

Measuring and Analyzing the Dynamic Effects of Monetary Policy on Gdp - Usa Case Study 1990-2023

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This study investigates the dynamic influence of monetary policy on the gross domestic product (GDP) of the United States over the period spanning 1990 to 2023. By employing dynamic macroeconomic models, the research elucidates the enduring effects of monetary policy across the economy, as central banks leverage these models to stimulate aggregate demand. The analysis employs the autoregressive distributed lag (ARDL) framework to assess the dynamic interplay between GDP and specific monetary policy instruments, including required reserves, excess reserves, net domestic credit, and the central bank interest rate. The results show a link of long-term equilibrium between GDP growth and monetary policy tools. In the short term, excess reserves exhibit a negative impact on economic output, while net domestic credit demonstrates no significant effect. Conversely, over the long term, the central bank interest rate, net domestic credit, and required reserves all exert a substantial and positive influence on output. However, excess reserves are associated with a notable decline in output.

Keywords: Monetary Policy, Static Effect, Dynamic Effect, Economic Growth.

Introduction

Two essential aspects of the economy that are ignored by comparative static analysis are the existence of persistent inflation and steady long-term economic growth, which leads to a continuous rise in the general price level. This analytical approach fails to provide insights into the duration required to achieve a new equilibrium or the behaviour of internal variables during the transition between equilibria. Furthermore, comparative static analysis does not offer predictions regarding the establishment of a new equilibrium, nor does it address the stability of such an equilibrium. These limitations highlight the necessity of dynamic analysis, which incorporates the dimension of time to account for the fact that economic adjustments do not occur instantaneously. Dynamic analysis evaluates the stability of equilibrium and examines the process of transition between equilibria. Consequently, dynamic equilibrium models are better suited to explain how variables evolve over time. The impact of monetary policy on the real economy remains a contentious issue within macroeconomic discourse, as highlighted by recent research (Boug et al., 2023). Dynamic models, by incorporating temporal dimensions, provide a more comprehensive framework for understanding these complex interactions and their implications for economic stability and growth.

Governments and central banks utilise monetary policy as a key instrument to foster economic growth and maintain stability (Chugunov et al., 2021). Central banks are tasked with managing the money supply to sustain economic progress and ensure price stability (Perng, 2021). Through various monetary policy tools, authorities aim to regulate inflation, stimulate economic growth, or achieve both objectives, thereby influencing critical outcomes such as

unemployment rates, exchange rates, and overall economic performance (Adegboyo, Keji, & Fasina, 2021). Maintaining low and stable inflation over extended periods is essential for robust economic development and employment generation, making price stability a cornerstone of monetary policy in advanced economies (Islam et al., 2022). Monetary authorities in industrialised nations bear responsibility for managing price levels, economic growth, employment, and financial stability, employing a range of policy instruments to achieve these objectives (Huerta de Soto, Sánchez-Bayón, & Bagus, 2021).

While the concept of monetary neutrality in the long run has been widely debated in macroeconomic theory, empirical evidence challenges this doctrine, suggesting that monetary policy can have lasting effects on real economic variables (Jordà, Singh, & Taylor, 2020). In developed countries, the adoption of inflation targeting frameworks reflects the prioritisation of price stability as a central goal of monetary policy over the long term (Serletis & Dery, 2025). Central banks design monetary policies to mitigate financial instability and promote economic advancement, focusing on objectives such as economic expansion, job creation, price stability, and sustainable interest rates (Islam et al., 2022). For instance, the U.S. Federal Reserve, in collaboration with the Federal Open Market Committee, aims to achieve price stability, curb inflation, expand employment opportunities, and address persistently low interest rates through refined monetary policy strategies (Amaral et al., 2022). Monetary policy shocks have been shown to significantly influence both nominal and real economic variables (Gambetti et al., 2022). Empirical studies indicate that output tends to decline following a positive monetary policy shock (Giacomini, Kitagawa, & Read, 2021). Additionally, the

rapid adjustment of prices in developing economies reduces the impact of monetary policy shocks on output compared to their effects in advanced economies (Ha, Kose, & Ohnsorge, 2022).

Literature Review

Comparative Statics Versus Dynamics of Adjustment

A distinction can be made between temporal and static equilibrium, the latter of which has a dimension of time. With expectations introduced into the analysis, equilibrium must be temporal. In order for such an equilibrium to be meaningful, expectations made in each period must be consistent and reinforcing with one another (Garegnani, 2024). Dynamic and stochastic equilibrium models are employed to model behaviour of economic variables over a duration of time. These are stochastic in that they take into account unpredictability that is inherent in economic activity. Contemporary short-run models of economic fluctuations illustrate global equilibrium by exhibiting interdependence between economic variables and demonstrating how such interdependence contributes to economic fluctuations. The dynamic aggregate supply-demand model, for instance, elucidates how macroeconomic variables such as output, inflation, and interest rates respond to shocks and interact over time. This model underscores the necessity for central banks to strike a balance between inflation variability and output volatility in their monetary policy decisions. It also highlights the importance of decisive policy actions to prevent inflation from escalating uncontrollably (Mankiw, 2016). Static analysis typically doesn't take into account ongoing inflation, year-to-year price level changes, and long-run growth in the economy (Xie et al., 2024). Comparative static analysis doesn't tell us when a new equilibrium will be reached and doesn't explain changes in endogenous variables in moving from one equilibrium point to another. Comparative static approaches don't tell us whether a new equilibrium will be reached or whether it will be stable. These limitations underscore the importance of dynamic analysis, which incorporates the dimension of time to acknowledge that economic adjustments do not occur instantaneously. Dynamic analysis tracks the transition between equilibria and assesses the stability of the resulting equilibrium, offering a more comprehensive understanding of economic processes (Gartner, 2009).

Modern Monetary Policy - Between Rules and Automaticity

Interest Rate and Monetary Policy

To limit the growth of the money supply, the central bank controls interest rates. However, due to the overall volume of liquid assets in the economy, these rates may exhibit volatility (Abadi, Brunnermeier, & Koby, 2023). By adjusting loan interest rates, the central bank aims to maintain low inflation while preventing significant fluctuations in production and employment. However, setting appropriate rates remains a complex challenge. A

general principle suggests that interest rates should rise when inflation increases. Higher interest rates reduce the money supply, leading to lower investment, decreased output, higher unemployment, and reduced inflation. Conversely, interest rates should decline when economic activity weakens, as indicated by changes in real GDP or unemployment levels. Within the framework of the dynamic aggregate supply-demand model, lower interest rates expand the money supply, stimulating investment and production while reducing unemployment (Miller, 2024).

Taylor Rule

Given that the credibility of implementing expansionary monetary policy to boost employment in the short term is increasingly questioned, central banks are prioritising their long-term objective of economic stability (Dikau & Volz, 2021). Policy implementation can be broadly classified into two approaches: rule-based and discretionary. Rule-based policies involve establishing clear guidelines and commitments, which help set consistent expectations. In contrast, discretionary policies allow policymakers the flexibility to adapt their decisions in response to changing circumstances. Though discretionary policies appear more appealing at first due to their flexibility, they are faulted for being incoherent and prone to policy asymmetry. This has been a stronger argument in favor of rule-based systems as it enhances policy decisions' credibility by providing a clear and foreseeable framework (Schmidt & Scott, 2021). In analyzing monetary policy length and efficacy, macroeconomic models such as the Taylor rule are employed by economists as an extension of the aggregate supply and demand model (Helgadóttir, 2023). The Taylor rule, developed by John Taylor, guides central banks in adjusting interest rates based on inflation and unemployment. If inflation exceeds targets or unemployment is too low, rates rise to curb inflation. If inflation is low and unemployment high, rates are cut to boost growth. The rule emphasizes price stability as key to sustainable economic growth, aligning with the aggregate supply-demand model's insights on inflation and output gaps.

