

# QUATERNARY SECTOR AND ECONOMIC DEVELOPMENT IN JAPAN: A CAUSAL ANALYSIS

**Jagannath Mallick**

**Abstract:** *There is no study on the linkage between the quaternary sector and economic development. The present study contributes to the existing literature by analysing the patterns of development of quaternary sector and its implication to the economic development and growth in Japan over the periods 1970-2008. The study uses disaggregated data from Japanese Industrial Productivity database, and multivariate VAR method for the empirical analysis. The findings show a significant role of quaternary activities in the development of Japan economy. The evolution of development of quaternary sector is mainly due to the development of activities of security and care. Also there is bidirectional causality between the quaternary sector and the economic development in Japan. Quaternary sector is very crucial for the economic development and growth. Hence, the practicable measures should be taken to accelerate the development of quaternary sector.*

**Keywords:** *Quaternary services, Economic development, Causal effect, Multivariate VAR.*

**JEL Classification:** *O11, F63, C32.*

## Introduction

The development level of service industry is an important indicator that measures the overall economic competitiveness of a nation and region. The included activities in the service sector are heterogenous in nature. The modern social services have become a new impetus for regional economic development in the developed countries. The recent emergence of service sector in advanced countries is due to several factors based on the socioeconomic and demographic behaviours, and technological and organizational change, and shift in the international patterns of comparative advantage [10]. There is a comparatively new and fast growing branches of knowledge-based and informational services in this globalisation era [10]. These branches of knowledge-based and informational services are called quaternary sector. Therefore, it is very necessary to make an empirical research on the intrinsic relations between the development levels of quaternary services and economy as a whole. The existing literatures have focused on the issue of service sector and economic growth. However there is no study that examines the linkage of quaternary activities with the economic development. The issue is very important in case of the Japanese economy, as it is predominated by the service sector. Particularly, due to the socioeconomic and demographic structure, there has been increasing demand for the care security, education and other development activities in Japan. Hence, the paper attempts to make an empirical analysis of the relations between the quaternary sector and economic development during the periods in 1970-2008 in Japan by using multivariate vector autoregressive (VAR) and Granger causality test.

## 1 Statement of Problem

Despite the increasing importance of services in national economies, its contribution to national productivity and economic development remains a debatable issue. Services lie

at the heart of any economic process and no material goods could be manufactured without the combination of various services. The increasing demand for services along with technological and organizational change, and shift in the international patterns of comparative advantage are the sources of recent structural changes [10]. The activities included in the service sector are extremely heterogeneous. The general shift of economic activities away from the primary and secondary sectors, in favour of the service sector, has not occurred uniformly across the service industries.

The recent emergence of service sector in advanced countries is due to several factors based on the economic, social and demographic behaviours. For instance, the demographic behavior of Japan shows that, the total dependency ratio and old age dependency ratio is highest in the world. Hence, due to the large number of old age people, the demand for services including pension, social and health insurance increases. Recently, the developed economies are dominated by the knowledge intensive services (KIS) and informational services, which required skilled labour. Particularly, the increasing role of high and medium high tech sectors in the modern economy generates demand for KIS and informational services. Even, the demand for skilled labour is sourced from the traditional sector due to the increasing incorporation of knowledge and some new sub-sectors, which are formed by the innovative fast growing firms [10]. There is the particular group of knowledge-based services, which has benefited most from technological change and general increases in demand. The growth of the recent service sector is due to the growth of the comparatively new and fast growing sectors of knowledge-based and informational services, which are called quaternary sector [10]. In other words, the recent dominant pattern of structural development in the 20th century, is characterised by the steady rise of information and knowledge-based services. The general rationale behind this process is the information society, or the knowledge-based economy.

The knowledge-based and informational services can contribute directly to economic development through their own growth in employment and income. Also they can additionally have the potential to improve performance in the economic system via knowledge transfer and progressive specialisation, which are capable of stimulating various kinds of competitive advantage and productivity growth: (i) technological innovation, (ii) organisation, corporate finance and strategy and (iii) marketing. Hence, the quaternary sector is the complementary factor of production and raises general prospects for entrepreneurial discovery and productivity growth. The quaternary sector has increased its importance in terms of social and economic development in the advanced countries mainly due to the recent demographic behavior and changing life style, technological change and hence increasing demand for new services etc.

