ANALYSIS OF THE DYNAMIC RELATION BETWEEN LOGISTICS DEVELOPMENT AND ECONOMIC GROWTH IN INDONESIA

Mohamad Reza

Ph.D. Student, Logistics Management Faculty of Graduate Studies, Chulalongkorn University
Information Technology Officer, United Nations Economic Commission for Asia and the Pacific
Bangkok, Thailand
email: reza@un.org

Abstract

Purpose: This paper investigates the relationship between logistics development and economic growth in Indonesia from the data of traffic volume and GDP growth rate from 1988 to 2010.

Design/methodology/approach: The analysis of the dynamic relation will be performed by linear and logistic regression. Literature reviews have been conducted to find the most applicable statistical model. Survey data was collected, whereby data of cargo volume that travels through sea, air and rail is used as the logistics index, while GDP is used for the economic growth index.

Findings: The outcome of the study shows that development of logistics plays an important role in supporting and sustaining economic growth. The linear equation model presents a good trend, while the logistic econometric model, using the upperbound value of Indonesian GDP in 2015, shows an even a better relationship.

Research Impact: The logistic regression model is quite useful in analyzing Indonesia's logistics contribution. Even though the model is developed in the context of Indonesia, the overall statistical analysis is generic and can be generalized to other developing economies.

Originality/Value: Analyzing relationship of logistics infrastructure and economic growth that has been done in previous research in specific geographical region using various regression analysis of other statistical method can perhaps be built for understanding Indonesia's economic situation. This paper will hopefully present a strong and interesting angle of the necessity to keep the stability of Indonesian economic growth rate and be in pursuit of continuously improving the logistics infrastructure.

1. Introduction

Logistics is playing an important part in a country's economy, where rapidly developing economy would intuitively support the logistics development. With this linkage, logistics would grow accordingly with the economic development, and reversibly the economic development would influence the logistics industry. Until 2012 Indonesian economy has

grown in an average of 5%[1]per year since post monetary crisis in 1998, and has reached it peak growth rate of 6.5% in 2012. The latest GDP data shows that Indonesian GDP reached 1,124 billion USD in 2011, with the current forecast, it can reach GDP value of 1,542 billion in 2015[2]. With this the current trend, the economy will keep growing for the subsequent years. An inquiry of whether logistics can meet the demand of the economic development is an issue worth investigating.

To support the Indonesian economy, logistics, as a growing service industry must improve its capacity and move away from the use of its colonial infrastructure. As a motivation, there exists a necessity to study the relation between Indonesian logistics and its the macroeconomic indicator. Then, in accordance to their relationship and rate of change, policies and action plan can be prepared reach synchronization point between logistics development and the currently rapidly growing economy. The findings would be useful to estimate how close is the relationship, in order to finally get something useful as a tool to plan the long–term development of Indonesian national economy. The research will hopefully present to a strong and interesting angle of the necessity to keep the stability of the regional economy in growth rate and be in pursuit of continuously improving the trade infrastructure by means of supporting the Indonesian logistics industry.

2. Literature Review

Several researches has been attempted to present the linkages between logistics and economic growth, as follows:

1. Liu (2010) has done research on the relationship between the Logistics Industry Development and Economic Growth of China using the grey analysis method, using GDP as dependent variable, and several logistics industry indicator, namely: logistics industry added value, total employment of logistics industry, new fixed assets investment, freight volume, freight turnover as independent variable.

2. Shao and Zheng (2011) constructed an econometrical model of the relationship between economic growth and logistics industry in Jilin province using the logistic curve model. The research concluded that the logistics industry contributes greatly to the regional economic growth by showing different trend in different stages, spotting potential saturation point, and identifying the elastic coefficient value.

3. Huang et al. (2006) performed an analysis of the relationship between Logistics Development and GDP Growth in China. Their research uses the traffic turnover volume as the index of logistics scale and GDP as the economic growth index. Their research uses time series data of both indexes, of which the correlation will be tested using statistical regression method which then the result be used for Granger causality test.

