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The Empirical and Dynamic Relationship between Sectoral Output, Capital Formation, and Per Capita Income in Nepal

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Abstract: This study investigates the relationship between key economic sectors, capital formation, and per capita income in Nepal. Focusing on the period from 1975 to 2023, it has two central objectives: (ii) to show the empirical relationship between gross capital formation, primary and tertiary sectors on real per capita output, and (iii) to explore the short-run and long-run relationship between these variables. Using time-series data and employing the Johansen cointegration test and the Vector Error Correction Model (VECM), the analysis confirms a significant long-run relationship. The results reveal statistically significant impacts of the primary sector, the tertiary sector, and gross capital formation on real per capita income in both the short and long run. The Error Correction Term was -0.28 and significant, indicating a 28% annual adjustment towards long-run equilibrium. The study concludes that primary and tertiary sector outputs, along with capital formation, are fundamental to Nepal's per capita income, with significant implications for economic policy.

Keywords: *Empirical Relationship, Short-Run Dynamics, Long-Run Equilibrium, VECM, Cointegration, Sectoral Output, Gross Capital Formation, Nepal*

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1. Introduction

The crucial indicator of economic growth is sectoral share, as it influences overall economic development and real per capita GDP growth. Empirical studies have examined the relationship between per capita income and sectoral shares to assess how shifts in sectoral contributions affect economic development (Kuznets, 1979; Lewis, 1954). The structure of the Nepalese economy has undergone notable changes in the contribution of its major sectors. Data reveal a steady decline in the agricultural sector, moderate growth in the secondary sector, and a significant expansion of the tertiary sector (CBS, 2014/15). This shift highlights the evolving economic landscape in Nepal, with an increasing emphasis on services and industrial activities compared to traditional agriculture.

The share of the primary sector declined from 71.8 per cent in 1975 to 33.12 per cent in 2015 (CBS, 2014/15). The decline in the share of the primary sector has largely been redistributed to the secondary sector, which is currently contracting rather than expanding, and to the tertiary sector, which now holds a substantial share. Consequently, the study suggests the need to examine the empirical relationship between the shares of major sectors and real GDP in Nepal, alongside traditional growth regressors. It is anticipated that the sectoral shift, as reflected in the contributions to real GDP, will drive economic growth by absorbing excess labour from the agricultural sector into more productive modern sectors such as manufacturing and services. This transition is expected to enhance overall productivity and stimulate economic development.

In the context of Nepal, there is a limited amount of empirical research focusing on the relationship between sectoral shares and real GDP. A previous study by Bhatta (2014) analysed structural change and per capita income, consisting of time series data from 1975 AD to 2012 AD and applied the unit root test and ordinary least squares (OLS) method. This study lacks time series data from 2013 to 2023. This thesis addresses the gap in the current time period. This paper also

analyses a comparative study of the period before and after liberalisation, as well as the short-run and long-run effects on sectoral output and per capita income.

To sustain economic growth and increase per capita income, the government must prioritise the distribution of sector shares. The primary sector faces challenges such as low productivity, a lack of modernisation, and rising industrial wages, which contribute to its declining share. In contrast, the tertiary sector is expanding rapidly, driven by technological innovation, urbanisation, and rising incomes. Gross capital formation is considered a key indicator of economic growth, as it represents the total value of a country's investments in physical and financial assets. Therefore, investigating the relationship among the primary, tertiary sectors, gross capital formation, and per capita real GDP, both in the long term and short term, provides insights into the performance of these sectors and helps balance inputs and outputs in the economy.

Understanding this relationship is important for two main reasons. Firstly, Economic Planning and Policy Making: It helps policymakers design strategies to foster balanced growth across sectors, optimise resource allocation, and address sector-specific challenges. Sector shares play a vital role in driving economic growth and enhancing per capita income. Secondly, Sectoral Development and Growth: It provides a basis for assessing how changes in sectoral contributions affect overall economic development, guiding investments and interventions aimed at enhancing productivity and economic stability.

Against this backdrop, this study has two specific objectives:

- To show the empirical relationship between gross capital formation, primary and tertiary sectors on real per capita output of Nepal.
- To explore the short-run and long-run relationship between primary, gross capital formation and the tertiary sector with real per capita output.

2. Materials and methods

Research design

The study examines the relationship between the primary, secondary, and tertiary sectors and real GDP. Specifically, this research aims to address the following question: Is there a meaningful causal relationship among the primary, secondary, and tertiary sectors and real per capita GDP? What is the nature of this relationship? Is this relationship significant alongside other key explanatory variables? The econometric procedure for answering these questions involves testing for stationarity using unit root tests. Next, the OLS equation is estimated along with other core determinants. Residual tests, including those for normality, serial correlation, and heteroskedasticity, are performed. Multicollinearity among the explanatory variables is assessed. Finally, the cumulative sum of squares test is conducted to check the stability of the equation.