There exist some studies that address the relationship of service sector with the economic growth development. For instance, the relationships among KIS sector, the changing nature of the innovation process, and the globalising learning economy are discussed by [1], [3], [6], [7], [8], [12], [13]. Also, the relation between services and manufacturing in the post-industrial society is examined by [2] and [4]. [2] suggested that, consumers expand their basket of purchases beyond basic material goods to a whole new realm of services corresponding to the increase in wealth. In contrast, [4] emphasised on the manufacturing base. Further, [9] argued that, there is shift of services as production and consumption 'sectors' to services as 'functions'. This change stems from new insights into the role of knowledge production and distribution in the economy, particularly with respect to new knowledge based services and the reshaping of existing service activities. [13], for example

highlights the role of strategic services in shaping competition and comparative advantages, while [12] draws attention to the role of technological services and competencies in shaping new industrial structure and organizational patterns. [7] extends the analysis further, stating the location of advanced business services as a key factor of growth. But, there is no detailed empirical study on the relationship of quaternary sector with the economic development. In this context, this is important to understand the linkage of quaternary activities with economic growth and development, which will have policy implication to achieve high growth and development. Hence, the main objectives of the study are:

- a. To examine the causal relationship between the development of quaternary sector and economic development.
- b. To suggest policy for sustainability of economic growth through the development of quaternary activities.

## 2 Methodology and Data

The objective of the study is to examine the patterns of quaternary activities and to examine its linkage with economic development and growth in the Japan during the periods in 1970-2008. The study chooses Japan for the empirical analysis, due to the relevance of quaternary activities in Japanese economy for its socioeconomic and demographic characters. The rising of the aging population and changing society, needs the development of security and care. Currently, the changing society is characterized as weakened communities increase in small-sized families, and increase of working women, financial and psychological burden of family facing the care for the elderly has become unbearably large, which demand for care and health security. Further, Japanese economy is a service sector based and IT intensive economy, which requires skilled labour, due to which high quality of education is very important.

The Japanese Industrial Productivity (JIP) data base provides information on input and output at the disaggregate level for 108 sector [14]. The concordance of JIP data base and ISIC Rev 4 has been constructed, and accordingly the quaternary activities have been identified and measured. Based on the ISIC Rev 4 classifications, the activities of quaternary sector include the activities of security & care and development. The security & care includes public administration and defence; compulsory social security (O84), human health activities (Q86), residential care activities (Q87) and social work activities without accommodation (Q88). The activities of scientific research and development (M72), other professional, scientific and technical activities (M74), education (P85), creative, arts and entertainment activities (R90), sports activities and amusement and recreation activities (R93) and libraries, archives, museums and other cultural activities (R91) are considered as the development activities of quaternary activities. The estimated gross output and valued added of quaternary activities based on JIP data has been used for the analysis<sup>8</sup>. The real value of output and value added of quaternary sector is measured at 2000 prices in JPY.

The patterns of quaternary activities have been examined by using the simple algebraic calculations. However, the core of the analysis of the study i.e., the linkage of quaternary sector and economic development has been examined by using the time series technique, particularly multivariate VAR method. This methodology assesses the cumulative effects, which is accounted into the dynamic response between quaternary sector and the other

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<sup>8</sup> Based on the concordance of ISIC Rev4 and JIP, in terms of JIP codes, the security and care includes 70, 72, 82, 83, 89, 96, 97, 100, 101, 102, 104 and 105, and development includes 80, 81, 94, 95, 98, 99, 100 and 106.

variables of interest [11]. As the tertiary sector is an important component of service sector, the empirical analysis considers it, while examining the causal relation between quaternary sector and economic development. The three variables are measured as real value added at constant prices 2000 in the economy, tertiary sector and quaternary sector. The analysis used annual data covering the period 1970-2008. The first step of the time series is the understanding of data generating process of the variables. That means the testing of stationary is very crucial in the time series data, because, the use of non-stationary data in the regression, gives spurious and inefficient relations. There are various methods of testing of stationary of variables, which are called unit root test as well. Based on the data generating process, the appropriate method has been used for estimating the relations.