Federal funds rate target = inflation rate + equilibrium real federal funds rate + 1/2 (inflation gap) + 1/2 (output gap)

The inflation gap, output gap, or the percentage deviation of real GDP from its estimated full employment level can be calculated by subtracting the current inflation rate from the target inflation rate (Valogo et al., 2023). When real GDP exceeds its natural level, the output gap is positive, indicating an inflationary gap. Conversely, when real GDP falls below its natural level, the output gap becomes negative, signalling a recessionary gap (Barigozzi & Luciani, 2023). The Taylor rule suggests central banks adjust nominal interest rates in response to inflation and output gaps. Nominal rates need to climb more when inflation rises by 1%, ensuring the real interest rate rises by at least 0.5%. This helps manage inflation and stabilise output around potential levels, smoothing business cycle fluctuations (Bernanke, 2022).

Time Horizon - Natural Output and Response Dynamics

Time Horizon and Natural Outcome

Monetary policy enables central banks to influence real GDP and price levels by modulating aggregate demand (Chugunov et al., 2021). In the short term, production may deviate from its natural level due to shifts in factors affecting the relationship between aggregate supply and demand, which in turn impact output and price levels (Pérez-Domínguez et al., 2021). When output exceeds the natural level, wage setters revise their price level expectations upward, resulting in prices higher than anticipated. This reduces real money balances, increases interest rates, and subsequently lowers production and demand. On the other hand, when output is below its natural level, prices decrease and demand is stimulated while production is boosted. In the long run, a return to its natural level of output is achieved through adjustments in price levels (Nikonenko et al., 2022). However, there are instances when aggregate demand is insufficient to maintain real GDP at its natural level, and central bank intervention is necessary. In an attempt to stem excessive growth in aggregate demand, contractionary monetary policy is employed by the central bank while expansionary policy is employed to address severe recessions in the economy. This is because inflation rises when real GDP is at its natural level and careful calibration of policy is essential in balancing growth and stability in the economy (Fornaro & Wolf, 2023).

Dynamics of Output Response to Stability Indicators

Economic variables have varying speeds of adjustment with some of them moving rapidly and others slowly.

Exchange rates, for instance, and interest rates and prices in financial markets adjust quickly in a bid to bring equilibrium in money and exchange markets as a consequence of dynamic interaction between demand and supply. Output in goods markets adjusts at a slower pace as firms take time to scale up or scale down production in response to a shift in sales. Patterns of consumption also take time to respond to changes in levels of output and income. These lags are behind the delay in the multiplier effect as full implications of changes in the economy might take a long period of time to materialize. Importers and exporters also take time to adapt to changes in exchange rates since they might take time to terminate existing contracts, negotiate new trading relations, or acquire new suppliers and markets (Rego et al., 2022). These varying speeds of adjustment are a testament to the complexity of economic dynamics and policymakers' challenges in making effective and timely interventions.

Monetary Policy Dynamics in the Economy

Monetary Policy Dynamics in a Closed Economy

In a closed economy, Figure (1-a) shows output and interest rates as functions of the nominal money supply, while Figure (1-b) depicts the IS-LM framework. Initial equilibrium is at point A (IS-LM intersection), with natural output (Y_n) and initial interest rate (i). Monetary expansion shifts the LM curve downward (LM to LM'), moving short-run equilibrium to A', where output rises and interest rates fall. In the short run, prices increase (P to P'), shifting LM upward (LM'' to LM''), partially offsetting the expansion. Eventually, the LM curve returns to its original position, restoring equilibrium at A (Y_n and i). Real money balances remain unchanged in the long run, as nominal money supply and price levels rise proportionally. This adjustment aligns with Okun's law, linking output growth to unemployment changes.

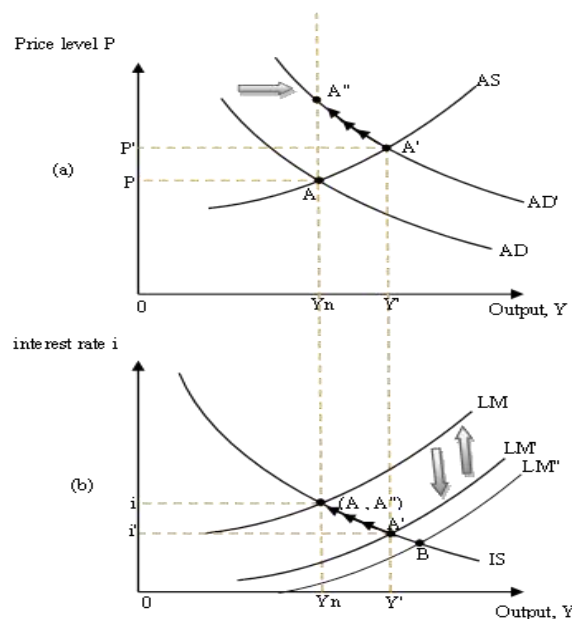


Figure 1: The Dynamic Monetary Expansion Effect on Output and Interest Rates in a Closed Economy (Blanchard & Johnson, 2013).

Monetary Policy Dynamics in Open Economies

Monetary policy boosts production by reducing interest rates and encouraging investment. In a closed economy, increased money supply raises spending, while in a small open economy, rates align globally (Wei & Han, 2021). Under flexible exchange rates, production rises briefly before price shifts establish a new equilibrium (Demir & Razmi, 2022). When the central bank expands the money supply, the LM curve shifts rightward, increasing production and depreciating the exchange rate, assuming a stable price level (Vintu, 2022). As illustrated in Figure 2, under a floating exchange rate system, monetary expansion results in a rightward shift of the LM curve to position B, representing both temporary and long-term equilibrium, thereby increasing output. However, the economy does not immediately reach point B, as short-term equilibrium is not instantly attainable. In the context of dynamic adjustment,

expectations of currency depreciation must be considered, which are overlooked in static comparative analysis. International investors should factor in the potential movement of exchange rates towards a new equilibrium when making investment decisions. The following equation illustrates equilibrium in the foreign exchange market:

$$i = i^{world} + \frac{E_{+1}^e - E}{E}$$

Here, E_{+1}^e is the expected exchange rates, E the current exchange rate, and i^{world} The world interest rate is the horizontal FE curve. As expectations of currency appreciation or depreciation intensify, the horizontal FE curve shifts upward or downward. Given that expectations play a crucial role in dynamic adjustment, understanding how future exchange rate expectations are formed is essential (Gartner, 2009).