4. Shuai and Sun (2009) proposed a correlation relationship between logistics industry and national economy development using stochastic variable model, using GDP as the economic indicator and volume of freight and logistics cost as the logistics industry indicator.

5. Li (2010) carried out empirical research on effects of modern logistics the six provinces in Central China. The research used GDP as an explained variable and freight turnover as

---

[1]Annual percentage growth rate of GDP at market prices based on constant local currency, World Bank, available at: http://data.worldbank.org/indicator/. Actual growth rate 4.961% using annual GDP data from 1999 to 2011, growth rates of real GDP calculated in US dollars at constant prices.

[2]GDP purchasing power parity (PPP), a GDP value converted to international dollars using purchasing power parity rates. World Economic Outlook, April 2012.

explanatory variable, of which both will then used to build a simple bivariate regression model.

6. Xie and Luo (2010) performed a similar research as Huang et al. (2006) focusing on Hunan Province in China using cointegration test and causality tests. It uses GDP as the most common economic indicator with freight volume and added value of Hunan's tertiary industry as the research indexes. The research was also extended by means of performing stability analysis using cumulative sum test and Hansen test.

7. Chen (2011) did a similar research as Shao et al. (2011) by adopting logistic growth curve model focusing on Jiangsu Province in China, and found that the logistics industry is closely related with the growth of national economy.

8. Gopal (2012) has presented his result by comparing graphical similarities between nominal GDP growth and external trade growth trends. This research is the trigger of the Author's curiosity and motivation to try to connect between the two topics.

On one hand there already exists a research on mapping the similarities of logistics growth and GDP growth; on the other hand there already exists a research on relationship between logistics infrastructure and economic growth in a region. Gopal (2012) has given an idea that there is quite a high interest of readership to make a case on developing logistics infrastructure (ports, roads, trade facilitation, etc.). While Huang et al. (2006), Chen (2011), and Liu (2010) has given an idea that a mathematical and/or economic model can be built, the model that has been built for analyzing relationship of logistics infrastructure and economic growth in China or in Chinese provinces can perhaps be built for analyzing Indonesia.

3. Data Selection and Method

Selection of a Representative Index

The challenge of this study is to collect the data and select representative index. With regards to the logistics index, in the beginning, it is practically difficult to get an index that can reflect the logistics volume or scale because of the broad concept of logistics. The aspect of logistics of physical items covers the field of material handling, inventory, transportation, warehousing. It perhaps can be seen that the intersecting point of all the aspect is the cargo or the goods itself. Therefore in this research, after careful consideration, Author will use selected the traffic or cargo volume as the logistics index.

GDP is used as the economic indicator index, as it is a well-accepted indicator of the national economic development. GDP is the value of all goods and services produced within a country. The GDP time series annual data has been adjusted using purchasing power parity (PPP) calculation taking into account relative costs and inflation, rather than using nominal GDP of which it uses government official exchange rates of the given year which may distort the real differences in income.

Data Selection

The original data for this research are taken from Indonesian Bureau of Statistics. Indonesian GDP is well recorded since 1967, while the logistics volume data of sea, rail, and air are recorded later, from 1988, 1987, 2003, respectively. Due to the limitation of the data available from the data collection source, there will be two types of analysis in this paper. First, the research will combine the sea and rail logistics volume starting from 1988 to 2010, and then will combine all the three logistics medium of sea, rail, and air starting from the latest available data from 2003.

4. Empirical Data Analysis

Linear Regression

Using the data from sea and rail logistics volume starting from 1988 to 2010 taken from the Indonesian Statistics Bureau, this paper selects GDP as dependent variable at the *y* axis, and the total tonnage of cargo volume as the independent variable at the *x* axis. The numbers used for linear regression analysis is displayed in Table 1 and scatter plot graph is displayed in Figure 1.