### 3 The problem solving and Discussion

The study examines the patterns of development of quaternary activities by its components, and then it examines the relation between the quaternary activities and economic development. The patterns of development have been examined by classifying the economy into agriculture, industrial, tertiary and quaternary sectors.

#### 3.1 Patterns of Economic Growth and Quaternary sector

The pattern of quaternary sector is examined during the period 1970-2008 using the gross output series at constant prices 2000. The trend growth rate and annual average share of sectors in the output as a whole economy is presented for the two sub-periods i.e. 1970-89 and 1990-2008 in figures 1 and 2, respectively. The service sector has registered higher growth (4.6) than the agriculture (0.6) and industrial sector (2.9) in the first period (1970-89). This is important to observe that, the quaternary sector has grown at the rate of 5.1 per cent, which is higher than the growth of tertiary sector at 4.4 per cent. In the recent period, there is no such economic growth in Japanese economy as it is revealed from the Fig. 1. The growth rate of economy declined from 3.6 per cent in the first period to a sluggish growth rate of 0.9 per cent in the second period. Nevertheless, the growth of quaternary sector is continued to dominate over the other three sectors i.e. agriculture, industrial and tertiary sector. Further, coming to the components of quaternary sector, the growth of Care and security is much stronger than the development sector in the two sub-periods. Therefore, the quaternary sector is emerged as the important sources of growth of service sector in Japan.

**Fig. 1: Sectoral growth of output (in %)**

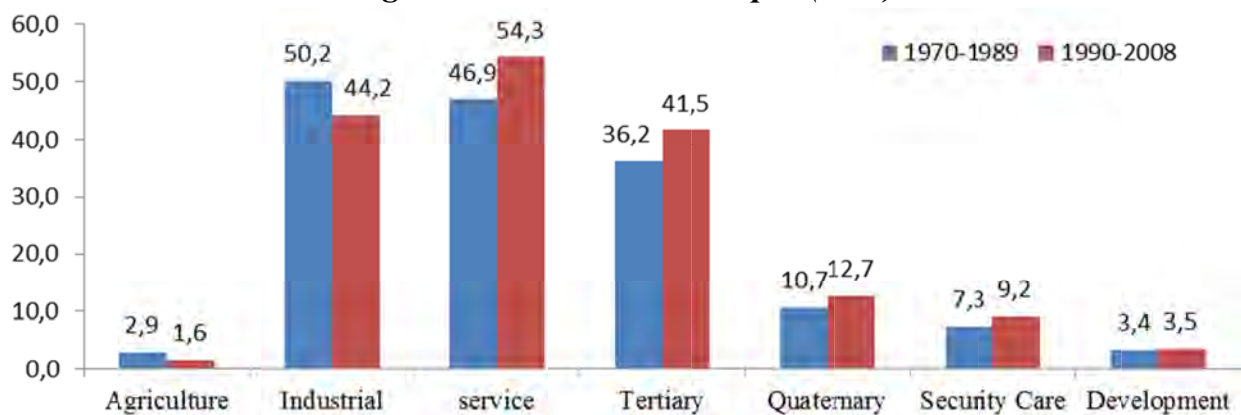


Sources: [14]

The sectoral shares in terms of output or income represent the structure of economy, which has been provided in Fig. 2. Japan is smoothly progressing towards economy

with an increasing weight in the services sectors and a corresponding decrease in the non-service sectors. This trend is visible when one compares the changes in the sectoral shares of the output in 1970-89 and in 1990-2008. This fact lies in the higher growth of both the sub-sectors of service sectors than the other non-service activities. The annual average of share of tertiary sector was 36.2 per cent in 1970-89, which has increased to 41.5 percent in 1990-2008. Similarly, the share of quaternary activity has increased from 10.7 per cent in 1970-89 to 12.7 per cent in 1990-2008. The rise of service sector particularly the quaternary activities are due to the changing pattern of consumption behaviour, population structure and socio-economic behaviours. The fundamental widespread change of the economic structure can be influenced by policy decisions, by permanent changes in the resources, or by changes in the education and skills profile of the population of a region/country. Particularly, the rising of quaternary sector in Japan could be due to its structure and system of care, security and education & development. This is evident from the figures 1 & 2 that, the security and care activities have been dominating over the development activities within the quaternary sector.