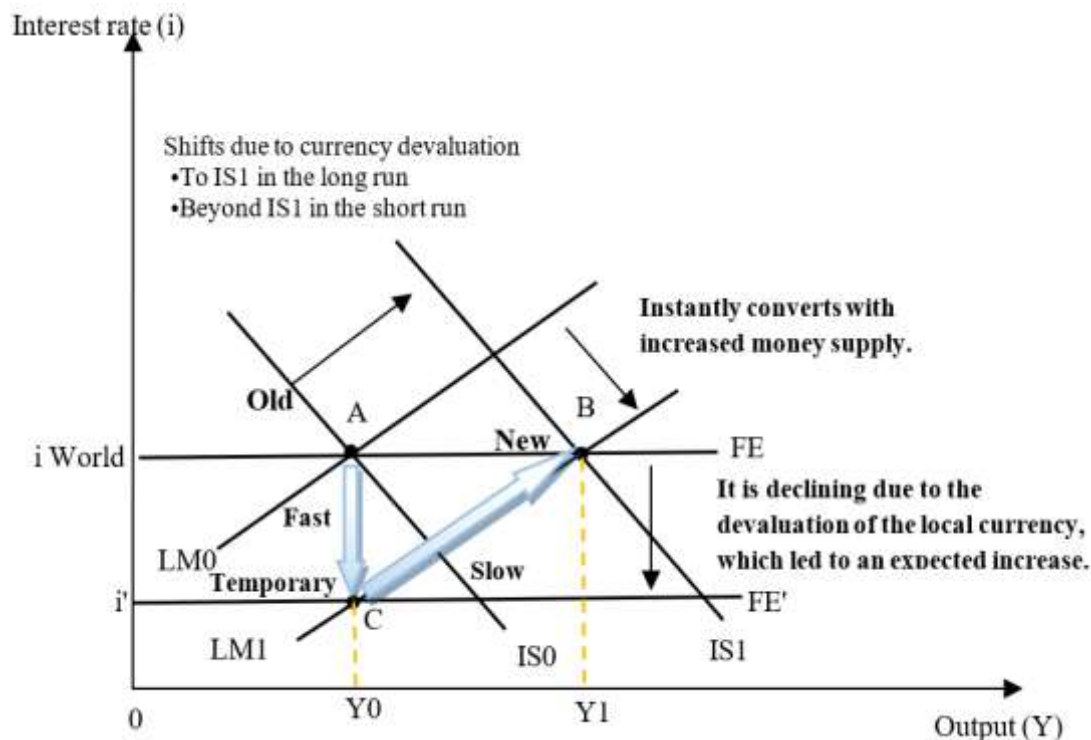


Figure 2: The Dynamic Impact of Monetary Expansion on Output and Interest Rates in an Open Economy (Gartner, 2009).

The IS curve shifts rightward due to increased net exports, while the home currency depreciates as the actual exchange rate influences aggregate demand (Leightner, 2024). Figure 2 illustrates that at the new static equilibrium point B, When the money supply increases, the LM curve moves to LM1, accompanied by a rightward shift of the IS curve. In the immediate short term, output remains fixed at Y_0 . The money market will only experience disequilibrium at this production level if interest rates decline to i' . At this rate, Both the exchange rate and the demand for domestic bonds decline. When the exchange rate falls to its new equilibrium level, expectations of future domestic currency appreciation emerge. At this point, anticipated appreciation offsets the interest rate differential, stabilising the foreign exchange market. Consequently, investors are

indifferent between holding domestic or international bonds. The depreciation of the exchange rate causes a further rightward shift of the IS curve beyond IS1, establishing a new equilibrium at IS1. Increased demand for goods and services raises output, which in turn heightens money demand, leading to higher interest and exchange rates. This triggers an upward shift in the FE curve, progressively elevating the intersection of the FE and LM curves until it reaches LM1 at point B (Gartner, 2009). Monetary policy shocks tend to have a greater impact in economies with more flexible exchange rates and higher foreign trade as a share of GDP. A strong correlation exists between trade openness and the responsiveness of production to monetary policy shocks (Eichenbaum, Johannsen, & Rebelo, 2021).

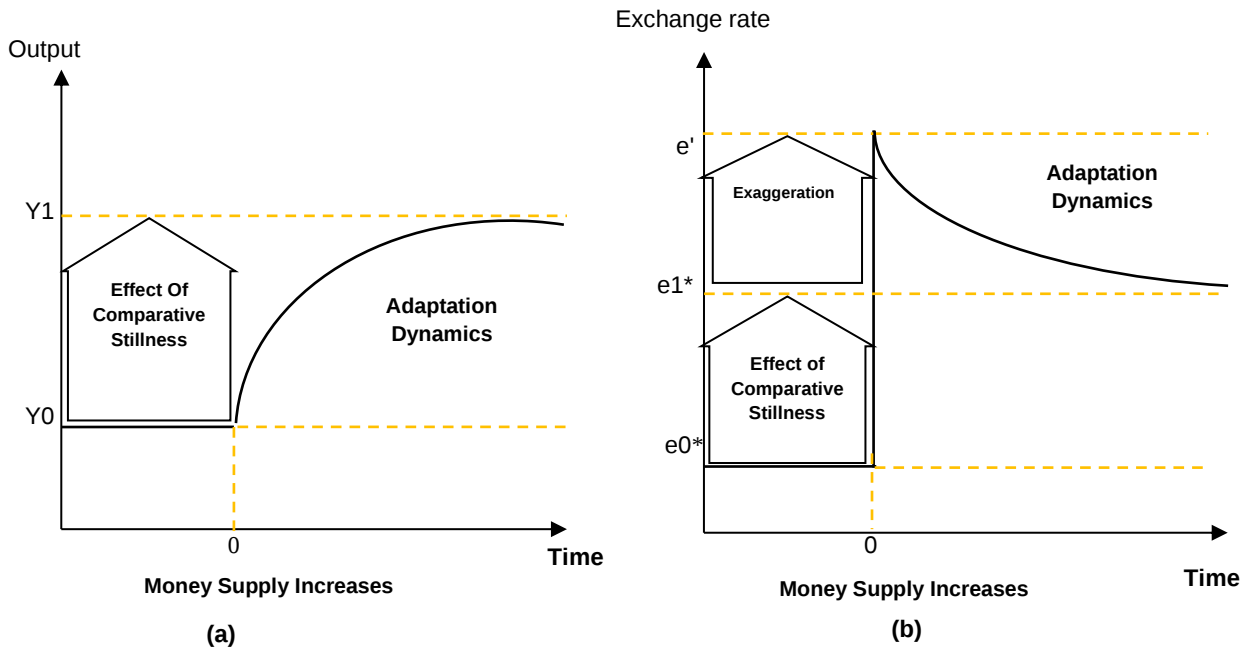


Figure 3: Adjustment Dynamics Following a Monetary Expansion Under Flexible Exchange Rates (Gartner, 2009).

Figure 3 illustrates the adjustments following a monetary expansion under a flexible exchange rate regime. According to the Mundell-Fleming model, an increase in the money supply has strategic implications, as output adjusts gradually due to the delayed response of production, as shown in Figure 3(a). Although output is expected to increase in the long run, this process unfolds over time. In contrast, the exchange rate reacts swiftly, achieving the necessary adjustment almost immediately, as depicted in Figure 3(b). In the short term, the burden of adjustment falls on the exchange rate, which ultimately responds more significantly. The exchange rate must eventually go from $e0^*$ to $e1^*$, as shown in Figure 3(b), representing the comparative static effect. Exchange rate overshooting occurs when the immediate response to a shock, When the desired long-term adjustment is exceeded, like in the case of an increase in the money supply, the rate eventually returns to its equilibrium level (Gartner, 2009).

Methodology

This study examines the influence of monetary policy indicators on the US economy using data from the World Bank, IMF, and Federal Reserve. By analysing data from 1990 to 2023, it aims to quantify and interpret the evolving impact of various monetary variables on US GDP. The central research question is whether monetary policy indicators exert dynamic long-term effects or if their influence is confined to the short term. Accordingly, the study evaluates the effectiveness of monetary policy across different time horizons. An inductive analytical approach is adopted, involving an examination of the development of research variables, an extrapolation of economic trends, an analysis of economic events, and a deduction of their economic implications through time series analysis. To determine the relationships between the study's economic variables, the ARDL model is employed.

$$\begin{aligned}
 GDP = & c + \lambda GDP_{t-1} + \beta_1 RR_{t-1} + \beta_2 ER_{t-1} + \beta_3 NC_{t-1} \\
 & + \beta_4 IR_{t-1} + \sum_{i=1}^n a_1 GDP_{t-i} \\
 & + \sum_{i=0}^m a_2 RR_{t-i} + \sum_{i=0}^m a_3 ER_{t-i} \\
 & + \sum_{i=0}^m a_4 NC_{t-i} + \sum_{i=0}^m a_5 IR_{t-i} + \mu_t
 \end{aligned}$$

Data Analysis

Table 1 facilitates the analysis of the evolution of key monetary policy indicators and their relationship with US GDP at constant 2012 prices (2012 = 100) over the research period. The analysis proceeds as follows:

Required Reserves

Table 1 shows that required reserves fell by 20.74% in 1991, accompanied by a 0.93% decline in GDP. Subsequent years saw fluctuations in both reserves and output growth. The highest output growth rate occurred in 2021 at 5.69%, coinciding with a 9.26% decline in required reserves, which expanded the money supply, reduced interest rates, and boosted investment. The compound growth rate for 1990–2023 was 0.82%.

