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VECM Analysis of Tax-Growth Nexus of India

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Abstract
The study is conducted to explore the short run dynamics and long run relationship between Direct Tax, Indirect Tax and Economic Growth of India taking Gross Fixed Capital Formation and Trade Openness as control variables. Taking time series secondary data of last five decades Vector Error Correction Model (VECM) has been employed because all the variables are integrated of same order, further Johansen Co-integration test reveals long run equilibrium relationship among the variables. In the long run relationship, Direct Tax, Indirect Tax and Trade Openness have positive relationship while Gross Fixed Capital Formation reveals negative relationship with Economic Growth of India. In the short run Indirect Tax acts as a stabilizer to correct short run deviation in order to maintain the long run equilibrium. The findings of this paper may be reliable for policy implication because the econometric model VECM has passed all the diagnostic tests.

Keywords: VECM, Economic Growth, Direct Tax, Indirect Tax.

1. Introduction

India's taxation system has undergone substantial transformations over the past five decades. This also impacts the Economic Growth simultaneously. As tax revenue constitutes one of the primary means of financing developmental programs. Since last few years, India has to face numerous challenges in its pursuit of becoming a developed nation by 2047, necessitating substantial revenue sources to finance developmental activities. Given existing budget constraints, determining an optimal tax structure for revenue generation and its contribution to economic growth has become a subject matter of vast discussion amongst the economists, researchers and policy makers in recent time period.

The main purpose of tax systems is to fund public spending. In addition to addressing social and economic issues, tax systems are utilized to further other goals including equity. They must be set up to discourage tax evasion and avoidance while minimizing the expenses of government administration and taxpayer compliance. However, households' decisions to save, provide labor, and invest in human capital, businesses' decisions to produce, create employment, invest, and innovate, and investors' choices of savings channels and assets are all impacted by taxation. The way that various tax instruments are created and integrated to produce income is just as important for these decisions as the amount of taxes (Johansson et al., 2008)

According to Endogenous Growth Models taxation policy have long run effects on economic growth. Taxes affect growth through channels of labor supply, investment decisions and productivity. The endogenous growth theory of taxation suggests that taxation plays a crucial role in fostering economic growth by influencing factors such as human capital development and technological innovations

The relationship between tax revenue on economic growth is complex. It is the economic performance of an economy over a significant period of time. Both economic and non economic factors have been found to be drivers of economic growth. Some of them are physical capital accumulation, productivity growth, innovation, human capital, government expenditure, international trade, infrastructure, geography, climate, culture etc. are considered as drivers of long term economic performance.

Endogenous growth theory emphasizes that growth is not automatic. Growth is attained through the dual engines of 'Capital Accumulation' and 'Innovation'. Investment in physical capital and human capital expands productive capacity while innovations drive technical progresses. Crucially these processes are endogenous which is influenced by economic agent's decision and policy which makes taxation and fiscal design central to long run growth outcomes (Gareth D Myles, 2009)

Physical capital accumulation means investment in machinery, infrastructure, factories and equipments which increases productive capacity and output per worker ultimately contributing to growth by raising output level but subject to diminishing returns unless complemented by innovation therefore, taxation can influence investment incentives. Another part of capital accumulation is human capital accumulation where investment in education, skills, training and knowledge enhances labour productivity which sustains growth by improving efficiency and enabling innovation. Policy on education, training and labour taxation directly affects human capital accumulations. Lastly, innovation and technical progress lead by creation of new ideas improves efficiency of both capital and labour. It removes diminishing returns enabling sustained long run growth.

The rate of growth can be affected by policy choices through the effect that taxation has upon economic decisions. An increase in taxation reduces the returns to investment in physical and human capital and R&D. Lower returns means less accumulation and innovation and hence a lower rate of growth, this is a negative aspect of taxation. Taxation also has positive aspect, for instance some public expenditure can enhance productivity, such as the provision of infrastructure, public education and health care. Taxation provides the means to finance these expenditures and indirectly, can contribute to an increase in the growth rate.

Taxes don't affect growth directly; they affect economic agent's behavior (action). Those actions then feed into the growth process. When taxes change, economic agent adjust their behavior for instance households may invest less in education, firms may reduce R&D spending or workers may alter labour supply, in other words Income tax affect the labour supply, corporate tax affect the investment, excise tax affect production and consumption while custom tax affect trade and productivity in India. (Gareth D Myles, 2009) observes that even if agent's respond similar to a tax, the growth effect can vary across countries depending on the type of growth driver. So economic agents are the decision makers whose responses to taxation determine how growth unfolds. Therefore, taxation effect on growth is two dimensional. It depends both on how agent's action/decision and how central those reactions are to growth. The same tax can produce different growth outcomes depending on the structural source of growth in the economy.

In human capital driven economy, income taxes are most harmful. In innovation driven economy, corporate taxes are most harmful while in infrastructure driven economy consumption and property taxes can be neutral or even beneficial if revenues are reinvested effectively. Therefore, countries must align tax structure with their dominant growth channels.

Moderate tax policy can provide necessary financial support for public investment, technological innovation and human capital development, thus having a positive effect on economic growth (Tan

Lingfeng,Tong Wanting, 2025) while theoretical and empirical studies disagree on whether tax policy has negative, zero or positive effect on long run growth because outcomes depend on how growth is driven, how tax revenue is spent and the broader economic setting. Different tax policies such as consumption and income taxes can have varying effects on economic growth.

For instance consumption taxes may promote capital accumulation while comprehensive income taxes can suppress growth (Xu, 1994). The optimal design of taxes is essential for promoting long term economic growth as it can influence the accumulation of capital and human capital. The global financial crises and European tax policies are a few examples in this regard (Johansson et al. 2008). Cutting down of several taxes because of the financial crises, contributed better growth performance in European Commission.

