# Economic Growth in East Java, Indonesia: A Geweke Causality Analysis

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## Abstract

*This article presents a causality analysis of output growth in East Java, Indonesia's second most competitive province after the capital city, Jakarta. We identify three variables which have stood out prominently for East Java: high output growth in the service sectors, a flexible labour market, and extensive infrastructure. Using a methodology developed by Geweke (1982), we measure the direction of causal effects between the three variables. Our findings confirm existing theories and research which argue that output growth is affected by the extent of infrastructure and quality of labour market. Such findings also support various calls for Indonesia to improve its infrastructure and labour market policies, and present East Java as a case from which lessons could be drawn for other Indonesian provinces.*

**Keywords:** Geweke Causality; Economic Growth; Infrastructure; Labour Market; Competitiveness; East Java; Indonesia.

**JEL Classification:** C32, J21, H54, O10

## *1. Introduction*

The province of East Java in Indonesia has fared favourably for economic competitiveness for the past two decades(Oxford Business Group 2014a; World Bank 2011; Bowring 2015). The competitiveness rankings of 33 Indonesian provinces over the years produced by Asia Competitiveness Institute (ACI) for instance has also consistently ranked the province in second place, just below the Special Capital Region of Jakarta(See Tan et al. 2013 and Tan et al. 2015). Similar studies also confirm the presence of a favourable business and investment climate in East Java (Partnership for Governance Reform 2013), as well as in many cities and regencies within the province (KPPOD and Asia Foundation 2011).

Considering the extent of decentralization that Indonesia has adopted since 2001 (Hill 2014; Ahmad and Mansoor 2002), it is important to understand the processes underlying economic development at the sub-national level. East Java, in particular, is interesting due to its large market (its 37.5 million population in 2010 is equivalent to California's), a sizeable economy (its Gross Regional Domestic Product of about USD 93.14 billion in 2013 is equivalent to 15% of Indonesia's and comparable to that of Ecuador's), and fast growing (its economy grew by 6.22% on average between 2004 and 2013).[1]

[1] Data on East Java and Indonesia, unless otherwise stated, is sourced from the Central Statistics Agency (*Badan Pusat Statistik* or BPS), accessible through bps.go.id.

But East Java's growth story is also one about industrial restructuring. The province's economy experienced a long transition from agriculture to manufacturing between 1920 to 1970, but then quickly gained manufacturing competitiveness for a couple of decades (Dick 1995). From the 1990s onwards, manufacturing started to slow down (McMichael 1998; Santosa and McMichael 2004; Irawan 2011), and by 2004,services became the largest component of the province's GRDP(BPS, n. d.).

Despite its oft-cited achievements in the media, business, and policy reports, not many academic studies have been conducted to understand the causes of growth in this province. Considering East Java's potential to pull-up or drag-down Indonesia's overall growth simply due to its size, more research into the factors that may contribute to the province's competitiveness is welcome.

In this light, this paper presents a causality analysis of East Java's output growth using the Geweke causality methodology that identifies and measures the different directions of causal effects between two or more time-series vectors, including the extent to which the causal effects take place instantaneously between the vectors (Geweke 1982).[2] The Geweke causality analysis intuitively helps us to understand and measure the linear dependence and feedback between multiple time series variables. To that effect, we perform both a bi-variety as well as multi-variety causality analysis.

Earlier studies on economic governance in Indonesia's regions have noted that East Java's vibrant business environment benefits from the presence of an ample supply of labour market and favourable industrial relations as well as relatively robust infrastructure(KPPOD and Asia Foundation 2011; World Bank 2011; ILO 2013).The two variables for East Java, namely labour market and infrastructure conditions, are tested against GRDP growth in the services sector, to possibly identify causal relationships among the variables. To preview the main empirical findings, we find our Geweke causality analysis to confirm the general theories and past empirical literature which argue that output growth is affected by good infrastructure and a flexible labour market. These findings further emphasize the calls for Indonesia to improve relevant policies (Schwab and Sala-i-Martin 2014; Oberman et al. 2012), and presents East Java as a case which could be emulated by other sub-national entities in Indonesia.