Excess Reserves

Table 1 shows that excess reserves grew by 23.02% in 1991, while GDP declined by 0.93%. In 1992, excess reserves fell by 16.98%, coinciding with GDP growth of 2.77%. The highest excess reserves growth occurred in 2008, alongside a 1.73% drop in GDP due to the financial crisis. From 2021 to 2023, excess reserves declined, while GDP grew by 5.69%, 1.03%, and 2.08%, respectively. A reduction in excess reserves can support GDP growth by reallocating funds to investment opportunities. The compound growth rate for 1990–2023 was 19.58%.

Table 1: The Development of Output and Some Indicators of Monetary Policy in the US Economy for the Period 1990-2023

Years	GDP at Constant Prices 2010 = 100 (Million Dollars)	Growth Rate%	Reserves Required at Constant Prices 2010 = 100 (Million Dollars)	Growth Rate%	Excess Reserves at Constant Prices 2010 = 100 (Million Dollars)	Growth Rate%	Broad Money Supply (M2) at Constant 2010 Prices = 100 (Million Dollars)	Growth Rate%	Net Domestic Credit at Constant Prices 2010 = 100 (Million US Dollars)	Growth Rate%	Central Bank Interest Rate	M2 to GDP Ratio %	Net domestic Credit to GDP Ratio %
1990	9951882.24		100370.48		1563.24		7088080.74		7885880.99		7.00	71.22	79.24
1991	9859736.14	-0.93	79558.17	-20.74	1923.04	23.02	6902135.04	-2.62	7564960.25	-4.07	4.00	70.00	76.73
1992	10132746.15	2.77	80250.98	0.87	1596.60	-16.98	6688966.29	-3.09	7521680.85	-0.57	3.00	66.01	74.23
1993	10352788.08	2.17	85514.99	6.56	1630.72	2.14	6535942.60	-2.29	7568124.13	0.62	3.00	63.13	73.10
1994	10720336.58	3.55	86968.56	1.70	1576.69	-3.31	6395629.23	-2.15	7771389.16	2.69	5.50	59.66	72.49
1995	10932227.64	1.98	80884.69	-7.00	1442.96	-8.48	6648442.32	3.95	8145632.89	4.82	5.50	60.82	74.51
1996	11223389.57	2.66	71977.55	-11.01	1522.55	5.52	6967153.35	4.79	8385499.77	2.94	5.25	62.08	74.71
1997	11652262.84	3.82	62295.02	-13.45	1777.81	16.77	7352881.72	5.54	8882070.46	5.92	5.50	63.10	76.23
1998	12123288.74	4.04	58379.26	-6.29	2032.17	14.31	7935713.51	7.93	9567111.99	7.71	4.75	65.46	78.92
1999	12607714.40	4.00	54488.35	-6.66	1597.75	-21.38	8504209.01	7.16	10173337.95	6.34	5.50	67.45	80.69
2000	12980699.56	2.96	49322.71	-9.48	1552.47	-2.83	8893615.17	4.58	10641822.59	4.61	6.50	68.51	81.98
2001	13031520.06	0.39	47336.76	-4.03	3405.11	119.33	9335296.09	4.97	11289067.71	6.08	1.75	71.64	86.63
2002	13248934.59	1.67	46985.73	-0.74	1773.17	-47.93	9598683.36	2.82	11719040.91	3.81	1.25	72.45	88.45
2003	13579933.50	2.50	48551.16	3.33	2140.95	20.74	9798934.85	2.09	12136303.45	3.56	1.00	72.16	89.37
2004	14104086.03	3.86	50908.16	4.85	1894.42	-11.51	10091422.89	2.98	12661040.24	4.32	2.25	71.55	89.77
2005	14559088.31	3.23	49724.47	-2.33	1944.97	2.67	10548278.16	4.53	13374941.73	5.64	4.25	72.45	91.87
2006	14943890.83	2.64	45712.60	-8.07	1811.86	-6.84	11138596.18	5.60	14116708.64	5.55	5.25	74.54	94.46
2007	15222090.46	1.86	43326.20	-5.22	1978.59	9.20	12098192.65	8.62	15000723.86	6.26	4.25	79.48	98.55
2008	14958719.21	-1.73	45694.91	5.47	139503.70	6950.65	12603376.29	4.18	15236025.45	1.57	0.13	84.25	101.85
2009	14715513.59	-1.63	62646.18	37.10	854613.37	512.61	13345599.94	5.89	15197421.60	-0.25	0.13	90.69	103.27
2010	15048971.00	2.27	66295.00	5.82	1035298.15	21.14	12768868.67	-4.32	14674896.61	-3.44	0.13	84.85	97.51
2011	15122343.57	0.49	79963.27	20.62	1407241.16	35.93	13205384.46	3.42	15120835.61	3.04	0.13	87.32	99.99
2012	15437114.39	2.08	98042.18	22.61	1399054.54	-0.58	13571825.08	2.77	15400770.58	1.85	0.13	87.92	99.76
2013	15800875.08	2.36	110926.61	13.14	1854777.25	32.57	13977954.69	2.99	16281524.85	5.72	0.13	88.46	103.04
2014	16218693.53	2.64	126532.16	14.07	2359380.09	27.21	14467100.40	3.50	16907605.02	3.85	0.13	89.20	104.25
2015	16831406.67	3.78	137630.38	8.77	2311728.62	-2.02	14904126.78	3.02	17444614.87	3.18	0.38	88.55	103.64
2016	17084967.77	1.51	147152.18	6.92	2004625.34	-13.28	15285017.75	2.56	18070393.09	3.59	0.63	89.46	105.77
2017	17446695.40	2.12	160554.07	9.11	1900073.43	-5.22	15684891.82	2.62	18503481.26	2.40	1.38	89.90	106.06
2018	17937651.74	2.81	165370.32	3.00	1613974.19	-15.06	15928004.07	1.55	18370759.88	-0.72	2.38	88.80	102.41
2019	18356043.05	2.33	170274.24	2.97	1212634.35	-24.87	16957363.05	6.46	19118297.34	4.07	1.63	92.38	104.15
2020	17965169.68	-2.13	151379.68	-11.10	1677000.41	38.29	19631771.32	15.77	21798748.28	14.02	0.13	109.28	121.34
2021	18986651.56	5.69	137357.79	-9.26	1441577.11	-14.04	21911658.08	11.61	24329013.84	11.61	0.13	115.41	128.14
2022	19181787.23	1.03	133538.77	-2.78	1134545.17	-21.30	20117058.16	-8.19	22380093.05	-8.01	4.38	104.88	116.67
2023	19580477.06	2.08	133389.59	-0.11	817267.41	-27.97	19664941.06	-2.25	21813380.36	-2.53	5.38	100.43	111.40
Timeframes													
1990-2000		-98.98		-99.06		-99.00		-98.98		-98.97			
2001-2011		1.36		4.88		72.92		3.20		2.69			
2012-2023		2.00		2.60		-4.38		3.14		2.94			
1990-2023		1.95		0.82		19.58		2.96		2.95			