These were the good example of how changes in tax structure have an impact on economic recovery, especially in crises context. Zipfel 2012 and European Commission 2011 provide real world evidence that complements the theoretical framework of endogenous growth models.

It also relates to Indian context as adjustment of custom duties during liberalization protected domestic industries while gradually opening trade, then GST introduction in 2017 simplified indirect taxation, aiming to reduce cascading effects and improve efficiency. Another reform in 2019 when corporate tax rates were lowered to attract investment and to boost up competitiveness especially in manufacturing sector. These few cited reforms reflect the same principle of endogenous growth.

In above both context, adjustment in tax structure whether it is crises driven cuts in Europe or structural reforms in India demonstrate the critical role of taxation in shaping long run growth outcomes. This comparative perspective underscores that tax policy is not merely a fiscal tool but a strategic instrument for economic resilience and development. But the big challenge is that the clear impact of tax structure on growth performance is very difficult to assess because tax structure is not only linked to growth but also with the other determinants like savings, investments, inequality and political attitudes, this creates the problem of simultaneity. Since these two variable influences each other at the same time which makes it difficult to establish a clear cut cause and effect relation. It is a key econometric challenge while studying the relationship between tax structure and economic growth. The interconnectedness creates simultaneity, complicating empirical analysis because the estimated effect of taxes on growth may be biased if growth itself is shaping tax policy.

Gober and Burns 1997 also observed that tax structure has a relation with the gross national product, saving and investment. Structure of tax in a country is very important for growth as tax can influence the factors that determines the growth rate(Van Sinderen, 1993). Changes in tax structure mean a change in the relative share of any particular tax in the total tax revenue. Tax structure often changes with economic progress as the government is in search of alternative revenue sources (Tosun and Abizadeh 2005).

After several tax policy changes in India the relationship between tax structure and economic growth is still unclear. India has adopted GST policy in 2017 which has transformed the entire structure of indirect tax policy. The policy also brings concern about its possible impact on growth performance in both short run and long run.

1.1 Tax structure in India

All the tax reform after independence and before 1991 was very immature and unsystematic. There were several tax reforms take place in both direct taxes and indirect taxes in mid of the 1980s. In the year of economic reform, 1991 tax enquiry committee (TRC) recommended broadening the tax base, reduction

in marginal tax rates and simplification of the tax structure. The main policy recommendation made by this committee is to reduce the share of trade taxes to the total tax revenue and increase the share of consumption taxes. (M. Govinda Rao & Rao, 2005).

Following the economic liberalization that transpired in 1991, the taxation framework of India has experienced substantial, ongoing and significant reforms that are focused on the enhancement of simplification, rationalization, and the expansion of the tax base. These reforms have been intentionally formulated to refine the tax framework, lower tax rates, and improve administrative efficiency associated with both direct and indirect taxation. Key moments in the reform journey encompass the insights presented by the Tax Reforms Committee. A Tax Reform committee (TRC) was appointed by the government in August 1991under the chairmanship of the noted Public Finance expert Dr. Raja J. Chelliah to suggest necessary reforms in central taxes also known as Chelliah Committee (TRC) in 1991, regarded one of the first reform on both direct and indirect tax with productive and structured policy recommendations in the recent decade,. The amendments in the finance acts, 1992 and 1993, are mostly based on the recommendations of Chelliah Committee Report. The computerization of the income tax department started in 1993-94 and gradually picked up pace with the establishment of a nationwide network and primary data centre another major reform was Kelkar Task Force in 2002, and the groundbreaking rollout of the Goods and Services Tax (GST) in 2017 (Samantara, 2021).

There were around 4 income tax brackets in India in the mid-1980s, which reduced to 3 following the recommendation of TRC. The rate was 20, 30 and 40 per cent, which was further reduced to 10, 20 and 30 per cent in 1997-1998. In 2017-2018, the government of India reduces the tax brackets to 05, 20 and 30 per cent. In financial year 2020-21, India introduced an optional “New Tax Regime” (Section 115BAC) alongside the old regime. The New Tax Regime offers lower tax rates but requires forgoing most deductions. The basic exemption limit was Rs. 2,50,000. The Finance Act 2024 has amended the provisions of Section 115 BAC with effect from AY 2024-25 to make new tax regime the default tax regime for the assesses being an Individual, HUF, AOP (not being co-operative societies), BOI or Artificial Juridical Person. The amendment has increased the tax bracket and raised the basic exemption limit to Rs. 3, 00,000. In FY 2025-26 the new regime has limited deductions and a basic exemption limit has also risen to Rs. 4, 00,000 and standard deduction rose to Rs. 75,000. However, the eligible taxpayers have the option to opt out of new tax regime and choose to be taxed under old tax regime.

High range of central excise duties was shifted through MODVAT (1986). In 2000-2001, and all the three rates of value added tax (VAT) merged to one rate, which is known as Cen-VAT. Import duties were high as 150 per cent before 1992-1993. Systematically these rates were reduced to 85 per cent in 1993-1994, to 65 per cent in 1994-1995 and then to 50 per cent in 1995-1996. In 2000, the top corporate tax was 35 per cent (Neog and Gaur 2020)

In 2017, India has adopted the biggest indirect tax reform in the form of GST. GST is the indirect tax reform levied mainly on manufacture, sale and consumption. GST transform the whole Indian economy into a single market. There are three main components of GST, state GST, central GST and Integrated GST (IGST). IGST is for interstate taxable transactions. With the implementation of GST, it is expected that it will reduce tax rates, broadening tax bases and minimize tax evasions.

2. Literature Review

Several studies have been done to explore tax growth nexus in literature. These studies can be divided into two major categories namely, country specific and cross country specific. Empirical studies find

heterogeneous relation of tax structure and growth across various dimensions (Ojede & Yamarik, 2012). Based on empirical evidences of the impact of tax structure on growth performance are conflicting and not uniform and mainly depends upon national configurations and estimation techniques.