This study employs a descriptive and analytical approach, utilising quantitative methods. The research is entirely based on time series secondary data.

Sample period

The study utilises annual data on various variables from FY 1974/75 to FY 2022/2023, comprising 49 observations for each variable. For simplicity, FY 1974/75 is denoted as 1975, and subsequent fiscal years follow the same pattern.

Sources of data

The study predominantly relies on secondary data sources. In reviewing theoretical and empirical concepts on economic growth and sectoral shares, it references a range of materials, including journals, working papers, study reports, case studies, peer-reviewed articles, and books. These sources are published by various national and international institutions and scholars. Additionally, unpublished theses and dissertations are also utilised.

The main sources of data and information for this study are the Quarterly Economic Bulletin (NRB), Banking and Financial Statistics (NRB), Government Finance Statistics (NRB), Economic Survey Reports (MOF, GON), National Accounts of Nepal (CBS), Statistical Year Book of Nepal (CBS), Statistical Pocket Book (CBS), along with data from the International Monetary Fund and the World Bank Data Bank.

Model specification

For model specification, the study utilises an equation to describe the relationship between the dependent and explanatory variables. The proposed model aims to examine the connections between the shares of the primary and tertiary sectors, gross capital formation, broad money supply, total trade, and real per capita GDP in Nepal.

ln${PCI}{t}$ = $\alpha{1}$ + α_{2}ln${PRY}{t}$ + $\alpha{3}ln\ {GCF}{t}$ +$\alpha{4\ }$ln${TER}{t}$ +$\alpha{5\ }ln\ {MS}{t}$ + ${\alpha{6\ }ln\ {TT}{t}\ + \varepsilon}{t}$ ..... (1)

Here, PCI represents real per capita GDP, while PRY, SEC, and TER denote the shares of the primary, secondary, and tertiary sectors in real GDP, respectively. MS and TT are the money supply and total trade, respectively. Finally, t$ is the time subscript for time series data and ε_{t} is the white noise error term.

The inclusion of MS and TT is grounded in established growth theory and the specific context of the Nepalese economy. While sectoral output and capital formation are core drivers of growth, financial depth and trade openness are critical complementary factors.

MS is employed as a proxy for financial development and depth (Gautam, 2014; Timsina, 2014). A well-developed financial system, indicated by a larger money supply relative to GDP, facilitates efficient capital allocation, mobilises savings for investment, reduces transaction costs, and mitigates risk. In the context of Nepal, where capital markets are still developing, the banking sector and its liquidity, captured by MS, play a pivotal role in financing the investments in the primary, secondary, and tertiary sectors that are essential for growth. Omitting this variable could lead to a mis-specified model that overlooks a key channel through which sectoral growth and capital formation are financed and transmitted to per capita income.

Total Trade (exports + imports as a share of GDP) is a standard measure of trade openness. Theoretically, trade openness can influence per capita income through several channels: it facilitates the diffusion of technology and knowledge, promotes competition and efficiency, enables access to a broader range of goods and capital inputs, and allows economies to specialise according to their comparative advantage (Dissanayaka et al., 2021). For a landlocked economy like Nepal, which relies on imports for capital goods and key inputs and on exports for foreign currency earnings, the volume of trade is a significant determinant of overall economic activity and, by extension, per capita income. Its inclusion controls the external sector's influence on the domestic economy.

Data analysis technoques

The variables used in each model are converted to natural logarithms to simplify the calculation of elasticity and enable the transformation of non-linear models into log-linear form. Summary statistics are calculated and presented, including measures of central tendency (i.e., mean), dispersion (i.e., standard deviation), distribution shape (i.e., skewness and kurtosis), and normality (i.e., Jarque-Bera). A unit root test, specifically the Augmented Dickey-Fuller test, is conducted to determine the order of integration for each variable used in the empirical model. A correlation matrix of the variables is presented to illustrate how the dependent variable correlates with each explanatory variable for each model. Multicollinearity among explanatory variables has been identified, so highly correlated variables will be removed, but at least one related variable will be retained. The Variance Inflation Factor (VIF) test is conducted to check for multicollinearity among explanatory variables. Serial autocorrelation in the error terms is detected and corrected. The normality of error terms is tested using both graphical methods (histogram) and the Jarque-Bera (J-B) test. The problem of heteroskedasticity is identified and corrected. The overall explanatory power of the model is measured using the adjusted R-squared and R-squared statistics. The F-test is used to determine the overall goodness of fit of the model, while the t-test is used to test the individual coefficients of explanatory variables. The estimation procedures were performed using Microsoft Excel 2010 and EVIEWS 7.