The table was prepared by researchers based on the Federal Reserve Bank, Federal Reserve Economic Data, and Economic Research Division, St. Louis. Link: <https://fred.stlouisfed.org>

IMF, IMF data portal, International Financial Statistics (IFS). <https://data.imf.org/regular.aspx?key=61545855>

IMF, IMF (IFS). <https://data.imf.org/regular.aspx?key=61545849>

Federal Reserve Bank, Federal Reserve Economic Data, Economic Research Division, St. Louis. Link: <https://fred.stlouisfed.org>

The World Bank for Reconstruction and Development, international statistics and data files, statistical bulletins for different years: <https://data.albankaldawli.org/country/united-states?view=chart>

The simple growth rate was calculated according to the following equation: $r = \left(\frac{P_t - P_{t-1}}{P_{t-1}} \right) * 100$

The compound growth rate was calculated according to the following equation: $R = \left[\left((P_t / P_0)^{(1/N)} \right) - 1 \right] * 100$

Broad Money Supply

The broad money supply has fluctuated, with GDP growth varying accordingly, particularly after financial crises. In 2021, it grew by 11.61%, alongside a 5.69% rise in GDP. US monetary policy influences global financial cycles, as the dollar underpins international banking, affecting borrowing costs (Miranda-Agrippino & Rey, 2020). The compound growth rate for 1990–2023 was 2.96%.

Net Domestic Credit

Net domestic credit fluctuated throughout the study period, with its growth generally aligning with GDP expansion. The highest increase occurred in 2020–2021, contributing to a 5.69% GDP rise in 2021. A decline of 8.01% in 2022 corresponded with GDP growth slowing to 1.03%. Historically, increased demand driven by money and credit has supported US GDP growth and employment (Labonte & Makinen, 2008). The compound growth rate for 1990–2023 was 2.95%.

Interest Rate

Over the course of the research, the central bank interest

rate varied, reflecting economic conditions and policy objectives. It peaked at 7% in 1990 before falling to 3% in 1993. By 2000, it rose to 6.5% but dropped sharply in 2001–2002 to 1.75% and 1.25% following the September 11 recession, prompting the Federal Reserve to lower rates to stimulate growth. The lowest rate of 0.13% occurred in 2020–2021 to counter the COVID-19 recession. Expansionary monetary policy reduces interest rates, boosting spending, while rate hikes curb expenditure, lower the exchange rate, and support exports (Labonte & Makinen, 2008). The Fed's model predicts that a 1% rise in interest rates widens output gaps by 0.2–0.5% and reduces inflation by 0.2–0.8% over two years, with the impact varying based on employment levels. During the 2007–2009 financial crisis, the Fed took unprecedented measures, including cutting rates to zero, providing direct financial support, and implementing quantitative easing—policies that continue to influence monetary strategy (Labonte & Makinen, 2008). Table 1 indicates that the broad money supply to GDP ratio was lowest in 1994 at 59.66% and peaked at 115.41% in 2021, reflecting high liquidity. Net domestic credit stood at 72.49% in 1994 and 128.14% in 2021, suggesting increased credit allocation for investment. Figure 4 illustrates output growth alongside key monetary policy indicators from 1990 to 2023. Moreover, Figure 5 illustrates the trend in the total money supply and net domestic credit to GDP ratio from 1990 to 2023, highlighting their unified movement.

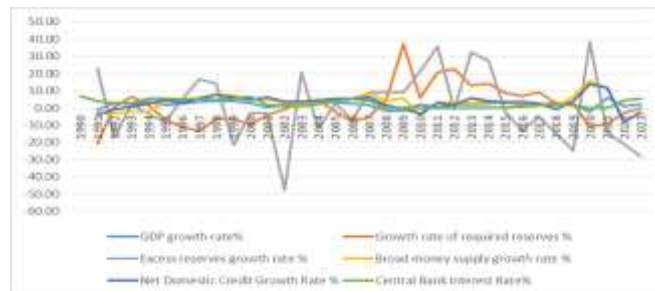


Figure 4: Shows the Researchers' Use of Data From Table 1 to Analyze Output Growth and a Few Monetary Policy Indicators in the US Economy From 1990 to 2023.

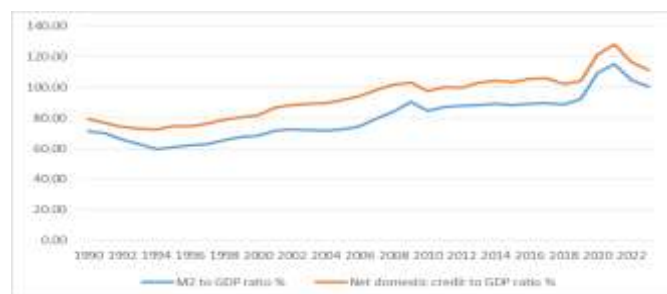


Figure 5: The Ratio of Broad Money Supply and Net Domestic Credit to GDP in the US Economy for 1990-2023 by the Researchers According to Table 1.

Analysis of the Results of the Standard Tests

For the base year 2012 = 100, the research standard component was determined based on a set of economic indicators, outlined as follows:

$$GDP = F(RR, ER, NC, IR)$$

Where:

- **GDP:** The pace of growth of the gross domestic

product.

- **RR:** The pace of growth of required reserves.
- **ER:** The pace of growth of excess reserves.
- **NC:** The pace of growth of net domestic credit.
- **IR:** The interest rates.

The study analysed the impact of monetary policy indicators on US GDP growth from 1990 to 2023, focusing on interest rates, net domestic credit growth, excess

reserves, and required reserves. Before selecting an appropriate model for estimating the output function, the stability of these economic indicators must be assessed.

Unit Root Test

Table 2 presents the extended Dickey-Fuller unit root test results, indicating that the NC series is stable at level with a secant and general trend at a 5% significance level. The IR series is also stable at level, without a secant and general trend, at a 10% significance level. GDP is stable at the first

difference with a secant and general trend at a 1% significance level. At a 5% significance level, RR is stable at the first difference with a secant; at a 1% significance level, it is stable without a secant and general trend. ER is stable at the first difference with and without a secant and general trend at 1%, and with a secant and general trend at 5%. Given that some indicators are stable at level and others at the first difference, the ARDL model is appropriate, particularly for the dependent variable.

Table 2: The Augmented Dickey-Fuller Test for Unit Root.

UNIT ROOT TEST RESULTS TABLE (ADF)						
Null Hypothesis: The variable has a unit root						
		At Level				
With Constant		GDP	RR	ER	NC	IR
	t-Statistic	0.4310	-1.0903	-1.0237	1.6544	-2.4678
	Prob.	0.9813	0.7074	0.7331	0.9993	0.1325
With Constant & Trend		n0	n0	n0	n0	n0
	t-Statistic	-2.1581	-1.5222	-0.7937	-4.0036	-2.9556
	Prob.	0.4961	0.8006	0.9561	0.0188	0.1597
Without Constant & Trend		n0	n0	n0	**	n0
	t-Statistic	6.2339	0.3275	-0.4291	4.3947	-1.7088
	Prob.	1.0000	0.7740	0.5204	1.0000	0.0826
		n0	n0	n0	n0	*
		At First Difference				
With Constant		d(GDP)	d(RR)	d(ER)	d(NC)	d(IR)
	t-Statistic	-6.1635	-3.2606	-3.9328	-5.7190	-4.9110
	Prob.	0.0000	0.0255	0.0050	0.0000	0.0004
With Constant & Trend		***	**	***	***	***
	t-Statistic	-6.0709	-3.0414	-3.9255	-6.1898	-4.8904
	Prob.	0.0001	0.1373	0.0224	0.0001	0.0022
Without Constant & Trend		***	n0	**	***	***
	t-Statistic	-1.5205	-3.1994	-3.9809	0.1135	-5.0049
	Prob.	0.1184	0.0023	0.0002	0.7109	0.0000
		n0	***	***	n0	***

Notes:

a: (*)Significant at the 10%; (**)Significant at the 5%; (***) Significant at the 1% and (no) Not Significant

b: Lag Length based on SIC

c: Probability based on MacKinnon (1996) one-sided p-values.

