Data portal.

India
The regression models below have used yearly data from 1968 to 2023. The data on interest rates was obtained from the Bank of International Settlements Data Portal and data on inflation and output gap was obtained from the World Bank's Data portal.

Sweden
The regression models below have used yearly data from 1968 to 2023. The data on interest rates was obtained from the Bank of International Settlements Data Portal and data on inflation and output gap was obtained from the World Bank's Data portal.

United Kingdom

The regression models below have used yearly data from 1968 to 2023. The data on interest rates was obtained from the Bank of International Settlements Data Portal and data on inflation and output gap was obtained from the World Bank's Data portal.

Denmark

The regression models below have used yearly data from 1968 to 2023. The data on interest rates was obtained from the Bank of International Settlements Data Portal and data on inflation and output gap was obtained from the World Bank's Data portal.

Canada

The regression models below have used yearly data from 1968 to 2023. The data on interest rates was obtained from the Bank of International Settlements Data Portal and data on inflation and output gap was obtained from the World Bank's Data portal.

Germany

The regression models below have used yearly data from 1968 to 2023. The data on interest rates was obtained from the Bank of International Settlements Data Portal and data on inflation and output gap was obtained from the World Bank's Data portal.

The time frame for the data chosen and country choice was motivated by our objective of capturing varying macroeconomic conditions. Specifically, our time frame allows the models below to include periods of restrictive monetary policy such as the oil price shock of the 1980s alongside periods of expansionary monetary policy such as the post financial crisis period.

Below we provide a general description of the data used in the Taylor rule regressions.

Table : Summary Statistics-Switzerland

	CPI	Policy Rate	Output Gap
Mean	0.6273	0.4420	-0.1175
Std Dev	1.0331	1.1785	1.6425
Median	0.5667	0.1056	-0.2207

Table : Summary Statistics-USA

	Inflation (CPI)	Policy Rate	Output Gap
Mean	4.0658	4.9800	0.0000
Std Dev	2.8213	3.8013	1.8523
Median	3.2491	5.0200	0.2914

Table : Summary Statistics-South Africa

	CPI	Policy Rate	Output Gap
Mean	8.5572	10.5904	0.0913
Std Dev	4.5752	4.6282	2.0532
Median	7.0397	9.5000	0.1141

Table : Summary Statistics-New Zealand

	CPI	Policy Rate	Output Gap
Mean	3.5572	6.5395	0.0473
Std Dev	3.7168	5.3870	2.2712
Median	2.3020	5.0000	0.2988

Table : Summary Statistics-India

	CPI	Policy Rate	Output Gap
Mean	7.3733	8.1143	-0.0000
Std Dev	4.8464	2.1824	2.3792
Median	6.6445	8.0000	-0.2456

Table : Summary Statistics-Sweden

	CPI	Policy Rate	Output Gap
Mean	4.4325	5.2091	-0.0000
Std Dev	3.8968	4.0354	2.1284
Median	2.5736	4.6750	0.2052

Table : Summary Statistics-UK

	CPI	Policy Rate	Output Gap
Mean	5.4040	6.5375	-0.0000
Std Dev	5.0216	4.7066	2.5717
Median	3.4745	6.0625	-0.1275

Table : Summary Statistics-Denmark

	CPI	Policy Rate	Output Gap
Mean	4.3061	5.0009	-0.0000
Std Dev	3.6494	3.8752	1.9750
Median	2.5708	5.0000	0.1876

Table : Summary Statistics-Canada

	CPI	Policy Rate	Output Gap
Mean	3.9797	5.6634	-0.0000
Std Dev	3.0728	4.1475	1.9979
Median	2.7390	4.8750	0.4695

Table : Summary Statistics-Germany

	CPI	Policy Rate	Output Gap
Mean	2.7141	3.7170	0.0000
Std Dev	1.9417	2.6317	1.8670
Median	2.0374	3.4000	0.0364

OLS Regressions for Taylor Rule

Switzerland

$$i = 0.8521 + 0.2702(\Pi - \Pi*) + 0.3343(y - y*)$$

The Taylor equation above is obtained by regressing the Swiss National Bank's policy rate on the inflation and output gaps noting that the inflation target is 2%.

The results imply that the monetary policy of the Swiss National Bank did not follow the Taylor rule of responding one-for-one for deviations from the inflation target ($\beta 1 < 1$).