The rest of the paper is structured as follows: Section 2 begins with outlining briefly the key socio-economic characteristics specifically focusing on the competitiveness profile of East Java. This will form the basis for developing empirically testable hypotheses that we test in the paper. Section 3details the data and methodology used. Specifically, it furnishes the details of the Geweke causality analysis and the empirical strategy. The empirical results are discussed in Section 4, while Section 5 concludes with a brief note on policy implications.

## *2. Background and Hypotheses*

East Java is the second most populous province in Indonesia, after West Java. In 2011, it had a population of 37.7 million (about 15% of the country's population). East Java's capital, Surabaya, with a population of 2.7 million in 2011, is Indonesia's second largest city after Jakarta. The Surabaya metropolitan area is home to 9.1 million people or almost a quarter of the province's population. Almost half (47.5%) of the province's population live in urban areas(BPS Kota Surabaya 2014).

East Java has the second highest GRDP in the country, only slightly below Jakarta. In 2011, the province's GRDP was Rp 884,143 billion, while Jakarta's was Rp 982,540 billion current market prices(BPS, n. d.). In fact, East Java has the second highest GRDP among 33 Indonesian provinces for each of the three economic sectors. For agriculture and mining it is second after East Kalimantan, for manufacturing it is second after West Java, and for trade and services it is second after DKI Jakarta. This shows that East Java is a well-rounded competitive province with good performance in multiple aspects of the economy. East Java is also Indonesia's second largest source of non-oil & gas exports after Jakarta. The Surabaya metropolitan area is home to the country's second largest cluster of industrial zones (after that located in Jakarta metropolitan area). Other notable clusters of industrial zones in Indonesia are found in Riau Islands province (especially Batam), West Java and Banten provinces (especially the areas surrounding Jakarta and Bandung), and Central Java province (especially those along the Trans-North Java highway).

[2] Geweke (1982) expanded the methodology of causality analysis developed earlier by Granger (1969) and Sims (1972). See Appendix 1 for a technical description of the methodology.

Despite East Java's favourable economic performance, there is plenty of room for improvement, especially in reducing poverty rate and achieving better human development. East Java's poverty rate was at 13.8% in 2011, while its Human Development Index was ranked 17$^{th}$out of 33 Indonesian provinces. This stands in contrast with the province's economic achievements highlighted earlier, and has prompted the World Bank to propose a growth diagnostic to enable a more inclusive growth in East Java(World Bank 2011).

Several studies including the competitiveness analysis by Tan et al. (2013, 2015) have found that East Java shows notable strengths in dimensions such as Regional Economic Vibrancy, Physical Infrastructure, and Labour Market Flexibility for comparison of East Java's scores with the nationwide median scores). East Java obtained the highest score nationwide for Labour Market Flexibility (Tan et al. 2015), having the largest number of labour force and employment, the lowest unemployment rate, and the second lowest minimum wage among Indonesia's provinces in 2011. Furthermore, surveys conducted separately with business owners, government, and academics in 2013 confirm that labour relations in East Java are harmonious (Tan et al. 2015).

(Insert Figure 1 here)

The analysis also found East Java with the highest score for Physical Infrastructure. Aside from having the highest density of paved roads nationwide, the province's Tanjung Perak seaport in Surabaya is Indonesia's second busiest after Jakarta's Tanjung Priok, and its Juanda airport just outside of Surabaya is the second busiest for domestic travels after the Soekarno-HattaAirport just outside of Jakarta. Surveys with business owners, government, and academics in 2013 also confirm a positive perception towards the quality of infrastructure in the province in general (Tan et al. 2015).