(Johansson et al., 2008) provide compelling evidence that the design of tax structures significantly influences economic growth. By ranking taxes according to their growth impact—corporate taxes being most harmful, followed by personal income and consumption taxes, with recurrent property taxes least distortive and offered a clear roadmap for growth-oriented reform in a cross country analysis.

(Macek, 2015) highlights the heterogeneity of effects across tax categories and countries as empirical evidence on the tax–growth nexus. Using OECD data for 2000–2011, the study evaluates individual types of taxes through regression analysis, employing both traditional tax quota measures and the World Tax Index to capture broader burdens. The results confirm theoretical expectations that capital and human capital accumulation drive growth, while government spending tends to reduce it, largely due to crowding-out and unproductive welfare expenditures. Overall, corporate taxation emerges as most harmful, followed by personal income and social security contributions, while property taxes remain least harmful. However they accepted that measurement of the tax burden for countries is not free from bias as countries are heterogeneous with different tax policies.

The impact of consumption tax, personal income tax, corporate profit tax and property tax on income is estimated by (Durusu-Ciftci et al., 2018), using the common correlated effects (CCE) panel co-integration approach, which allows for cross-sectional dependencies and provides both panel- and country-specific results. The panel findings for 30 OECD countries for the period of 1995–2016 indicate that only consumption tax has a statistically significant negative effect on long-run income. However, because the type and sign of the tax coefficients are heterogeneous for the country-specific results, they concluded that taxation has heterogeneous effects on income.

(Tosun and Abizadeh 2005) empirically examines the changes in the tax mix of the OECD countries in response to economic growth from 1980 to 1999. They found that economic growth, measured by GDP per capita, has had a significant effect on the tax mix of the OECD countries. Analysis reveals that different taxes respond differently to the growth of GDP per capita. It is shown that while the shares of personal and property taxes have responded positively to economic growth, shares of the payroll and goods and service taxes have a negative relation with GDP per capita.

(Stoilova, 2017) studied the impact of tax structure on the economic growth in the EU-28 member states for the period 1996 to 2013 through regressions on pooled panel data. The empirical results proved that government expenditure do not contribute to an increase in the annual GDP growth rate while total tax revenue seems to be less harmful for the growth. VAT affected negatively, property taxes were neutral while the personal income tax and social contributions have positive effect on economic growth.

(Gllogjani & Durguti, 2023) empirically analyzed the impact of direct tax and indirect tax revenues on economic growth in the transition countries of Southeast Europe, based on panel data for the period 2005-2019 using OLS regression analysis, random effects regression, and fixed effects regression. The findings with a regression with fixed effects confirmed that the revenues from indirect taxes resulted in a positive and statistically significant effect; in contrast, direct tax revenues did not significantly affect economic growth.

(Jelena Andrašić et al., 2018) in their paper “Econometric Modeling of Tax Impact on Economic Growth: Panel Evidence from OECD Countries” have done an empirical evaluation of the tax effects on economic growth in 35 OECD countries from 1996 to 2016 with the objective to find effect of taxes on

the economy, where analysis involves Gross Domestic Product as a proxy for economic growth. Ensuring fundamental econometric procedures, the research paper reflects fixed effect model. The analysis includes main macroeconomic determinants as an inflation, unemployment, government expenditure and investment in observed countries and found that 1% increase of tax revenue growth enhances the Gross Domestic Product for 0.29%.

Above few cited literatures are based on either panel data or are cross country analysis. There are few more empirical studies which are country specific or where India is included in the cross country data set.

(Lee & Gordon, 2005) in their paper titled Tax structure and economic growth, where India is included in the cross-country dataset of 70 countries during 1970-1997, controlling for many other determinants using a panel data set. India is listed among countries with very high corporate tax rates (1985) of 55%. The study emphasizes that corporate tax rates significantly negatively correlated with economic growth and higher corporate taxation was linked to slower growth. The paper establishes a strong link between corporate tax rates and economic growth; the estimates suggest that cutting the corporate tax rate by 10 percent points can increase the annual growth rate by around 1.1%.

Empirical evidence from Pakistan underscores the critical role of tax revenue in sustaining long-run economic growth. Using ARDL bounds testing, (Rehman et al., 2020) confirm a positive and significant relationship between tax revenue and GDP, with estimates suggesting that a 1% increase in tax revenue leads to a 1.24% rise in economic growth. In contrast, non-tax revenue was found to be statistically insignificant, reflecting its residual nature from support and service activities, while additional receipts exhibited a negative and significant impact, hindering growth despite their rising share in government revenue. Pakistan's economic growth is most responsive to changes in tax revenue, whereas reliance on additional receipts has become increasingly harmful in recent decades. Forecasting models validated the robustness of these findings, projecting GDP with minimal deviation.

The empirical analysis of (Mdanat et al., 2018) using analytical approach of ECM, shows that taxes have negatively influenced the economic growth of Jordon. Similarly the findings of (Munir & Sultan, 2018) shows that taxes have positive relation with economic growth in the long run in Pakistan under ARDL framework from 1976 to 2014. However a study made by (Ilaboya & Mgbame, 2012) for Nigeria, found a negative and an insignificant relationship between indirect tax and economic growth. (Dahal, 2020), explored the relation of tax revenue with Nepal's GDP based on the secondary data using Vector Error Correction Model (VECM) and found that there is a high degree of the positive relationship between tax revenue and GDP of Nepal. The tax revenue and GDP are co-integrated and have a long-run association ship. (Kharel, 2021) examined the economic impact of tax revenue and economic growth of Nepal, from 2000 to 2018 using Time-series secondary data employing linear regression model and found that tax revenue and total revenue has a positive significant effect on GDP. (Deepak Neupane, 2023) assessed the relationship between tax revenue and economic growth in Nepal using the time series data from the fiscal year 1974/75 to 2019/20 and measured the nature and strength of the relation of the dependent and independent variables, through vector error correction model (VECM). Johansen's co-integration results revealed the existence of the relationship between the variables in long run and found that, in the long run, income tax has significant and negative relationship. Regarding the short-run, the value of the error correction term (ECT) indicated weak have positive relation with the dependent variable. (Wen Fang, 2024) focused on researching the impact of income tax on economic growth; including individual income tax and corporate income tax to figure out whether cut in tax promotes economic growth in the

United States and found that income tax rate indeed have a negative relationship with economic growth rate. Cut in taxation somewhat promotes the GDP growth, while people are more willing to consume, invest, and governments are more abundant in funding.