Unit root test

The empirical analysis uses time series data. For this analysis, it is assumed that the time series data must be stationary. Data are considered stationary if the mean, variance, and covariance remain constant over time (Gujarati, 1995). However, it is widely recognised that most time series data tend to be non-stationary (Dickey-Fuller, 1979). In the case of non-stationary time series data, the regression results are spurious, meaning they are unreliable. Hence, it is necessary to avoid the non-stationary or unit root in time series data. For this purpose, the Augmented Dickey-Fuller test and the Phillips-Perron test are employed. However, this study employs the augmented Dickey-Fuller test to discuss the unit root test.

Johansen cointegration test

The Johansen cointegration test is used to examine the long-term correlation between dependent and independent variables. For this, variables are stationary at first difference (I) and not at level (0). Johansen and Juselius (1990) provided two likelihood ratio tests to obtain the number of integrated vectors.

$\lambda trace(r) = -T\sum_{i = r + 1}^{n}{ln(1 -}\lambda)$ ... ... (2)

$\lambda max(r, r+1) = -T \ln(1-\lambda)$ ... ... (3)

Where λ equals the estimated eigenvalue of the characteristic roots, r = 0, 1, 2..., T is the number of observations. The null hypothesis of the first test (trace) is to test if the number of distinct cointegration vectors is less than or equal to r against the alternative. The null hypothesis of the second (Max) test is the number of cointegrating vectors r against the alternative of r+1 cointegrating vectors. The results obtained from this test are used in applying the VECM, which measures the long-run relationship.

Vector error correction model (VCEM)

The vector error correction model shows the movement between the variables. It is used for studying the long-run causality between exogenous and endogenous variables.

General VCEM Model

$\mathrm{\Delta}Yt = \beta 0 + \sum_{i = 1}^{n}{\beta 1\mathrm{\Delta}Yt - 1 +}\sum_{i = 0}^{n}{\delta i\mathrm{\Delta}Xt - 1 +}ϕZt - 1 + ut$ ... .(5)

$\mathrm{\Delta}Zt - 1 = Yt - 1 + \ \beta 0 + \beta 1Xt - 1$ ... (6)

Where equations (5) and (6) $\mathrm{\Delta}$ are represented by the different operator, Yt refers to the dependent variable, and Xt is the independent variable. $\mathrm{\Delta} Zt-1$ is the error correction, while $ Zt-1$ is the error term generated by the Johansen cointegration test, $\beta 0,\beta 1$ \ $and δi are the coefficients, and $ϕ$ is the coefficient of the error term. Ut is the disturbance terms.

3. Results

3.1. Stationary (Unit Root) Test

All the variables are not stationary at level or order zero 0, ,they are stationary at first difference, that is, order I (1). For this purpose, the data series are transformed into natural logarithm form. For this, we use the unit root test, using the Augmented Dickey-Fuller (1981) and Phillips-Perron (1998) tests. The results of the unit root tests are presented in Table 1.

Table 1: The results of the unit root tests

Variables	ADF – test (Order I)	Phillips - Perron test (Order I)
LMS	0.0000*	0.0000*
LPCI	0.0000*	0.0000*
LPRI	0.0000*	0.0000*
LGCF	0.0000*	0.0000*
LTER	0.0000*	0.0000*
LTT	0.0393**	0.0000*

Sources: Authors' calculation from E-views 10 Software

*indicates significant at 1 percent level and ** at 5 percent level.

3.2. Johansen's Cointegration Test

The VECM model is employed to examine the long-run relationship between the stock price and macroeconomic variables. Before using the VECM model, the Johansen cointegration test is applied to determine the long-run relationship between sector-wise output and per capita income. Trace statistic and Maximum Eigen statistics are tested. Table 2 presents the Johansen cointegration test results. According to Trace Statistic and Maximum Eigenvalue statistic, the equations are cointegrated at a 5 per cent level. The Trace Statistic and Maximum Eigenvalue exceed the critical value and are significant at the 5% level, indicating that one equation is cointegrated.