East Java's economic development has also been characterized by a strong and steadily growing tertiary (services) sector, which has grown substantially higher than the primary and secondary sectors. This can be considered as a restructuring of the economy from one that relies on agriculture and manufacturing to one that thrives on services. The proportion of East Java's GRDP generated by the services industry has risen from 42.9% at the beginning of 2000 to 49.3% at the end of 2011. Meanwhile, the primary sector's contribution to East Java's GRDP has decreased from 21.7% to 17.6% during the same period(BPS, n. d.). **Error! Reference source not found.**2 shows the increasing proportion of the tertiary sector against the relative decrease of the primary and secondary sectors.

By breaking down the tertiary sector, we can see that the Trade, Hotels and Restaurants sub-sector has been growing the fastest(BPS, n. d.). 3, between 2000 and 2011 the GRDP for this sub-sector has risen by more than two-folds in real terms: from Rp 49,475 billion to Rp 116,645 billion (in constant 2000 prices). Meanwhile, the other service sub-sectors combined also rose in similar fashion: from Rp45, 605 billion to Rp 92,378 billion for the same time period. The Trade, Hotels and Restaurants sub-sector currently produces the most economic output, overtaking manufacturing in 2004.

(Insert Figure 2 here)

These arguments are consistent with the literature. Economists since the time of Adam Smith have identified a theoretical link between infrastructure and economic development. Infrastructure can be seen as public capital that serves as a factor of production. It also allows other factors of production to be utilized more efficiently (Serven 2010; Gramlich 1994), ultimately leading to higher productivity and output growth (Sanchez-Robles 1998; Esfahani and Ramírez 2003; Straub and Terada-Hagiwara 2011; Hashimzade and Myles 2010). Transport infrastructure, in particular, facilitates economic integration (Asian Development Bank 2009; Bhattacharyay, Kawai, and Nag 2012; Brooks and Menon 2008; Sahoo and Dash 2012) and electricity consumption was found to have significant correlation with long-term GDP growth (Aslan 2014; Abdoli, Gudarzi Farahani, and Dastan 2015; Narayan and Smyth 2009; Apergis and Payne 2011).

(Insert Figure 3 here)

Another factor of production which is argued to have direct linkage to output is labour. A flexible labour market enables dynamic allocation of manpower that better responds to changing production demand (Giersch 1985; Busse and Hefeker 2009; Dutt, Charles, and Lang 2015). An equilibrium unemployment and job vacancies contributes to optimal production, and is dependent on the presence of an effective a "matching function" and efficient bargaining between workers and firms (Pissarides 2000; Lisi 2011; Roa, Saura, and Vázquez 2011). The availability of workers who are well-trained and engage with employers in harmonious industrial relations provides the services sector with the needed human resources. The foregoing discussion leaves us with some empirically testable hypotheses. Considering the theoretical links which has been proposed between the strengths of East Java, it is hypothesized that flexible labour market and extensive infrastructure contributes to East Java's high growth in the services sector. We test this formally in the remainder of the paper.

## *3. Methodology and Data*

### 3.1. Geweke Causality Analysis

Complementary tests for the existence of unidirectional causality has been provided and Granger (1969) and Sims (1972). Subsequently, Geweke (1982)developed the concept further by including instantaneous (two-way) linear feedback between multiple time series. Although the determinants of a single economic variable are likely to be multi-dimensional, most applications found in the literature focus on bi-variety cases. The multi-variety causality test proposed by Geweke (1982) is essentially a test between two vectors of variables. The equivalence of linear dependence measures enables the conduction of a multivariate test which is as convenient as a vicariate test. Essentially, the idea of causality between multiple time series X and Y can be summarized as follows:

$$F_{X,Y} = F_{X\to Y} + F_{Y\to X} + F_{X\cdot Y}$$

This means the measure of linear dependence between two series of variables ($F_{X,Y}$) is the sum of the measures oflinear feedback from the first series to the second ($F_{X\to Y}$), linear feedback from the second series to the first ($F_{Y\to X}$), and instantaneous linear feedback between the two series ($F_{X\cdot Y}$). The measures are non-negative and zero only when feedback (causality) of the relevant type is absent.