Estimating the Output Function by the Autoregressive Distributed Lag Model (ARDL)

Table 3 indicates that the independent variables account for 64.4% of the variation in the dependent variable, with

an Adjusted R-squared of 0.5413. The estimated F-value confirms the model's statistical significance at the 1% level. Based on Akaike's criterion, it is clear from Figure 6 that the optimal slowdown periods are (1,0,1,1,0), as they give the lowest value.

Table 3: ARDL Model for Output Function.

Variable	Coefficient	Std. Error	T-Statistic	Prob.*
GDP(-1)	-0.553319	0.158996	-3.480084	0.0019
RR	0.101237	0.040886	2.476110	0.0207
ER	-0.000528	0.000176	-2.996214	0.0063
ER(-1)	-0.001074	0.000256	-4.202876	0.0003
NC	0.057599	0.062232	0.925549	0.3639
NC(-1)	0.184347	0.061138	3.015256	0.0060
IR	0.626067	0.171844	3.643220	0.0013
C	1.071479	0.641404	1.670521	0.1078
R-Squared	0.644900	Mean dependent var		2.181250
Adjusted R-Squared	0.541330	S.D. dependent var		1.693955
S.E. of Regression	1.147234	Akaike info criterion		3.324903
Sum Squared Resid	31.58752	Schwarz criterion		3.691337
Log Likelihood	-45.19845	Hannan-Quinn criter.		3.446366
F-Statistic	6.226666	Durbin-Watson stat		1.996983
Prob(F-Statistic)	0.000314			

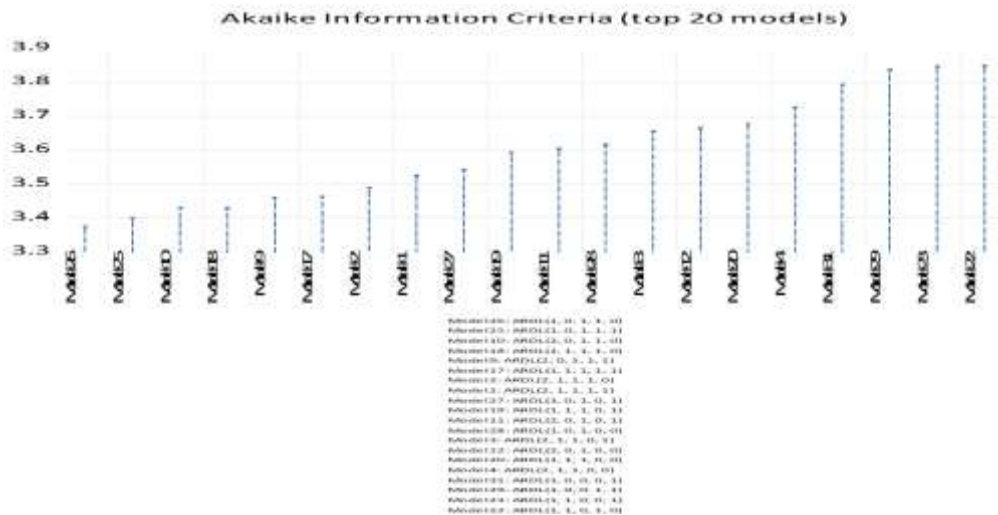


Figure 6: Optimal Deceleration Periods.

Bounds Test

The bounds test results in Table 4 indicate that the calculated F-value (17.3859) exceeds the maximum tabular F-value (4.37) at a 1% significance level. Thus, the null hypothesis of long-term equilibrium among the variables is rejected.

Table 4: Test of Boundaries.

F-Bounds Test		Null Hypothesis: No Levels Relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
F-Statistic	17.38592	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Diagnostic Tests

Serial Correlation LM Test

The null hypothesis is accepted as Table 5 demonstrates that the F and Chi-Square probability values are not significant at 5%. Consequently, the model is unaffected by residual serial correlation.

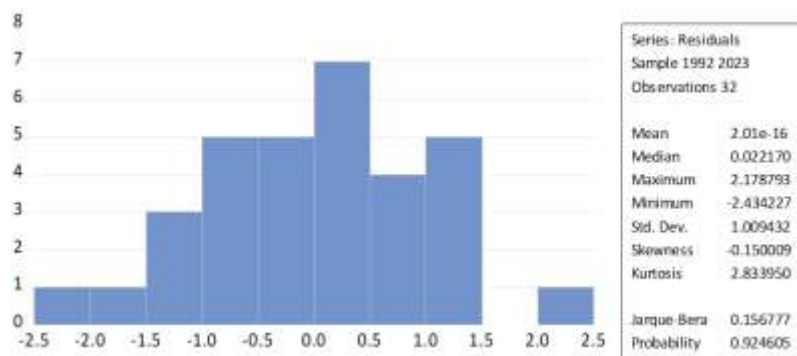


Figure 7: The Normal Distribution of Random Errors.

Testing the Predictive Performance of the Error Correction Model

Figure 8 shows that the Thiel coefficient is 0.219, close to zero, indicating model accuracy. The bias ratio (BP) is

Table 5: The Serial Correlation Test.

Breusch-Godfrey Serial Correlation LM Test:			
Null Hypothesis: No Serial Correlation at Up to 2 Lags			
F-Statistic	0.435383	Prob. F(2,22)	0.6525
Obs*R-squared	1.218346	Prob. Chi-Square(2)	0.5438

Heteroskedasticity Test

Table 6 shows that the computed F and Chi-Square probability values exceed 5%, indicating insignificance. This suggests that heteroskedasticity does not affect the estimated model.

Table 6: Heteroskedasticity Test.

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
Null Hypothesis: Homoskedasticity			
F-Statistic	1.973198	Prob. F(7,24)	0.1015
Obs*R-Squared	11.68920	Prob. Chi-Square(7)	0.1113
Scaled Explained SS	6.029269	Prob. Chi-Square(7)	0.5363

Histogram-Normality Test

The model's errors are distributed normally, as seen by the Jarque-Bera statistic probability value of 0.924604 in Figure 9, which is not significant at the 5% level.

0.000136, and the variance ratio (VP) is 0.083254, both near zero. The covariance ratio (CP) is 0.916611, close to one. These results confirm that the estimated model is suitable for prediction, planning, and future economic policymaking.

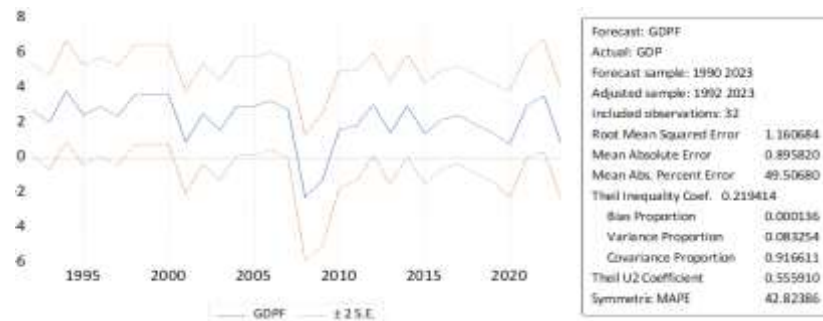


Figure 8: Predictive Performance of the Error Correction Model.