There are also few studies on tax growth nexus of India. Some of them are (Geetanjali & Venugopal, 2017), who accessed the impact of Direct taxes on GDP from 2000 to 2016 using Time series data collected using OLS Regression Analysis and found that there is significant impact of net collection of direct taxes on GDP at current market price and found that a 1% increase in the net collection of direct taxes is associated with a 17% increase in GDP. The paper concluded that net collection of direct taxes is having statistically significant effect on GDP of India. (Durga Prasad et al., 2022) applied the ARDL model for examining both short-run and long-run relationships between tax variables and economic growth of India and concluded that Direct tax growth does not significantly influence economic growth, though it shows a correlation. Indirect taxes have no statistically significant impact on GDP growth. (Sumandeep et al., 2023), investigated the influence of various elements of tax revenues and development expenditure on Gross Domestic Product (GDP) of India using time series data from 1990 to 2017, covering a 27-year period. A multivariate VAR framework with a specific emphasis on the Generalized Impulse Response Function and found that there is a positive association between tax revenue and GDP, suggesting that increases in tax revenue can lead to economic growth. (Venkataraman & Urmi, 2017) using ARDL Bounds test approach to co-integration investigated both short-run and long-run impacts of various components of direct and indirect taxes on economic growth in India and found that among direct taxes in long run personal income tax shows negative and insignificant impact but corporation tax had positive and statistically significant impact on GDP while among indirect taxes in long run custom duty and excise duty show positive sign but only custom duty has statistically significant impact on GDP. Total expenditure and dummy variables were positive but not statistically significant for economic growth in both models. In short run custom duty and corporation tax has positive and significant impact but personal income tax and excise duty has negative impact on GDP. Total expenditure estimates give dissimilar impact on GDP in both the models. (Neog & Gaur, 2020) has found that Income tax discourages labour effort, corporate tax reduces capital accumulation, excise tax distorts consumption and production, so all are exerting a negative impact on growth. In contrast, custom duties were found to support trade and growth by protecting domestic industries. Therefore the tax structure helps in shaping sustainable growth trajectories.

From above existing literatures, study on tax growth nexus for India is very limited. And there on, most of the studies are lacking econometric analysis and are without formal diagnostic tests which make their findings unreliable. This paper will re-establish the relationship between Tax and GDP of India using econometric model with proper diagnostic tests for further reliability of the findings which may be used for policy implications. This study contributes to the literature in examining the role of direct and indirect taxes in determining growth performance with the use of recent time series data of last five decades.

3. Research Methodology

This study employs secondary time series data of 54 years collected from Handbook of Statistics on Indian Economy published by RBI. Since the data has been collected from single source therefore data is reliable. GDP is taken as proxy variable for representing economic growth. GDP as dependent variable is taken at current prices (Nominal GDP), Direct tax (DT) and Indirect tax (IT) are the independent

variables and taking Gross Fixed Capital Formation (GFCF) and Trade openness (TO) as control variables.

GDP=f (DT, IT, GFCF, TO) (1)

Augmented Dickey Fuller Test (ADF) (Dickey & Fuller, 1979) test have been applied for checking presence of unit root in the time series data , lag order selection is done using AIC, HQ, SC and FPE. If all variables are integrated at same order then Johansen co-integration test will be employed for checking the co-integration (long run relationship) among variables but If variables were of mixed order like I(0) and I(1) then ARDL bounds test will be applied.

The objectives of this research paper are:

1. To explore the short run and long run relationship between tax structure and GDP
2. To identify the variable that corrects the deviation significantly for establishing long run equilibrium

4. Empirical results and discussions

Trend of Direct Tax GDP ratio and Indirect Tax GDP ratio can be viewed in Figure 1 and Table 1. Initially Indirect tax to GDP ratio shows increasing trend till 1989-90 at a maximum of 6.6%. Duration of 1988 to 1990 shows climax for Indirect tax to GDP ratio. This may be due to MODVAT scheme introduced on March 1, 1986, as part of the Union Excise Duties (UEDs). After that it falls followed by economic reform of 1991. Year 2006-07 tax reforms in India, presented by Finance Minister P. Chidambaram, focused on expanding the tax base, rationalizing indirect taxes, and making the first official proposal for a national Goods and Services Tax (GST) has changed the scenario of tax to GDP ratio of both direct and indirect taxes.