Like Granger (1969) and Sims (1972), Geweke's causality analysis focused the attention on a wide-sense stationary, purely non-deterministic multiple time series $Z = \{z_t, t \text{ real}\}$. Therefore, the vector $z_t$ can be expressed under the following autoregressive representation:

$$z_t = \sum_{s=1}^{\infty} B_s z_{t-s} + e_t$$

Where$e_t$ is white noise and $z_t$ can be partitioned into $k$×1 and $l$×1 sub-vectors $x_t$ and$y_t$.
Geweke also showed that a canonical form for the wide-sense stationary time series $z_t = (x_t, y_t)$ is of the form:

$$x_t = \sum_{s=1}^{\infty} E_{1s}x_{t-s} + u_{1t}\ var(u_{1t}) = \Sigma_1 \quad (1)$$
$$x_t = \sum_{s=1}^{\infty} E_{2s}x_{t-s} + \sum_{s=1}^{\infty} F_{2s}y_{t-s} + u_{2t} var(u_{2t}) = \Sigma_2 \quad (2)$$
$$x_t = \sum_{s=1}^{\infty} E_{3s}x_{t-s} + \sum_{s=0}^{\infty} F_{3s}y_{t-s} + u_{3t} var(u_{3t}) = \Sigma_3 \quad (3)$$
$$x_t = \sum_{s=1}^{\infty} E_{4s}x_{t-s} + \sum_{s=-\infty}^{\infty} F_{4s}y_{t-s} + u_{4t} var(u_{4t}) = \Sigma_4 \quad (4)$$
$$y_t = \sum_{s=1}^{\infty} G_{1s}y_{t-s} + v_{1t}\ var(v_{1t}) = \mathsf{T}_1 \quad (5)$$
$$y_t = \sum_{s=1}^{\infty} G_{2s}y_{t-s} + \sum_{s=1}^{\infty} H_{2s}x_{t-s} + v_{2t} var(v_{2t}) = \mathsf{T}_2 \quad (6)$$
$$y_t = \sum_{s=1}^{\infty} G_{3s}y_{t-s} + \sum_{s=0}^{\infty} H_{3s}x_{t-s} + v_{3t} var(v_{3t}) = \mathsf{T}_3 \quad (7)$$
$$y_t = \sum_{s=1}^{\infty} G_{4s}y_{t-s} + \sum_{s=-\infty}^{\infty} H_{4s}x_{t-s} + v_{4t} var(v_{4t}) = \mathsf{T}_4 \quad (8)$$

The measure of linear feedback from *Y* to *X* is defined as:

$$F_{Y\to X} = \ln\left(|\Sigma_1| \,/\, |\Sigma_2|\right) \quad (9)$$

The measure $F_{Y\to X}$ is always non-negative and takes the value of zero only if the linear feedback running from *Y* to *X* is absent. Symmetrically, the measure of linear feedback from *X* to *Y* is defined as:

$$F_{X\to Y} = \ln\left(|\mathsf{T}_1| \,/\, |\mathsf{T}_2|\right) \quad (10)$$

The instantaneous feedback is defined as:

$$F_{X\cdot Y} = \ln\left(|\mathsf{T}_2| \times |\Sigma_2| \,/\, |\Upsilon|\right) \quad (11)$$

Where:

$$\Upsilon = \text{var}\begin{pmatrix} u_{2t} \\ v_{2t} \end{pmatrix} = \begin{bmatrix} \Sigma_2 & C \\ C' & \mathrm{T}_2 \end{bmatrix}$$

Thus, the measure of linear feedback between two vectors *X* and *Y* can be decomposed into the sum of measure of linear feedback from *X* to *Y*, the measure of linear feedback from *Y* to *X*, and the instantaneous linear feedback between the two vectors. That is:

$$F_{X,Y} = F_{X\to Y} + F_{Y\to X} + F_{X\cdot Y} \quad (12)$$

It is useful to note that the absence of a particular causal ordering implies that one of these feedback measures is equal to zero.