Table 2: Unrestricted Cointegration Rank Test

Hypothesized No. of CE(s)	Trace Statistic	0.05 Critical Value	Prob.**	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	137.6474	95.75366	0.0000	59.86634	40.07757	0.0001
At most 1	67.78105	69.81889	0.8101	31.83963	33.87687	0.0858

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

3.3. Long Run Equation/Cointegration Equation

LNPCI = 11.62 - 0.61LNPRI + 0.52LNM - 0.14LNTER - 0.14LNTT - 0.20LNGCF

The coefficient of PRI is -0.61, indicating that a one per cent increase in the primary sector results in a decrease in per capita income by 0.61 per cent, while holding other variables constant in the long run, which is statistically significant. The coefficient of LNM is 0.52, indicating that a one per cent increase in the money supply leads to a 0.52 per cent increase in per capita income in the long run, while holding other variables constant, which is statistically significant. The coefficient of LNTER is -0.14, indicating that a one per cent increase in the tertiary sector leads to a decrease in per capita income by 0.14 per cent, while keeping other variables constant, which is statistically significant. The coefficient of LNTT is -0.14, indicating that a one per cent increase in total trade leads to a decrease in per capita income by 0.14 per cent while keeping other variables constant, which is statistically significant. The coefficient of LNGCF is -0.20, indicating that a one per cent increase in gross capital formation leads to a decrease in per capita income by 0.20 per cent, which is statistically significant.

3.4. Short Run Model (VCEM Results

The coefficient of ECM for LNPCI is -0.28 and is statistically significant at the 1% level. It shows the speed of adjustment. It gives the speed of adjustment, which model restores its equilibrium from any error terms/ disturbance terms. The speed of adjustment is 0.28, which indicates that 28 per cent of the error terms are corrected within the same period. Moreover, it shows the long-run causality between LM, LPRI and LGCF, LTSS, and LTT to LPCI.

Table 3: Short Run Model (VECM Results)

Variables	Coefficient	Std. Error	t-Statistic	Prob.
VECT-1	-0.285728	0.082164	-3.477544	0.0013
D(LPCI(-1))	0.238266	0.021430	-2.962172	0.0469
D(LPRI(-1))	0.234136	0.044256	-3.623063	0.0126
D(LRMS(-1))	0.058152	0.079998	-4.726918	0.0716
D(LTER(-1))	0.058435	0.056627	-4.031933	0.0085
D(LTT(-1))	0.138699	0.080691	5.718880	0.0936
D(LGFC(-1))	0.061884	0.059678	2.036969	0.0061
R-squared	0.603609	Mean dependent var	0.024540	
Adjusted R-squared	0.584513	S.D. dependent var	0.045257	
Prob(F-statistic)	0.000149			

Sources: Self calculation by Author

The coefficient of LPCI is 0.23 (C2), which indicates that a one per cent increase in per capita income leads to a 0.23 per cent decrease in per capita income, while keeping other variables constant, and this is statistically significant. The coefficient LPRI is (C3= 0.23), which indicates that an increase in the primary sector by one per cent causes an increase in the stock price by 0.23 per cent while keeping other variables constant, which is statistically significant. The coefficient of LRMS is (C4 = 0.05), indicating that an increase in the primary sector by one per cent leads to a decrease in per capita income by 0.05percent while keeping other variables constant. The coefficient of LTER is (C5=0.05), indicating that an increase in the tertiary sector by one per cent leads to an increase in per capita income by 0.05 per cent while keeping other variables constant, which is statistically significant. The coefficient of LTT is (C6 =0.13), which means that an increase in total trade by one per cent leads to a decrease in per capita income by 0.13 per cent while keeping other variables constant. It is statistically significant. The coefficient of LGCF is (C7=0.06), indicating that an increase in total trade by one per cent leads to an increase in per capita income by 0.06 per cent while keeping other variables constant, which is statistically significant. The R-squared value of 0.60 indicates that the dependent variable PCI can be explained by the independent variables to the extent of 60%. The value of R-squared is high, indicating that the estimated model is a relatively good fit. The value of the F-statistic is 5.65, and its p-value is significant at the 1% level, indicating that the model is a good fit.

4. Discussion

The study found that all independent variables have a significant positive impact on real per capita income both in the short run and in the long run. However, the coefficients of primary, tertiary, gross capital formation, money supply and total trade are statistically significant.

This study examined the causal relationship between real per capita income, the primary sector, gross capital formation, total trade, money supply, and the tertiary sector. There is a rapid decline in the share of the primary sector, a decline in the share of the secondary sector and a rapid increase in the contribution of the tertiary sector to real GDP from 1975AD to 2023AD. The growth rates of the secondary and tertiary sectors before liberalisation are higher than those after liberalisation, while the primary sector, total trade, and gross capital formation exhibit lower growth rates before liberalisation compared to after liberalisation. In the short and long run, there is a positive impact of the primary sector, gross capital formation, the tertiary sector, money supply and total trade on real per capita income. All coefficients of variables are statistically significant.