Table 1. Processed data of Indonesian GDP (PPP) and Logistics Volume (sea and rail)
Source: Indonesian Central Bank and Indonesian Statistics Bureau

Year	GDP (millions of $)	Total Cargo (000 tons)
1988	208804	230734
1989	236347	246736
1990	267393	305474
1991	301163	332187
1992	329710	380508
1993	361380	404986
1994	396541	455557
1995	439836	535985
1996	481836	527455
1997	514207	518241
1998	452984	432249
1999	463262	438120
2000	496572	471365
2001	526332	511463
2002	558946	542367
2003	598002	532053
2004	645745	524317
2005	705159	541333
2006	767949	482889
2007	840352	659355
2008	910589	623695
2009	962871	794900
2010	1034307	721138

From Figure 1, although not perfectly linear in trend, we can see that *y* and *x* have a good positive correlation, which can construct a linear equation model for regression analysis:

$$\hat{y} = a + bx \qquad (1)$$

After processing the data using statistical software, it yields the equation (2) below:

$$\hat{y} = -215184.69 + 1.556x \qquad (2)$$

Where $R^2 = .841$, adjusted $R^2 = .833$, the goodness of fit is pretty very high. Whereby *x*'s t-test is 10.532, which is acceptable up to 0.009 level of significance; and F-test result is 110.91. Both the inferential statistics using t-test and F-test, result shows that the regression has a significant relationship.

From an economic sense, with a positive slope of 1.556, shows that each unit increase in cargo volume will lead to 1.556 units of the GDP growth. Statistical results also suggest, with the total sum of squares of $R^2 = .833$ is the sample regression line, of which 16.7% is not explained, so the sample regression line of the goodness of fit of sample points is quite high. Economic growth and development of the logistics industry is positively related, and the logistics industry plays a part in boosting economic growth.
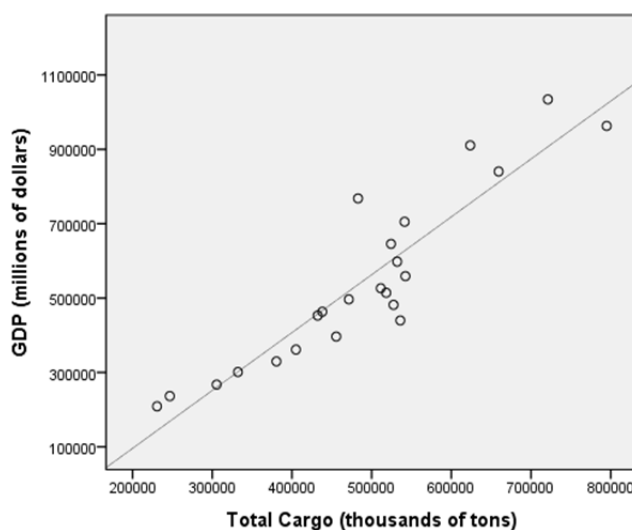
Figure 1. Scatter Graph between GDP and Logistics Volume with the estimated regression line
(Data Source: Indonesian Statistics Bureau)

With the same method, using the data from air, sea and rail logistics volume starting from 2003 to 2010, it yields the equation (3) below:

$$\hat{y} = 82314.52 \ + 1.188 \ x \qquad (3)$$

The R^2= .697, adjusted R^2=.647, while variable x's t-test is 3.717, which is acceptable up to 0.01 level of significance; and F= 13.812, which is quite conclusive though barely significant up to 0.01. From the statistical numbers of the test, the linear equation represents a trend, though perhaps due to limited data of only 7 samples, the result of regression equation (3) is less conclusive than equation (2).
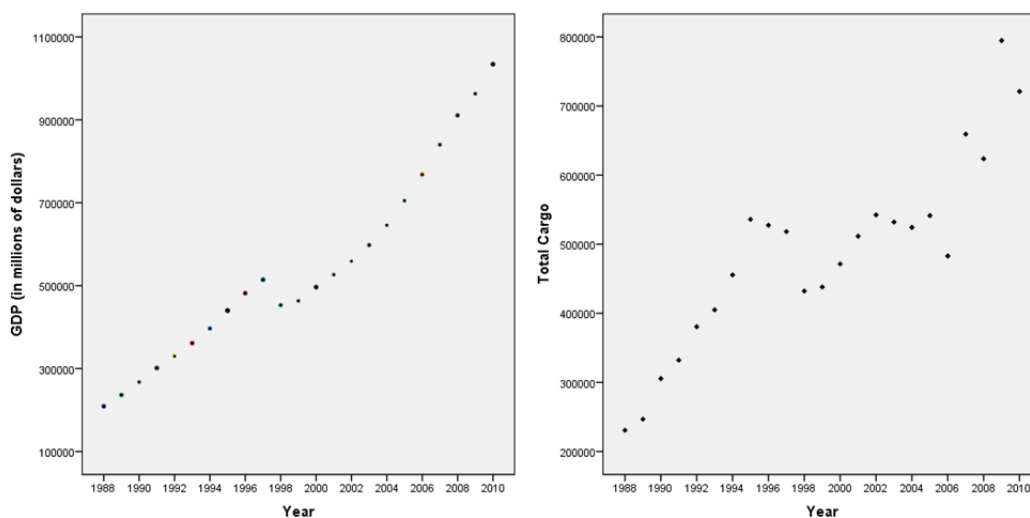

Figure 2. Scatter Graph between GDP (left) and Logistics Volume (right) annual growth
(Source: Indonesian Statistics Bureau)

Considering the lack of availability of the air cargo volume data (of only seven samples of data available), and the very low contribution of air cargo towards the overall logistics volume (average overall contribution of air cargo is 0.14%), further data analysis using logistics regression will use sea and rail logistics volume, of which it has data available since 1988.

Logistic Econometrical Model

From the GDP growth trend in Figure 2 and the relationship diagram of sea and rail cargo volume and GDP trend from 1998 to 2010 displayed in Figure 1, we can see the significant positive correlativity between cargo volume and GDP, with a potential of non-linear trend that may show an S-curve-like trend. Therefore the statistical description between the cargo volume and GDP relationship is possibly more presentable to be presented in Logistic Model. Based on the characteristic and with reference to previous research (Chen, 2011), we can try to use Logistics curve to fit the relationship. The proposed theoretical equation is presented as follows:

$$y = \frac{1}{\frac{1}{u} + ab^x} \qquad (4)$$

The interesting characteristic of a Logistic curve is that the rise is primarily slow and then gradually accelerating, when it is accelerated to some point, the growth rate is gradually stagnant then finally reached a horizontal line (Shao, 2011). To use easily the parameter estimation method of the linear model, the equation (4) is transformed into equations as below:

$$\frac{1}{y} = \frac{1}{u} + ab^x \qquad (5)$$

$$\frac{1}{y} - \frac{1}{u} = ab^x \qquad (6)$$

$$\ln\left(\frac{1}{y} - \frac{1}{u}\right) = \ln a + x \ln b \qquad (7)$$

We then transform

$y' = \ln\left(\frac{1}{y} - \frac{1}{u}\right)$ and $\ln a = a'$ and $\ln b = b'$, while u is the upperbound value where we will use

Indonesia's forecasted GDP in 2015 of 1,542 billion as the constant upperbound value. When we transform equation (7), of we then have a linear equation of:
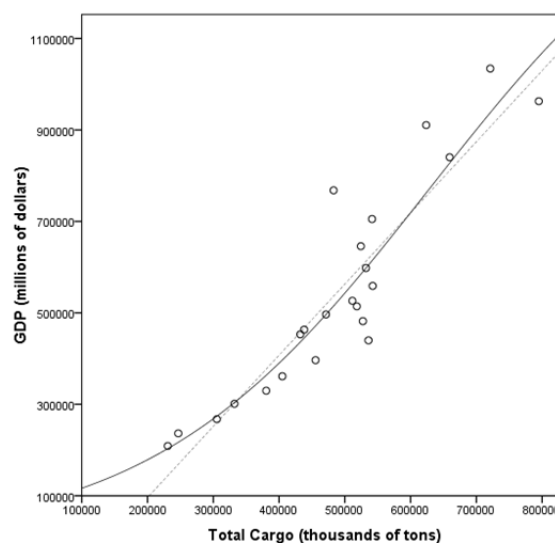
$$y' = a' + b'x \qquad (8)$$