United States of America

$$i = 2.990 + 0.9619(\Pi - \Pi*) + 0.1047(y - y*)$$

The Taylor equation above is obtained by regressing the Federal Reserve banks' fed funds rate on the inflation and output gaps noting that the inflation target is 2%.

The results imply that the monetary policy of the Federal Reserve follows the Taylor rule of responding one-for-one for deviations from the inflation target more closely.

However, the coefficient for output gap is not significant, suggesting that the Federal Reserve places a larger emphasis on inflation gaps rather than output gaps.

South Africa

$$i = 8.2794 + 0.5698(\Pi - \Pi*) + 0.2043(y - y*)$$

The above equation is estimated using the South African Reserve Bank's 4.5% inflation target. The coefficient of the output gap is not significant for the output gap for South Africa either.

New Zealand

$$\boldsymbol{i = 4.7679 + 1.1369\,(\Pi - \Pi*) + 0.0113(y - y*)}$$

We also consider New Zealand in our analysis given the Reserve Bank of New Zealand's inflation targeting policy framework. The key features of this framework emphasise inflation control as the RBNZ's target instead of the output gap. Specifically (Archer & Nicholl, 1992) outline:-

- A single objective for monetary policy, price stability, is enshrined in law.
- The RBNZ has effective independence to implement monetary policy as it judges necessary to meet its contracted target, without limitations on the techniques it may use, except that its choices "must have regard to the efficiency and soundness of the financial system."
- The legislation recognizes that any choices on the trade-offs between monetary policy and other economic policy objectives are the prerogative of the elected government.
- The way in which such trade-offs are made is a matter of public record and therefore transparent to the community at large.
- Operational independence is accompanied by clear accountability for all decisions on monetary policy implementation. The governor of the RBNZ is solely responsible for monetary policy outcomes in terms of the target to which he or she agreed when accepting the position.

Considering this features, the results from the OLS model are consistent with these features $(\beta1 > 1)$. The output gap is not statistically significant

India

$$i = 7.5554 + 0.1657\,(\Pi - \Pi*) + 0.0927(y - y*)$$

Sweden

$$i = 3.4317 + 0.7307\,(\Pi - \Pi*) - 0.0636(y - y*)$$

United Kingdom

$$i = 5.6110 + 0.1724\,(\Pi - \Pi*) + 0.4215(y - y*)$$

Denmark

$$i = 3.2591 + 0.7553\,(\Pi - \Pi*) + 0.0923(y - y*)$$

Canada

$$i = 3.6936 + 0.9950\,(\Pi - \Pi*) + 0.2091(y - y*)$$

While the data suggests that Canada follows the Taylor rule closely and does not respond to the output gap, the lack of a more than one-for-one relationship between the policy rate and inflation may be explained by the Bank of Canada's skepticism towards simple monetary policy rules, which it suggests are not robust in a large economy like Canada (Côté, Lam, Ying Liu, Pierre St-Amant, 2002).

Germany

$$i = 3.2079 + 0.7129\,(\Pi - \Pi*) + 0.1822(y - y*)$$

Overall, our selection of a variety of countries across different geographies, stages of development and macroeconomic fundamentals shows that monetary authorities have interpreted the Taylor rule as a systemic response to changes in economic conditions rather than a period-by-period optimization problem. While some central banks like the Reserve Bank of New Zealand and the Federal Reserve followed the rule more closely and responded to inflation by a more than one-for-one increase in interest rates, other countries such as Germany and the developing countries in our sample did not follow the Taylor rule. Monetary and credit aggregates took greater prominence in the ECB's policy decisions. The Bank of England's policymaking can be better understood as a flexible inflation target that closely tracks with the Taylor prescription.

Lastly, emerging market economies such as India and South Africa did not follow the rule given that these economies must also face exchange rate considerations while setting monetary policy. The results also show that there is reasonable central bank independence in the countries chosen in our sample, as the coefficient for output gap is not significant in any of the regressions except Switzerland. These results are also consistent with Keynes' (Keynes, 1936) hypothesis that central banks set rates on the tail end of the yield curve through their influence on the short-term rates. Keynes opposed classical theory and suggested that central banks are not swayed by inflation dynamics or the fiscal state (debt ratios or deficits) when setting monetary policy. The Keynesian hypothesis is consistent with empirical research (Akram & Das, 2017) and research from scholars across different schools of economic thought (Blanchard, 2019, Fullwiler 2020; Lavoie, 2014) Therefore, it can be deduced that policymakers set interest rates that were consistent with their long-term policy objectives instead of the temporal output and inflation gaps, which explains why the Taylor rule was not followed closely across all countries in our sample.