**Fig. 2: Sectoral share in output (in %)**



Sources: [14]

### 3.2 Quaternary sector and Economic development

The core objective of the study is to examine the inter linkage between the quaternary sector and economic development. As mentioned in the previous section, the Japan is smoothly progressing towards services sectors though the growth in its two components i.e., quaternary and tertiary sectors. Hence, it is important to empirically understand, how these components of services and economic development are interrelated to each other. This is important to be noted that, the testing of data generating process is very essential, before proceeding to explore such type of relations in the time series data. The non-stationary data gives us the spurious and inefficent estimates. Hence, the results of unit test is conducted and results for the three variables are presented in Tab.1. The results suggest that the null hypothesis of a unit root in the time series can be rejected at a 1% level of significance in variable levels. Therefore, all the variables are appeared to be stationary at their levels.

**Tab. 1: Unit root test**

Variables	ADF test
Economy	-4.19*
Tertiary	-5.5*
Quaternary	-6.4*

Source: Author

**Tab. 2: Lag selection**

Lag order	LL	LR	FPE	AIC	HQIC	SBIC
0	140.9	NA	0	-7.6	-7.83	-7.74
1	302.02	322.2	1.3e-11	-16.6	-16.4*	-16.04*
2	312.5	21*	1.2e-11*	-16.7*	-16.3	-15.7
3	318.5	12.3	1.5e-11	-16.5	-16.0	-15.1

**Note:** LL=log likelihood, AIC= Akaik information criteria, HQIC= Hannan quinn criteria, SBC= Schwarz Bayesian criteria

*Source: Author*

The stationary nature of data generating process of the three variables of interest i.e., the value added in quaternary sector, tertiary sector and the economy as a whole, directs us to estimate the simultaneous equations of the three variables by using VAR. Because, economic development may also affect the growth and development of services activities [2], which indicates that, there is the possibility of simultaneous relations among the variables. One difficulty, which a researcher faces with the estimation of an autoregressive VAR model, is the appropriate specification of the model. Specially, the researcher has to decide which deterministic components should be included and which number of lags should be used as well. Since arbitrarily selected specifications of the autoregressive VAR model may produce unreliable results. We use the lag selection criterion of a database model in order to specify the autoregressive VAR model for Japanese economy. There are different criteria for the selection of lag, as presented in Tab. 2. Based on HQIC and SBIC criteria, the number of lags should be chosen is 1. However, the majority of criteria suggest to considering the lags at 2. Therefore, VAR (2) is specified and estimated.

**Tab. 3: Estimated Results of VAR**

Variables	Economy	Tertiary	Quaternary
C	2.3 (1.11)**	0.82 (0.99)	1.94 (0.76)**
Economy			
L1	1.3 (0.29)*	0.64 (0.28)**	0.43 (0.2) **
L2	-0.7 (0.3)**	-0.67 (0.3)**	-0.31 (0.2)
Tertiary			
L1	0.24 (0.34)	0.7 (0.4)**	-0.45 (0.23)
L2	0.44 (0.49)**	0.29 (0.29)	0.6 (0.2)*
Quaternary			
L1	-0.24 (0.23)	-0.06 (0.23)	0.86 (0.16)*
L2	0.5 (0.23)**	0.08 (0.22)	0.07 (0.15)
R-sq	0.91*	0.91*	0.92*
n	37	37	37

*Source: Author*

The estimated result of VAR with three variables is provided in Tab. 3. The R-square in all the three models are significant in explaining measurement of goodness of fit of the regression models. As the variables are in terms of log. values, the coefficient of the independent variables can be interpreted as the elasticity's of independent variable with respect to the dependent variable. The results show that, the quaternary sector and tertiary sector are significant in explaining the development of economy in Japan. Services activities affect economic development by its own growth and development. Also, there could be the spillover effects from services innovation, and hence stronger flows of useful knowledge and information from services to other economic activities [15]. These

two sub-sectors of services are affecting the Japanese economy at their second lags. These two coefficients are statistically significant at the 5 per cent level. This is important to observe that, the coefficient of quaternary sector (0.5) is higher than the tertiary sector (0.44), which suggests that, the elasticity of quaternary sector is higher than the tertiary sector. We can infer that an increase of 1% on valued added of tertiary sector, lead to an increase of 0.44% on the value added of the economy, an increase of 1% on quaternary sector will lead to an increase of 0.5% on the value added of the economy. However, the tertiary sector is caused by its own in the one year lag and the economy. But it is not caused by the quaternary sector. Similarly, the quaternary sector is caused by the development of the economy as a whole and the tertiary sector. The economy causes the quaternary sector at its one year lag, while the tertiary sector causes at its two year lag period.