Figure 3. Scatter Graph between GDP and Logistics Volume with the estimated regression line
(Solid line: Logistic regression; Dotted line: linear regression)

After running the number using statistical software, it yields an equation (10), as below:

$$y = \frac{1}{\dfrac{1}{1,542,300} + (0.000013).(0.999995)^x} \qquad (9)$$

After running the statistical test we obtain, $R^2 = .874$, adjusted $R^2 = .868$, showing the goodness of fit is pretty very high. x and y variable t-test is 2545958.41 and 5.0332, respectively. Both t-test numbers are acceptable up to 0.0001 level of significance. While F= 145.7793, a highly accepted number. On the basis of coefficient of determination R^2 and inferential statistics tests, the logistic regression equation (9) is fits very well, even better than the linear equation (2). Comparison of the result between linear and logistic regression is displayed in Figure 3, it can be seen, to some extent that even visually the logistic regression fits better than the linear one.

5. Conclusion

Based on the quantitative analysis above, it can be seen that there is a strong relationship between logistics development and economic growth. Indonesia sits between very important trade routes, of which it will take the fullest advantage of the important geographic position and seize the opportunities of the rising consumer and producer market potential to develop modern logistics industry.

Many efforts has been proposed and undertaken like creation of domestic economic corridors, national logistics integration plan, and west-east sea corridor pendulum. All those efforts have very high potential to boost traffic of domestic and international goods, and would potentially contribute towards economic growth. Indonesian government has released an Indonesian Logistics Blueprint (Indonesian Cabinet Secretariat, 2012), these plan needs to be executed as scheduled. With support of the statistical data above, there is a risk of capacity saturation of logistics services. Government, with public and private partnership, must unite to develop the logistic infrastructure and foster its logistics industry. These infrastructures does not only cover physical infrastructure of building road, bridges, port, and airports; but also implement fast logistics turnaround with support of Information Technology and educate more logistics talents and supply chain experts.

With the nature of being an archipelago country and albeit sea cargo has played a huge part in logistics services, air cargo will need to be boosted, as it still contribute less than 1% of the overall logistics. While for land cargo, providing support and facilitation in building logistics parks, distribution centers and third party logistics company licences, can potentially contribute towards connecting urban and rural areas with to support industrial competitiveness.

According to the empirical data analysis, we can conclude that the logistics industry contributes greatly to the Indonesian economic growth. The contribution of logistics industry on economic growth shows different trend in different stages. Currently Indonesian GDP is showing a quite steady growth with strong resilience, despite the global economic slowdown which started in 2008. When relating it to logistics growth, it can be seen that there is a potential of a stagnant growth if the logistics infrastructure is not built. The tendency can be seen when the relationship of GDP and logistics volume is represented in the logistic regression. The future the development of logistics industry may risk being in a stagnant or even negative growth phase if the result of the economic growth does not translate to investments in logistics physical and supporting infrastructure.

With the mathematical model presented in the analysis, contribution of the logistics development towards the proportion of economic growth can offer quite a useful insight. However, it needs to be noted that, cargo volume, which was used as the logistics index for this paper is only one of many available potential indicator. Usage of other data such as, logistics industry added value, total employment of logistics industry, new fixed assets investment, freight turnover (in tons times kilometres) should also be taken into account, even though collecting the data for these indicators may be quite challenging, in comparison to collecting the cargo volume data. In addition, cargo volume, presented in the indicator does not cover the road cargo volume which may potentially play a quite significant part in domestic and international land border trade.

References

1. Chen, Y. (2011), "Empirical Analysis on the Effects of Logistics Industry on Economic Growth in Jiangsu Province", in *International Conference on Industrial Engineering and Engineering Management, Beijing, China, 3-5 September*, IEEE, pp. 1454-1457.