Figure 1- Trend Lines

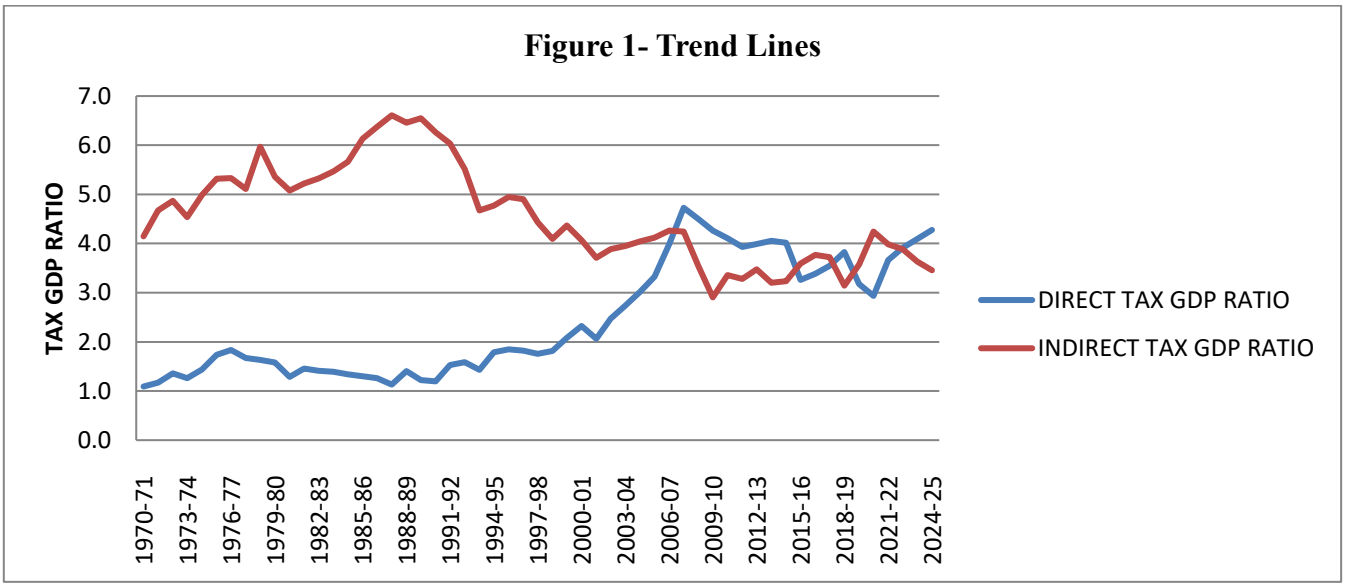


Table 1: Direct Tax-GDP Ratio and Indirect Tax GDP Ratio

Year	Direct Tax GDP Ratio	Indirect Tax GDP Ratio	Year	Direct Tax GDP Ratio	Indirect Tax GDP Ratio
1970-71	1.1	4.1	**1997-98**	1.8	4.4
1971-72	1.2	4.7	**1998-99**	1.8	4.1

1972-73	1.4	4.9	**1999-00**	2.1	4.4
1973-74	1.3	4.5	**2000-01**	2.3	4.1
1974-75	1.4	5.0	**2001-02**	2.1	3.7
1975-76	1.7	5.3	**2002-03**	2.5	3.9
1976-77	1.8	5.3	**2003-04**	2.7	4.0
1977-78	1.7	5.1	**2004-05**	3.0	4.0
1978-79	1.6	6.0	**2005-06**	3.3	4.1
1979-80	1.6	5.4	**2006-07**	4.0	4.3
1980-81	1.3	5.1	**2007-08**	4.7	4.2
1981-82	1.5	5.2	**2008-09**	4.5	3.5
1982-83	1.4	5.3	**2009-10**	4.3	2.9
1983-84	1.4	5.5	**2010-11**	4.1	3.4
1984-85	1.3	5.7	**2011-12**	3.9	3.3
1985-86	1.3	6.1	**2012-13**	4.0	3.5
1986-87	1.3	6.4	**2013-14**	4.1	3.2
1987-88	1.1	6.6	**2014-15**	4.0	3.2
1988-89	1.4	6.5	**2015-16**	3.3	3.6
1989-90	1.2	6.6	**2016-17**	3.4	3.8
1990-91	1.2	6.3	**2017-18**	3.5	3.7
1991-92	1.5	6.0	**2018-19**	3.8	3.1
1992-93	1.6	5.5	**2019-20**	3.2	3.6
1993-94	1.4	4.7	**2020-21**	2.9	4.2
1994-95	1.8	4.8	**2021-22**	3.7	4.0
1995-96	1.8	4.9	**2022-23**	3.9	3.9
1996-97	1.8	4.9	**2023-24**	4.1	3.6
Source: Data from handbook on Indian Economy published by RBI					

Descriptive statistics in Table 2 indicates that GDP, Taxes, Gross fixed capital formation, and Trade openness variables are positively skewed with moderate kurtosis, reflecting the presence of large outliers and long right tails. The coefficient of variation suggests substantial variability across the sample period. These characteristics justify the use of logarithmic transformations and robust econometric techniques in subsequent analysis.

Table 2: Descriptive Statistics

Statistics	GDP	DT	IT	GFCF	TO
Mean	5348775.27	191011.41	200092.58	1600915.35	2321048.02
Std.Dev	7781365.38	295030.90	288014.13	2328647.09	3561843.16
Min	46816.86	511.00	1940.00	7273.54	3587.00
Q1	225074.24	3131.00	12310.00	46295.67	30814.00
Median	1470054.93	26273.00	68413.00	366904.23	327706.00
Q3	7634472.10	313501.00	256367.00	2536936.20	3760375.00
Max	30122955.90	1233759.00	1093492.00	9165224.29	13553174.04
MAD	2034330.80	37008.66	92580.96	520198.60	471705.50
IQR	7085602.97	299839.50	231466.75	2395209.46	3524818.00
CV	1.45	1.54	1.44	1.45	1.53
Skewness	1.59	1.71	1.70	1.59	1.61
SE.Skewness	0.32	0.32	0.32	0.32	0.32
Kurtosis	1.47	2.33	1.88	1.65	1.77
N.Valid	54.00	54.00	54.00	54.00	54.00
N	54.00	54.00	54.00	54.00	54.00
Pct.Valid	100.00	100.00	100.00	100.00	100.00

Source: Author's computation in R-studio

Before conducting test for stationarity, all the variables are transformed into natural logarithmic form. The decision of the stationary or non stationary of data is made by unit root testing. Package "urca" is used for ADF test under "trend" and "drift" specification. The null hypothesis is that the variable series has unit root or the data is non stationery. The null hypothesis is rejected if the ADF test value in absolute terms is greater than the critical value at 5% level of significance. Unit root test of variables was conducted and found that all the variables were non stationery at level but all the variables became stationery and do not contain unit root after differencing. Therefore at 5% significance level the null hypothesis was rejected since the ADF test value are greater than the critical values, indicating that all the variables are integrated of the same order of order one, that is I(1). The outcome of the ADF unit root test is presented in Table 3.