Central Bank Independence

The results above can now be used to analyse the degree of central bank independence enjoyed by central banks. To do so, we will compare the coefficients of inflation and output gaps for all countries with their respective Central Bank Independence Extended (CBIE) indices. The CBIE index (Romelli, 2024) covers forty-two criteria of central bank institutional design. These criteria are selected to capture key characteristics of a central bank such as governor appointment powers, monetary policy objectives, limitations on lending to the government, conflict resolution mechanisms, financial independence and reporting and disclosure requirements. The information collected is used to build an index of central bank independence which ranges from 0 (no independence) to 1 (full independence). Therefore, the CBIE is a useful benchmark for our study linking the Taylor rule coefficients with central bank independence.

Switzerland

As an advanced economy, Switzerland has strong political and economic institutions. Further, the Swiss National Bank is one of the world's oldest central banks, reaffirming its independence. The CBIE index allots a score of 0.83 to Switzerland,

implying a very high degree of independence. This is also evident from the regression results. While the Taylor principle of a higher than one-for-one increase in interest rates in response to inflation, it is clear that the SNB does not respond to output gaps as aggressively as it does to inflation gaps. Research from the SNB (Markov and Nitschka, 2013), suggests that the SNB also considers the exchange rate while enacting its monetary policy decisions due to heavy reliance on exports and the strength and stability of the Swiss Franc.

United States of America
Taylor's seminal work suggested that the Federal Reserve followed the Taylor rule during the oil price shock of the 1990s. While the United States is characterised by more political uncertainity than Switzerland, the Federal Reserve still scored 0.61 on the CBIE index. Our regression results differ from Taylor as we have chosen a longer period during which the United States economy experienced differing macroeconomic conditions. Our sample includes the post-2007 crisis period during which the Federal Reserve engaged in massive Quantitiative Easing programs and cut interest rates aggressively. However, the results still support the notion that the United States follows a rules-based approach to monetary policy with interest rates that closely track movements in inflation.

South Africa
With a CBI score of 0.51, the South African Reserve Bank enjoys less freedom than other central banks in our sample. Further, the OLS results also suggest that, historically, the South African Reserve Bank has not responded aggressively to inflation.
These results are characteristic of a developing economy like South Africa where inflation is not necessarily the policy target of primary interest. However, it is important to note that the coefficient for output gap is not statistically significant either.

New Zealand
New Zealand was chosen for our study considering the RBNZ's aggressive inflation targeting mechanism. As discussed above, New Zealand has made a deliberate effort to reduce the political pressure on central bankers to pursue expansionary monetary policy. The outcome of this effort is evident in the regression results. The coefficient for output gap is not significant while the coefficient on inflation gap has a statistically significant coefficient which is greater than one. In spite of these results, New Zealand has been allotted a score of 0.46 on the CBIE index, largely due to the structure of the RBNZ's board.

India
The Reserve Bank of India has undergone consistent reforms since independence. Most significantly, after the liberalisation agenda of the 1990s, the Reserve Bank of India has prioritised inflation control as the main policy target. Similar to the results from the other regressions, the Reserve Bank of India responds to inflation gaps more aggressively than it does to output gaps. These results are corroborated by the CBIE index score of 0.59.

Sweden
Similar to the SNB, the Swedish Riksbank is one of the oldest banks in the world. Sweden has always emphasised on the importance of monetary sovereignty as evidenced by its decision to not join the eurozone. The Riksbank has undergone a series of reforms over the last decade, earning a score of 0.85 on the CBIE index, which supports the regression results showing that it only responds to inflation gaps and not output gaps.

United Kingdom
The Bank of England has not adopted the Taylor rule strictly, instead preferring a more flexible inflation targeting approach. The Bank of England's monetary policy decisions are based on a thorough assessment of the prospects for inflation rather than on one simple rule or single indicator. The regression results above encapsulate this policy framework, as the coefficient of both inflation and output gap are not significant at the 5% level. Consistent with these results, the United Kingdom has an unusually low score of 0.42 on the CBIE index, which is significantly lower than its advanced, monetarily sovereign peers.