**Tab.4: Diagnostic test**

Test	H0	Test statistic	Probability	Conclusion
LM	No auto correlation at lag 1	8.5	0.48	No auto correlation
	No auto correlation at lag 2	9.1	0.43	No auto correlation
Jarque–Bera	Normally distributed	7.52	0.28	Normally distributed

*Source: Author*

**Tab. 5: Granger Causality Test**

<b>Dependent variable : Economy</b>				
Excluded	Chi-sq	Df.	Probability	
Tertiary	3.26	2	0.05	
Quaternary	4.28	2	0.04	
All	8.86	4	0.05	
<b>Dependent variable : Tertiary</b>				
Excluded	Chi-sq	Df.	Probability	
Economy	3.23	2	0.05	
Quaternary	2.11	2	0.56	
All	9.08	4	0.05	
<b>Dependent variable: Quaternary</b>				
Excluded	Chi-sq	Df.	Probability	
Economy	3.22	2	0.05	
Tertiary	4.7	2	0.02	
All	9.8	4	0.05	

*Source: Author*

Further, the study has employed various diagnostic tests for the residuals' of the model viz., Jarque Bera normality test and LM test to examine the validity and reliability of the regression model. Jarque Bera test statistic (Tab. 4) is used for testing whether the residuals of the series are normally distributed. The results on the value of diagnostic tests indicate that, the estimated model satisfies all diagnostic tests. The null hypothesis is of a normal distribution – a small probability value leads to the rejection of the null

hypothesis. Here the null hypothesis cannot be rejected ( $p$  value=0.28). So it can be concluded that the residual series is normally distributed. Similarly, the LM test examines for null hypothesis of no autocorrelation. The probability value of LM statistics directs not to reject the null hypothesis. Hence, there is no autocorrelation in the system of equations. The estimated VAR model satisfies the diagnostic tests, and hence it is valid and reliable.

The results of the relationship of these three variables from the VAR model can be summarized by using the Granger causal relationships. As a testing criterion the F statistic was used. With the F statistic the hypothesis of statistical significance of specific groups of explanatory variables was tested for each separate function. The results relating to the existence of Granger causal relationships among the development of quaternary sector, tertiary sector and the economy as a whole is presented in Tab. 5. The result confirms some important findings of the study, such as; (a) the development of quaternary sector and tertiary sector leads to the development of economy as a whole, (b) the development of tertiary sector is caused by the development of economy, but not by the quaternary sector and (c) also the development of quaternary activities is caused by the development of economy and tertiary sector. That means, there are a bi-directional causality from economy to tertiary and quaternary sectors, and a unidirectional causality from tertiary to quaternary only.

## Conclusions

This paper tries to examine the patterns of development of quaternary activities, and analyse the relationship among the development of quaternary sector, tertiary sector and the entire economy, by using annual data over the period 1970-2008 in Japan. The empirical analysis suggested that the examined variables are stationary. On this basis the methodology of multivariate VAR model was applied to estimate the relationships. Then the Granger causality test is used to summarise and confirm the relationship among the variables. The results suggest that the development of quaternary sector like the tertiary sector is very crucial for the development of Japanese economy during the last 4 decades. The development of quaternary sector causes the economic development, and is also caused by the latter. The study provides important message is that, the quaternary sector along with the tertiary sector is crucial for the economic growth and development. Hence, appropriate measures should be taken for the development of quaternary activities to achieve high economic growth and development.

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**Contact Address****Dr. Jagannath Mallick**

University of Pardubice, Faculty of Economics and Administration

Institute of Regional and Security Sciences

Studentská 95, 532 10 Pardubice, Czech Republic

Email: jagannath.mallick@upce.cz

Phone number: +420 466 036665

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