At 5 percent level of significance it is fail to reject null hypothesis because the test value for Log GDP (lnGDP), Log Direct tax (lnDT), Log Indirect tax (lnIT), Log Gross fixed capital formation (lnGFCF) and Log Trade openness (lnTO) were found smaller than the critical value and it is concluded that the all the variables were non stationery at level. But all the log variables became stationery after first differencing because test values were greater than the critical value and therefore, it can be said that first difference of log GDP (dlnGDP), first difference of log Direct tax (dlnDT), first difference of log Indirect tax (dlnIT), first difference of log GFCF (dlnGFCF) and first difference of log Trade openness (dlnTO) are integrated of order I(1).

Table 3: Outcomes of the Augmented Dickey-Fuller Test

Variables	Constant (Drift) Critical value @ 5% = -2.89		Constant + trend (Trend) Critical value @ 5% = -3.45		Order of integration
	ADF test value	Decision	ADF test value	Decision	
lnGDP	-1.18 (0.05)	Fail to reject H_0	-1.57 (0.04)	Fail to reject H_0	Non stationery at level I(0)

dlnGDP	-4.95 (0.00)	Reject H_0	-5.16 (0.00)	Reject H_0	Stationery after first differencing I(1)
lnDT	-0.55 (0.85)	Fail to reject H_0	-1.74 (0.37)	Fail to reject H_0	Non stationery at level I(0)
dlnDT	-5.71 (0.00)	Reject H_0	-5.66 (0.00)	Reject H_0	Stationery after first differencing I(1)
lnIT	-1.3 (0.43)	Fail to reject H_0	-2.52 (0.06)	Fail to reject H_0	Non stationery at level I(0)
dlnIT	-6.34 (0.00)	Reject H_0	-6.55 (0.00)	Reject H_0	Stationery after first differencing I(1)
lnGFCF	-1.86 (0.18)	Fail to reject H_0	-0.51 (0.32)	Fail to reject H_0	Non stationery at level I(0)
dlnGFCF	-5.08 (0.00)	Reject H_0	-5.64 (0.00)	Reject H_0	Stationery after first differencing I(1)
lnTO	-1.55 (0.06)	Fail to reject H_0	-1.44 (0.06)	Fail to reject H_0	Non stationery at level I(0)
dlnTO	-4.97 (0.00)	Reject H_0	-5.34 (0.00)	Reject H_0	Stationery after first differencing I(1)
Note: Values in the parenthesis denotes p value Source: Author's computation using R Studio					

After determining the level of integration next step is to determine of optimal lag length. It is very important to determine the optimal lag length before determining the relationship. Lag selection is the process of identifying the period of one variable that can affect the other variable. Package "Vars" has been used for lag selection under "trend" and "constant" specification. All methods of lag selection Akaike information criterion (AIC), Hannan-Quinn information criterion (HQ), Schwarz information criterion (SC) and Final prediction error (FPE) under "constant" specification are suggesting lag 1 except AIC, it favors longer lag for large data set. It captures more dynamics but risks over parameterization. Similarly under "trend" specification all methods are suggesting lag 1 for the operation system equations. The asterisk (*) value indicates the suggestion of taking lag for system equations. The outcome of the lag order selection criteria is presented in Table 4.

Table 4: Var lag order selection criteria

Lag	AIC	HQ	SC	FPE
1	-27.6276	-27.1908*	-26.4804*	0.0000*
2	-27.5515	-26.7506	-25.4483	0.0000
3	-27.6313*	-26.4663	-24.5720	0.0000
4	-27.1220	-25.5929	-23.1067	0.0000
Note: (*) indicates lag order selected by the criterion.				
Source- author's computation in R Studio.				

After establishing the stationarity of the variables at first difference and lag one structure, the study proceeded to choose for co-integration test between the variables. Since all the variables are integrated at

order 1 i.e. same order therefore Johansen co-integration test will be employed for checking the co-integration among variables but If variables were of mixed order like I(0) and I(1) then ARDL bounds test would have been applied.

Johansen co-integration test using "urca" package under "constant" specification is employed to establish whether there exists a linear long run relationship between variables. The null hypothesis is that there is no co-integration among variables. The following Table 5 and 6 shows the outcomes of the Johansen co-integration test derived from trace statistics and max-eigen statistics.

Table 5: Results of Trace statistic (without linear trend and constant)

Hypothesized no. of CE(s)	Trace Statistic	5% critical value	Interpretation	Decision
None	79.70	76.07	Reject H_0	At least one co-integration vector exist
At most 1	40.95	53.12	Do not reject H_0	
At most 2	23.57	34.91	Do not reject H_0	
At most 3	10.26	19.96	Do not reject H_0	
At most 4	3.50	9.24	Do not reject H_0	
Source: Author's computation in R Studio				

Table 6: Results of Max-Eigen statistic (without linear trend and constant)

Hypothesized no. of CE(s)	Max-Eigen Statistic	5% critical value	Interpretation	Decision
None	38.75	34.40	Reject H_0	At least one co-integration vector exist
At most 1	17.38	28.14	Do not reject H_0	
At most 2	13.31	22.00	Do not reject H_0	
At most 3	6.76	15.67	Do not reject H_0	
At most 4	3.50	9.24	Do not reject H_0	
Source: Author's computation in R Studio				

Both the trace statistic and max-Eigen value statistic indicates the presence of one co-integration equation between the variables at 5 percent level of significance. Trace statistic 79.70 is greater than 5% critical value (76.07) therefore, we reject null hypothesis of saying none co-integrated equation in the system. Moving ahead, trace statistic 40.95 is smaller than 53.12 so here it is fail to reject null hypothesis and hence it is concluded that there exist at least one co-integrating relationship among the five variables. Similarly max-Eigen statistic also suggests the presence of at least one co-integrating equation. Hence, it can be said that all variables have a long run association ship and co-integration. Therefore, it is said that there is a long-run equilibrium relationship linking GDP, direct taxes, indirect taxes, gross fixed capital formation, and trade openness.