Parameter Estimation (Short-Term and Error Correction Parameter - Long-Term)

Error Correction Parameter and Short-Term Parameter Estimation

According to Figure 9, at the 1% level, excess reserves (ER) significantly hinder GDP growth; a 1% rise in ER lowers GDP growth by 0.000528%. This implies that

increased surplus reserves reduce production by limiting investment in productive industries. Since certain investments take longer to pay off, net domestic credit has little effect on production in the near term. According to Figure 9, the error correction coefficient has an absolute value greater than one and is negative and statistically significant at the 1% level. Given that 1.553319 of the deviations are adjusted in the near term to restore long-term equilibrium, this indicates a quick correction.

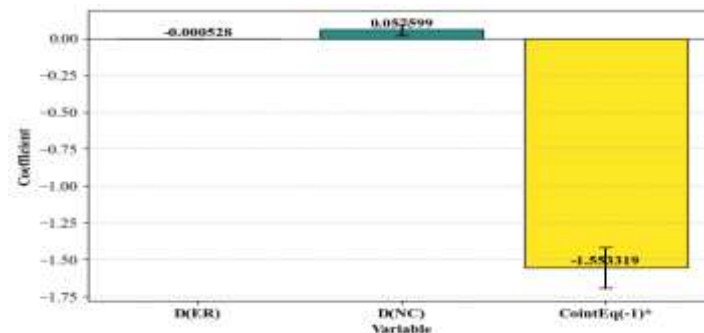


Figure 9: Short-Term Parameters and Error Correction Model.

Long-Term Parameters

Figure 10 reveals that RR positively influences GDP at the 5% level, with a 1% rise leading to a 0.065175% increase, reflecting credit expansion and investment. Conversely, ER negatively affects GDP at the 1% level, as a 1% increase causes a 0.001032% decline due to funds being

retained rather than invested. NC significantly impacts GDP at the 1% level, with a 1% rise leading to a 0.403051% increase, supporting local investment growth. IR also significantly affects GDP at the 1% level, as a 1% increase results in 0.403051% long-term GDP growth, attracting capital and fostering economic expansion.

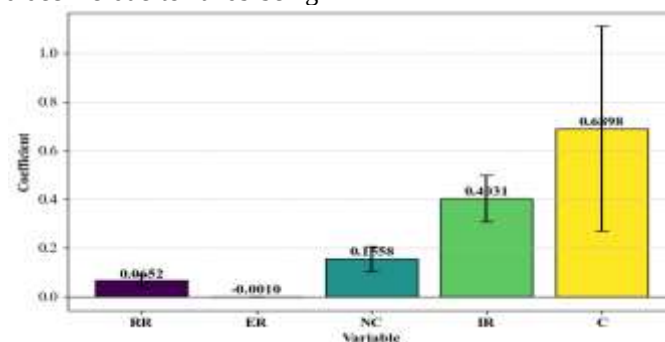


Figure 10: Long-Term Features.

Discussion

Monetary policy instruments are effective in both the short and long term. Amaral et al. (2022) assert that expansionary policies stimulate short-term economic growth, though their impact on inflation emerges over

time, as measured by the CPI. This aligns with Jordà et al. (2020), who contend that money is not neutral in the long run and that monetary policies produce lasting economic effects for a decade or more. Their findings confirm that monetary shocks influence production, capital, and overall economic productivity over extended periods. However,

these conclusions contrast with Christie Smith, who argues that the long-term effects of monetary policy on economic growth are minimal. While Hameed (2010) suggests that interest rates have little correlation with GDP, long-term estimations indicate a significant relationship. Similarly, the bounds test results are consistent with Islam et al. (2022).

Conclusion

The long-term effectiveness of monetary policy instruments depends on the economy's proximity to its natural output level, which influences the stability of equilibrium, despite their short-term efficacy. Dynamic equilibrium models illustrate the trajectory of economic variables over time, necessitating the incorporation of the time dimension into the analysis, as economic interactions do not occur instantaneously. Economists employ macroeconomic models, such as the Taylor rule, to evaluate the persistence of monetary policy effects and assess the Federal Reserve's capacity to manage economic shocks. An analysis of GDP trends during the study period reveals relative stability in growth rates across most years, though the impact of economic crises is evident in periods of GDP decline. The bounds test confirms a long-term equilibrium relationship between GDP growth and monetary policy instruments, with excess reserves exerting a negative influence on GDP and net domestic credit showing no significant short-term effect. Furthermore, rapid adjustment mechanisms are advantageous for correcting errors and achieving long-term equilibrium. Over the long term, required reserves exhibit a positive and statistically significant impact on GDP, whereas excess reserves significantly reduce it. Net domestic credit also demonstrates a favourable and substantial influence on economic output. Monetary policy proves effective in the long run, as evidenced by the positive impact of interest rates on GDP, facilitated by the free movement of capital. These findings underscore the importance of considering both short-term dynamics and long-term equilibrium when designing and implementing monetary policy.

References

- Abadi, J., Brunnermeier, M., & Koby, Y. (2023). The reversal interest rate. *American Economic Review*, 113(8), 2084-2120. doi: <https://doi.org/10.1257/aer.20190150>
- Adegboyo, O. S., Keji, S. A., & Fasina, O. T. (2021). The impact of government policies on Nigeria economic growth (case of fiscal, monetary and trade policies). *Future Business Journal*, 7(1), 59. doi: <https://doi.org/10.1186/s43093-021-00104-6>
- Amaral, A., Dyhoum, T. E., Abdou, H. A., & Aljohani, H. M. (2022). Modeling for the relationship between monetary policy and GDP in the USA using statistical methods. *Mathematics*, 10(21), 4137. doi: <https://doi.org/10.3390/math10214137>
- Barigozzi, M., & Luciani, M. (2023). Measuring the output gap using large datasets. *Review of Economics and Statistics*, 105(6), 1500-1514. doi: https://doi.org/10.1162/rest_a_01119
- Bernanke, B. S. (2022). *21st century monetary policy: The Federal Reserve from the great inflation to COVID-19*. WW Norton & Company. Retrieved from <https://wnnorton.com/books/9781324020462>
- Blanchard, O., & Johnson, D. R. (2013). *Macroeconomics* (6th ed.). Pearson Education. Retrieved from <https://www.amazon.com/Macroeconomics-6th-Olivier-Blanchard/dp/0133061639>
- Boug, P., Von Brasch, T., Cappelen, Å., Hammersland, R., Hungnes, H., Kolsrud, D., et al. (2023). Fiscal policy, macroeconomic performance and industry structure in a small open economy. *Journal of Macroeconomics*, 76, 103524. doi: <https://doi.org/10.1016/j.jmacro.2023.103524>
- Chugunov, I., Pasichnyi, M., Koroviy, V., Kaneva, T., & Nikitishin, A. (2021). Fiscal and monetary policy of economic development. *European Journal of Sustainable Development*, 10(1), 42-42. doi: <https://doi.org/10.14207/ejsd.2021.v10n1p42>
- Demir, F., & Razmi, A. (2022). The real exchange rate and development theory, evidence, issues and challenges. *Journal of Economic Surveys*, 36(2), 386-428. doi: <https://doi.org/10.1111/joes.12418>
- Dikau, S., & Volz, U. (2021). Central bank mandates, sustainability objectives and the promotion of green finance. *Ecological Economics*, 184, 107022. doi: <https://doi.org/10.1016/j.ecolecon.2021.107022>
- Eichenbaum, M. S., Johannsen, B. K., & Rebelo, S. T. (2021). Monetary policy and the predictability of nominal exchange rates. *The Review of Economic Studies*, 88(1), 192-228. doi: <https://doi.org/10.1093/restud/rdaa024>
- Fornaro, L., & Wolf, M. (2023). The scars of supply shocks: Implications for monetary policy. *Journal of Monetary Economics*, 140, S18-S36. doi: <https://doi.org/10.1016/j.jmoneco.2023.04.003>
- Gambetti, L., Görtz, C., Korobilis, D., Tsoukalas, J. D., & Zanetti, F. (2022). The Effect of News Shocks and Monetary Policy. In J. J. Dolado, L. Gambetti, & C. Matthes (Eds.), *Essays in Honour of Fabio Canova* (Vol. 44A, pp. 139-164). Emerald Publishing Limited. doi: <https://doi.org/10.1108/S0731-90532022000044A005>
- Garegnani, P. (2024). On a Change in the Notion of Equilibrium in Recent Work on Value and Distribution: A Comment on Samuelson. In P. Garegnani & R. Ciccone (Eds.), *Capital Theory, the Surplus Approach, and Effective Demand: An Alternative Framework for the Analysis of Value, Distribution and Output Levels* (pp. 209-227). Springer International Publishing. doi: https://doi.org/10.1007/978-3-031-23643-3_4
- Gartner, M. (2009). *Macroeconomics*. Pearson Education Limited Edinburgh Gate. Retrieved from <https://www.amazon.com/Macroeconomics-3rd-Manfred-Gartner/Dp/0273717901>
- Giacomini, R., Kitagawa, T., & Read, M. (2021). Identification and inference under narrative