The findings of this study are consistent with several previous investigations. The empirical evidence confirmed that financial development drives economic growth. Specifically, financial development served as the catalyst for short-term economic growth, while sustained economic growth supported long-term financial development (Gautam, 2014). Similarly, Timsina (2014) found that bank credit to the private sector has a positive influence on economic growth in Nepal in the long run.

The results also align with the broader literature on sectoral linkages. Subramaniam and Reed (2009) found a long-run relationship between the industrial, service and trade sectors and the agricultural sector, noting that the industrial sector in Poland contributes positively to the agricultural sector. In the context of Nepal, Bhatta (2014) found a positive relationship between agriculture, industry, gross capital formation, and population at working age, and per capita income. Furthermore, Dahal (2016) found that the service sector plays a crucial role in contributing to Nepal's economic growth, which supports the rapid expansion of the tertiary sector observed in our data.

The negative relationship observed in the long-run equation for some variables, while initially counterintuitive, can be explained through the lens of structural transformation. As economies develop, the contribution of the primary sector typically declines as resources shift to more productive sectors (Lewis, 1954; Timmer & Akkus, 2008). This structural transformation is evident in Nepal, where the share of the primary sector declined from 71.8 per cent in 1975 to 33.12 per cent in 2015 (CBS, 2014/15). The negative long-run relationship between the primary sector's share and per capita income is a classic signature of economic development, as described by Lewis (1954) and Kuznets (1979). This does not imply that agriculture is unproductive, but rather that as an economy develops, the relative share of agriculture in GDP inevitably declines as resources (especially labour) move to more productive sectors like manufacturing and modern services.

A negative relationship between capital formation and per capita income is paradoxical from the perspective of standard growth theory. However, in the context of Nepal, this can be explained by the efficiency and composition of investment rather than its volume. A significant portion of the GCF in Nepal has been directed towards unproductive or non-tradable sectors, such as real estate and construction, which may generate short-term activity but do not necessarily enhance long-term productive capacity or export competitiveness (GON & MCC, 2014).

The negative sign for the tertiary sector is the most surprising, given its expanding share. This result may stem from the nature of tertiary sector growth in Nepal. The expansion is likely dominated by low-productivity, informal services rather than high-value services. This type of growth is often associated with premature deindustrialisation, where labour moves from agriculture directly into low-end services due to a lack of opportunities in a robust manufacturing sector.

The variance decomposition analysis revealed that, in the short run, per capita income is largely explained by its own shocks; however, over time, other variables, such as money supply and total trade, gain explanatory power. This finding is consistent with Gamhewage and Peiris (2012), who found that the service sector was both the most influential and the most independent in an emerging economy.

The policy implications of these findings are substantial. As the contribution of the primary sector to gross domestic product has fallen at a rapid rate and the trade deficit is also increasing at the same pace, it is recommended that the government should focus investment on agriculture and the secondary sector simultaneously, which promotes the service sectors (Bhatta, 2014; GON & MCC, 2014). The increase in output in all sectors promotes capital formation and helps the trade deficit of the Nepalese economy. To increase the contribution of primary sectors to gross domestic product, government investment in agriculture, infrastructure, and market should be expanded from rural areas to the urban sector. The government should prioritise private sector investment in the energy sector, the manufacturing sector, the construction sector, and the water supply. The service sector should be linked up between the primary and secondary sectors (Sallam, 2021; Dissanayaka et al., 2021).

5. Conclusion

This study examined the empirical relationship and the short-run and long-run dynamics between primary sector output, gross capital formation, tertiary sector output, and real per capita income in Nepal. The empirical analysis confirms a significant long-run relationship among the variables. The findings indicate that the primary sector, gross capital formation, and the tertiary sector all exert a statistically significant influence on real per capita income. However, the long-run cointegration equation reveals a critical nuance: the expansion in the share of the primary and tertiary sectors, as well as gross capital formation, is negatively associated with per capita income.

The VECM reveals a significant speed of adjustment, with approximately 28 per cent of any disequilibrium corrected within a single period, confirming a stable long-run relationship and significant short-run dynamics. While these sectors are crucial to Nepal's economy, the negative long-run relationships suggest that the current growth in these sectors is not optimally contributing to rising per capita incomes.

The findings call for a fundamental shift in policy focus from quantitative expansion to qualitative transformation. The government's strategy should be to transform the primary sector, reorient the tertiary sector, and ensure that capital formation is efficient and productive, thereby converting these fundamental components of the economy into robust drivers of sustainable per capita income growth.

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