Based on the result of the Johansen co-integration test, it is necessary to follow Vector Error Correction Model (VECM) to analyze the impact and relation of GDP with other variables to capture both short run dynamics and long run equilibrium adjustments. VECM model is used when there is a long term relationship between multiple non stationary time series variables. These variables may individually follow random walks (non stationary) but there exist a combination of them that is stationary. This co-integrating relationship represents the long term equilibrium among the variables. In a VECM, short run

deviations are represented by error correction terms that adjust the variables back to the equilibrium when short term deviations occur.

The present VECM model (equation 2) is adapted from the works of (Takumah 2014, and Onakoya and Afintinni, 2016). The model is specified below with some modifications .

$$\Delta \ln(\mathrm{GDP})\,t = \beta 0 + \sum_{i=t}^{p} \beta 1 \Delta \ln(\mathrm{GDP})\,t-1 + \sum_{i=t}^{p} \beta 2 \Delta \ln(\mathrm{DT})\,t-1 + \sum_{i=t}^{p} \beta 3 \Delta \ln(\mathrm{IT})\,t-1 + \sum_{i=t}^{p} \beta 4 \Delta \ln(\mathrm{GFCF})\,t-1 + \sum_{i=t}^{p} \beta 5 \Delta \ln(\mathrm{TO})\,t-1 + \delta \mathrm{ECT}t-1 + ut \quad (2)$$

Where:

Δ- is the difference operator,

p- is the optimal lag length,

ln- is natural logarithm sign,

GDP= Nominal GDP

DT= Direct tax

IT= Indirect tax

GFCF= Gross Fixed Capital Formation

TO= Trade Openness

ECT= is the error correction term and

δ – is its coefficient

u- Error term of the model

Since all variables in the model are transformed into logarithm form and hence log linear model is used for the VECM model as opposed to linear model. Log linear model produces better results as logs are used in economics because the estimated coefficients in log regression have a good interpretation. It helps to interpret as percentage instead of as a marginal effect (Beniot, 2011).

Package "tsDyn" with lag one structure and one co-integrating rank using Maximum Likelihood (ML) estimation technique the long term relationship is estimated. The Long run relationship among the variables is expressed in following equation 3.

$$\ln\mathrm{GDP} = 0.197\ln\mathrm{DT} + 0.722\ln\mathrm{IT} - 0.168\ln\mathrm{GFCF} + 0.218\ln\mathrm{TO} \quad (3)$$

Equation 3 highlights that GDP is systematically linked to fiscal variables, investment (GFCF), and trade openness. The signs and magnitudes of the coefficients suggest that indirect taxes and trade openness exert persistent influences on GDP, while capital formation plays a more complex role in the long run equilibrium.

Direct Taxes (lnDT, coefficient = 0.197): A positive coefficient suggests that higher direct tax revenues are associated with higher GDP in the long run. Direct taxes are reflecting stronger fiscal capacity and compliance, which supports sustainable growth. It means one unit increase in direct tax will increases the GDP by 0.197 units.

Indirect Taxes (lnIT, coefficient = 0.722): it is the largest positive coefficient. It indicates that indirect taxation (like GST, excise, VAT) has a strong long run association with GDP. In emerging economies, indirect taxes often dominate revenue mobilization, and their expansion is closely tied to growth. It means one unit increase in indirect tax will increase the GDP by 0.722 units.

Gross Fixed Capital Formation (lnGFCF, coefficient = -0.168): Surprisingly it is negative. This suggests that, in the long run, higher investment levels (as measured by GFCF) are associated with lower GDP.

This counter intuitive result may reflect inefficiencies in capital allocation, lagged effects of investment, or crowding out due to fiscal pressures.

Trade Openness (lnTO, coefficient = 0.218): The coefficient is Positive and moderate. Greater openness to trade is associated with higher GDP, consistent with the idea that integration into global markets fosters growth through efficiency gains, technology transfer, and expanded demand. It means one unit increase in trade openness will enhance the GDP by 0.218 units.

The Vector Error Correction Model (VECM) results show that the error correction term (ECT) is statistically significant in the indirect tax (lnIT) equation, while weaker or insignificant in the equations for GDP, direct taxes, GFCF, and trade openness. This indicates that indirect taxes serve as the main adjustment variable, correcting disequilibrium and ensuring convergence back to the long run path. GDP and direct taxes exhibit limited responsiveness, while GFCF shows some adjustment but not strongly significant.

Investigating short run dynamics in the GDP equation, the lagged value of GDP is positive and marginally significant, indicating persistence in short run growth dynamics. In the indirect tax equation, both the intercept and lagged GDP are significant, confirming that indirect taxes respond actively to disequilibrium and short run shocks. In the GFCF equation, the lagged value of GFCF is weakly significant, suggesting some short run responsiveness. Direct taxes and trade openness show weaker short run effects, implying limited immediate adjustment to shocks.