Denmark

Denmark did not follow the Taylor rule precisely due to the fact that it had pegged its currency to the euro, which meant that the Danish short-term interest rate was effectively dictated by the European Central Bank (ECB). This implies an inherent risk that the interest rate set by the ECB might fall 'out of sync' with respect to the Danish business cycle. However, Denmark was allotted a score of 0.61 and the output gap remains significant in our regression, implying strong central bank independence from political pressures.

Canada

Canada has a similar 0.6 score on the index. Further, the Bank of Canada follows the Taylor rule closely as well with the coefficient of inflation gap being close to one.

Germany

Germany was considered in our analysis because of the fact that it joined the Eurozone during the period surveyed. This is particularly important because being a part of the Eurozone implied that Germany surrendered its monetary policy autonomy and sovereignty. However, the CBIE index allotted Germany a score of 0.91. This is also corroborated by the Taylor rule regression in which the output gap is not significant.

Conclusion

Our study contributed to the existing literature by computing backward looking estimates of how closely the Taylor rule was followed. We then used these results and the CBIE index to determine the level of independence that central banks enjoy. Overall, our results are consistent with the existing literature and show that central banks prefer following a rules-based approach to monetary policy. However, our results also suggest that central banks, especially those in developing countries, do not only consider output and inflation when studying monetary policy. Instead, other concerns such as exchange rates and the degree of monetary sovereignty of a country are also important factors. Future studies using ARIMA models to control for these factors can further enrich our study above. We also find that, regardless of the level of central bank independence (as measured by the CBIE index), central banks weigh inflation gaps more heavily than output gaps when forming monetary policy. This is a counterintuitive result as we would expect less independent central banks to be swayed by fiscal authotrities into praciticing more expansionary monetary policy that focuses on output gaps instead of inflation gaps. Consequently, we can draw two major conclusions from our research. First, Taylor rule remains a useful benchmark for monetary policy analysis for countries across different geographies and different stages of economic development. However, it is important to understand the Taylor rule as a policy guide and not a strict mathematical equation with constant parameters, especially given the information uncertainty under which central bankers make policy decisions (Asso, Kahn & Leeson, 2010).

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References

1. Taylor, John B., 1993. "Discretion versus policy rules in practice," Carnegie-Rochester Conference Series on Public Policy, Elsevier, vol. 39(1), pages 195-214, December.
2. Nicholl, Peter, and David Archer, 1992, "An Announced Downward Path for Inflation," *Reserve Bank of New Zealand Bulletin*, *Vol. 5*, No. 4, pp. 315–23.
3. Denise Côté & Jean-Paul Lam & Ying Liu & Pierre St-Amant, 2002. "The Role of Simple Rules in the Conduct of Canadian Monetary Policy," Bank of Canada Review, Bank of Canada, vol. 2002(Spring), pages 27-35.
4. Fullwiler, S. (2020). When the Interest Rate on the National Debt Is a Policy Variable (and "Printing Money" Does Not Apply). *Public Budgeting &Amp Finance*, *40*(3), 72–94. https://doi.org/10.1111/pbaf.12249
5. Lavoie, M. 2014. Post-Keynesian Economics: New Foundations. Cheltenham, UK, and
6. Northampton, MA: Edward Elgar.
7. Blanchard, O. (2019). Public Debt and Low Interest Rates. *American Economic Review*, *109*(4), 1197–1229. https://doi.org/10.1257/aer.109.4.119

8. Keynes, J.M. (1936) The General Theory of Employment, Interest and Money, Palgrave Macmillan, London.

9. Romelli, Davide, Trends in Central Bank Independence: A De-jure Perspective (February 5, 2024). BAFFI CAREFIN Centre Research Paper No. 217, Available at SSRN: https://ssrn.com/abstract=4716704 or http://dx.doi.org/10.2139/ssrn.4716704

10. Pier Francesco Asso & George A. Kahn & Robert Leeson, 2010. "The Taylor rule and the practice of central banking," Research Working Paper RWP 10-05, Federal Reserve Bank of Kansas City.