- restrictions. *arXiv preprint arXiv:2102.06456*, 1-60. doi: <https://doi.org/10.48550/arXiv.2102.06456>
- Ha, J., Kose, M. A., & Ohnsorge, F. (2022). From low to high inflation: Implications for emerging market and developing economies. *Available at SSRN* 4070079. doi: <https://doi.org/10.2139/ssrn.4074459>
- Hameed, I. (2010). Impact of monetary policy on gross domestic product (GDP). *Interdisciplinary Journal of Contemporary Research in Business*, 3(1), 1348-1361. doi: <https://doi.org/10.2139/ssrn.1857413>
- Helgadóttir, O. (2023). How to make a super-model: professional incentives and the birth of contemporary macroeconomics. *Review of International Political Economy*, 30(1), 252-280. doi: <https://doi.org/10.1080/09692290.2021.1997786>
- Huerta de Soto, J., Sánchez-Bayón, A., & Bagus, P. (2021). Principles of monetary & financial sustainability and wellbeing in a post-COVID-19 world: The crisis and its management. *Sustainability*, 13(9), 4655. doi: <https://doi.org/10.3390/su13094655>
- Islam, M. S., Hossain, M. E., Chakroborty, S., & Ema, N. S. (2022). Does the monetary policy have any short-run and long-run effect on economic growth? A developing and a developed country perspective. *Asian Journal of Economics and Banking*, 6(1), 26-49. doi: <https://doi.org/10.1108/AJEB-02-2021-0014>
- Jordà, Ò., Singh, S. R., & Taylor, A. M. (2020). *The Long-Run Effects of Monetary Policy* (No. w26666). National Bureau of Economic Research. doi: <https://doi.org/10.3386/w26666>
- Labonte, M., & Makinen, G. E. (2008). *Monetary Policy and the Federal Reserve: Current Policy and Conditions* (CRS Report Number: RL30354). Library of Congress. Congressional Research Service. Retrieved from https://digital.library.unt.edu/ark:/67531/metadc821636/m2/1/high_res_d/RL30354_2008Apr30.pdf
- Leightner, J. E. (2024). How US fiscal and monetary policy affect the GDP of countries with fixed and flexible exchange rates. *Journal of Economic Integration*, 39(1), 86-106. doi: <https://doi.org/10.11130/jei.2024002>
- Mankiw, N. G. (2016). *Macroeconomics* (9th ed.). Worth Publishers. Retrieved from <https://www.amazon.com/Macroeconomics-N-Gregory-Mankiw/dp/1464182892>
- Miller, T. (2024). Fiscal policy and inflation control: insights from the COVID economic response. *Mercatus Policy Brief Series*. doi: <https://doi.org/10.2139/ssrn.4946322>
- Miranda-Agrippino, S., & Rey, H. (2020). US monetary policy and the global financial cycle. *The Review of Economic Studies*, 87(6), 2754-2776. doi: <https://doi.org/10.1093/restud/rdaa019>
- Nikonenko, U., Shtets, T., Kalinin, A., Dorosh, I., & Sokolik, L. (2022). Assessing the Policy of Attracting Investments in the Main Sectors of the Economy in the Context of Introducing Aspects of Industry 4.0. *International Journal of Sustainable Development & Planning*, 17(2), 497-505. doi: <https://doi.org/10.18280/ijssdp.170214>
- Pérez-Domínguez, I., Del Prado, A., Mittenzwei, K., Hristov, J., Frank, S., Tabeau, A., et al. (2021). Short-and long-term warming effects of methane may affect the cost-effectiveness of mitigation policies and benefits of low-meat diets. *Nature Food*, 2(12), 970-980. doi: <https://doi.org/10.1038/s43016-021-00385-8>
- Perng, F.-n. (2021). Speech Delivered for the Acceptance of an Honorary Ph. D. Degree in Economics at National Tsing Hua University. *Review of Pacific Basin Financial Markets and Policies*, 24(03), 2150026. doi: <https://doi.org/10.1142/S0219091521500260>
- Rego, L., Brady, M., Leone, R., Roberts, J., Srivastava, C., & Srivastava, R. (2022). Brand response to environmental turbulence: A framework and propositions for resistance, recovery and reinvention. *International Journal of Research in Marketing*, 39(2), 583-602. doi: <https://doi.org/10.1016/j.ijresmar.2021.10.006>
- Schmidt, R., & Scott, C. (2021). Regulatory discretion: structuring power in the era of regulatory capitalism. *Legal Studies*, 41(3), 454-473. doi: <https://doi.org/10.1017/lst.2021.13>
- Serletis, A., & Dery, C. (2025). Monetary policy in advanced and emerging economies. *Macroeconomic Dynamics*, 29, e9. doi: <https://doi.org/10.1017/S1365100524000105>
- Valogo, M. K., Duodu, E., Yusif, H., & Baidoo, S. T. (2023). Effect of exchange rate on inflation in the inflation targeting framework: is the threshold level relevant? *Research in Globalization*, 6, 100119. doi: <https://doi.org/10.1016/j.resglo.2023.100119>
- Vîntu, D. (2022). Modeling the dynamic equilibrium under the policy of adjusting the interest rate and Taylor's rule of National Bank of Moldova (NBM). *Management Strategies Journal*, 55(1), 171-194. Retrieved from <https://ideas.repec.org/a/brc/journal/v55y2022i1p171-194.html>
- Wei, X., & Han, L. (2021). The impact of COVID-19 pandemic on transmission of monetary policy to financial markets. *International Review of Financial Analysis*, 74, 101705. doi: <https://doi.org/10.1016/j.irfa.2021.101705>
- Xie, P., Shu, Y., Sun, F., & Pan, X. (2024). Enhancing the accuracy of China's electricity consumption forecasting through economic cycle division: An MSAR-OPLS scenario analysis. *Energy*, 293, 130618. doi: <https://doi.org/10.1016/j.energy.2024.130618>