Table 7: Short run coefficients

Variables	Coefficients	Std. Error	t- Statistic	Significance
ECT	-0.09	0.06	-1.40	Not significant
$lnGDP_{t-1}$	0.33	0.08	4.12	Marginal 10%
$lnDT_{t-1}$	-0.02	0.04	-0.5	Not significant
$lnIT_{t-1}$	-0.08	0.06	-1.33	Not significant
$lnGFCF_{t-1}$	-0.06	0.10	-0.6	Not significant
$lnTO_{t-1}$	0.03	0.07	0.42	Not significant
C	0.44	0.24	1.83	Marginal 10%
R-squared=0.9997 Adjusted R-squared=0.9996 F-statistic=13745.17				
Source- Authors computation using R studio				

$$D(\ln GDP) = -0.09 + 0.33 \times D\big(\ln GDP(-1)\big) - 0.02 \times D\big(\ln DT(-1)\big) - 0.08 \times D\big(\ln IT(-1)\big) - 0.06 \times D\big(\ln GFCF(-1)\big) + 0.03 \times D\big(\ln TO(-1)\big) + 0.44 \quad (4)$$

In table 7, the ECT coefficient (-0.0966) is negative but not significant, meaning GDP does not adjust strongly to disequilibrium in the short run. The lagged GDP term (0.3322) is marginally significant, showing persistence in GDP dynamics. Other lagged variables (DT, IT, GFCF, TO) are not significant in the short run. Despite weak short run adjustment, the R^2 and adjusted R^2 are extremely high, and the F statistic is very large, confirming the overall equation is statistically strong.

The model has also passed the diagnostic checks of no serial correlation through portmanteau test, residuals are normal through Jarque-Bera test and homoskedastic through ARCH test. The result of these tests is shown in Table 08.

Table 8: Summary of Diagnostic test results

Diagnostic	Statistic	Interpretation
Serial Correlation Test (Portmanteau Test)	Chi-squared=193.06 p-value=0.9985	No serial correlation
Normality Test (Jarque-Bera)	Chi-squared=15.153 p-value=0.1266	Residuals are normal
Heteroskedasticity Test (ARCH Test)	Chi-squared=705 p-value=1	Residuals are homoskedastic
Source: Author's computation in R-Studio		

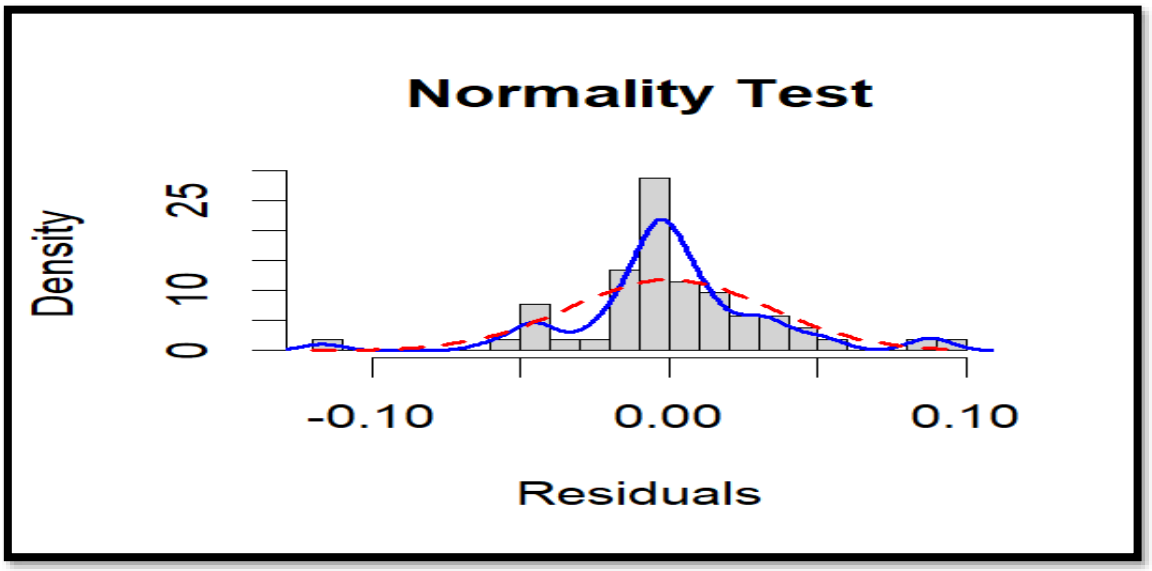
5. Conclusion

All the macro economic variables discussed in this paper have a stable long run equilibrium relationship among them. This is confirmed by Johansen Co-integration test. Hence, the first objective of this paper is achieved. In the long run direct tax, indirect tax and trade openness have positive impact on GDP while Gross fixed capital formation shows negative impact on GDP. In the short run the adjustment mechanism is asymmetric and indirect taxation absorbs most of the disequilibrium by acting as the stabilizer of the system while GDP, direct taxes, GFCF, and trade openness do not significantly adjust in the short run. The findings of the paper are consistent with the broader literature (Dahal, 2020; Durga Prasad et al., 2022; Geetanjali & Venugopal, 2017; Gllogjani & Durguti, 2023; Neog & Gaur, 2020; Venkataraman & Urmi, 2017; Wagle & Manerkar, 2022) on fiscal policy in emerging economies, where indirect taxes are more flexible and responsive to shocks, while direct taxes remain relatively rigid due to administrative and compliance challenges. Investment and trade openness contribute to growth dynamics but do not serve as primary adjustment variables. The value of the error correction term is 0.3910 in the indirect tax equation, and this is the only statistically significant adjustment coefficient. So, the second objective has also been achieved by identifying the variable i.e. Indiret tax which corrects the deviation significantly in short run for establishing long run equilibrium.

6. Policy Implications

The findings of this paper are reliable as the model has passed all the diagnostic checks. Therefore, it can be said that the Indirect tax reforms are crucial for maintaining macroeconomic stability, as they are the primary adjustment mechanism. Strengthening the responsiveness of direct taxes would enhance fiscal sustainability and reduce reliance on indirect taxation. Investment (GFCF) and trade openness, though not the main adjustment variables, remain essential drivers of growth and should be supported through structural reforms and liberalization policies.

7. Annexture



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