2. Cui G., Li X. (2011), "Research on the Relationship between the Regional Logistics and Economic Development Based on the Model VAR", in *International Conference on Management Science and Industrial Engineering, Harbin, China, 8-11 January*, IEEE, pp. 120-124.

3. Gopal, R. (2012), "Overview of Port Logistics Infrastructure Development in ASEAN", in *10th ASEAN Shipping and Ports*, Jakarta, Indonesia, 30 May 2012, available at: http://www.slideshare.net/FrostandSullivan/frost-sullivan-overview-of-port-logistics-infrastructure-development-in-asean (accessed 1 October 2012).

4. Huanhuan, L. (2011), "Positive Analysis of Influence on International Trade Development in International Logistics Industry in Tianjin", in *International Conference of Information Technology, Computer Engineering and Management Sciences, Nanjing, China, 24-25 September*, IEEE, pp. 182-185.

5. Huang W., Li W., and Liu W. (2006), "Analysis of the Dynamic Relation between Logistics Development and GDP Growth in China", in *International Conference on Service Operations and Logistics, and Informatics, Shanghai, China, 21-23 June*, IEEE, pp.153-157.

6. Indonesian Cabinet Secretariat (2012). *Indonesian Logistics Blueprint* (in Bahasa Indonesia), Jakarta, Indonesia, available at: http://www.ekon.go.id/ pages/sislognas/ cetak-biru-pengembangan-sistem-logistik-nasional (accessed 1 October 2012).

7. Li, N. (2010), "Empirical Analysis on the Effects of Modern Logistics on Economic Growth of Six Provinces in Central China, School of Economics and Trade", Hunan University, Changsha, China, available at: http://www.seiofbluemountain.com/ upload/product/201007/ 2010wlhy01a11.pdf (accessed 1 October 2012).

8. Lingxiang, J., Yujin, Y., and Dongbing, L. (2011), "Study on Contribution of the Logistics Industry to the National Economy in China", in *International Conference on Transportation, Mechanical, and Electrical Engineering, Changchun, China 16-18 December*, IEEE, pp 174-177.

9. Liu, S. (2010), "A Research on the Relationship of Logistics Industry Development and Economic Growth of China", *International Business Research*. Canadian Center of Science and Education, Vol. 2, No. 3, Toronto, Canada, pp 197-200.

10. Shao, Y. (2010), "An Application of Spatial - Panel Analysis - Provincial Economic Growth and Logistics in China", *Annals of the University of Petroşani, Economics*, Vol. 10, Issue 2, pp 315-322.

11. Shao, Y., Zheng, J. (2011), "Research on the Effects of Logistics Industry on Economic Growth in Jilin Province in China", *Canadian Social Science*, Vol.7 No. 6, pp. 134-137.

12. Shuai, B., Sun, C. (2009), "The Correlativity Analysis between Logistics Industry and National Economy Development, Southwest Jiaotong University, China", available at: http://www.seiofbluemountain.com/upload/ product/201001/12646716644xym9b6o.pdf (accessed 1 October 2012).

13. Sun, Y. (2009), "Empirical Analysis of Beijing logistics Industry's GDP Contribution to the National Economy", *First International Workshop on Database Technology and Applications, Wuhan, Hubei, China, 25-26 April 2009*, pp. 53-56.

14. Xie, C. and Luo, D. (2010), "Empirical Studies on the Relationship Between Logistics Development and the Economic Growth of Tertiary Industry of Hunan Province", Finance and Economics Department, Hunan University of Technology, Zhuzhou, Hunan, China, pp. 102-107, available at: http://www.seiofbluemountain.com/upload/ product/201007/2010wlhy02a3.pdf (accessed 1 October 2012).

15. Zhu C., Huo J. (2011), "Study on the Correlation of Logistics Industry and Local Economy", in *International Conference on Mechatronic Science, Jilin, China, 19-22 August*, IEEE, pp. 823-825.