Geweke also proved that the equations in the following set are equivalent:

$$F_{X,Y} = \ln(|\Sigma_1| \times |\mathrm{T}_1| / |\Upsilon|) = \ln(|\Sigma_1| / |\Sigma_4|) = \ln(|\mathrm{T}_1| / |\mathrm{T}_4| \quad (13)$$

$$F_{X\to Y} = \ln(|\mathrm{T}_1| / |\mathrm{T}_2|) = \ln(|\Sigma_3| / |\Sigma_4|) \quad (14)$$

$$F_{Y\to X} = \ln(|\Sigma_1| / |\Sigma_2|) = \ln(|\mathrm{T}_3| / |\mathrm{T}_4|) \quad (15)$$

$$F_{X\cdot Y} = \ln(|\mathrm{T}_2| \times |\Sigma_2| / |\Upsilon|) = \ln(|\Sigma_2| / |\Sigma_3|) = \ln(|\mathrm{T}_2| / |\mathrm{T}_3|) \quad (16)$$

The distribution of statistics and the calculation of their respective confidence intervals can be found in Appendix 1.

### 3.2. Data Description

The dependent variable selected for the Geweke analysis is GRDP growth in the services sector, namely the Change in GRDP in the Trade, Hotels and Restaurants sub-sector (GDP, for shorthand). This variable is chosen to represent the growth of East Java's services sector. Here the change (Δ) is derived from first order difference. Of the two independent variables, one is related to labour market condition, namely Employment Rate (measured in the percentage of labour force who are employed), and the other is related to infrastructure condition, namely Access to Electricity (measured in percentage of households with access to electricity). For all three variables, the data is sourced from the Indo-Dapoer database maintained by the World Bank.[3] To conduct the Geweke Analysis, a time-series data with at least 30 data points is needed for each indicator. Considering two important issues, (1) limited availability of data at the province level that goes back 30 years, and (2) the presence of several structural breaks in Indonesia's political economic history, we used quarterly (instead of yearly) data, for a period of 11 years (2000 until 2011). This provides us with 44 data points (quarters) for each indicator.

Since the data was only available on a yearly basis (11 data points for each indicator), we converted the yearly data into quarterly data. The method of conversion was "Quadratic Match Sum" for the Change in GRDP in Trade, Hotel and Restaurant, and "Quadratic Match Average" for both Employment Rate and Access to Electricity.

The data shows that East Java has had a relatively high employment rate (EMP, for shorthand): consistently over 90% from the first quarter of 2000 until the fourth quarter of 2011. Some fluctuations occurred between 2001 and 2005, but overall we can safely say that from 2005 onwards East Java's employment rate has been growing steadily, reaching a high of 96% in the last quarter of 2011.The data also shows relatively high and increasing access of electricity (ELEC, for shorthand) throughout the province between 2000 and 2011. East Java already had over 93% of its households connected to the state electricity grid in 2000. The coverage has kept on increasing since then until currently almost all of the households (over 99%) are covered.

## *4. Empirical Results*

The Geweke analysis is conducted in both bi-variety and multi-variety approaches. In the bi-variety analysis, correlation between the dependent variable (X) and independent variables (Y1 and Y2) were tested separately. This means that Geweke tests were conducted between X and Y1 as well as between X and Y2, checking the extent of correlation in both directions (X to Y and Y to X). Results of the bi-variety tests are presented in **Table 1**.

[3] Indo-Dapoer stands for Indonesia Database for Policy and Economic Research. It can be accessed online through: http://data.worldbank.org/data-catalog/indonesia-database-for-policy-and-economic-research. Data used in this research was accessed in September of 2014.

First, we discuss the correlation between the change in GRDP in the Hotels, Trade and Employment sub-sector (GDP) and Employment Rate (EMP).

**Table 1**shows a significant total correlation between GDP and EMP in either direction ($F_{x,y}$ is significant at 1% level for both directions). Most of the correlation takes place instantaneously between GDP and EMP ( $F_{x\cdot y}$ is significant at 1% level for both directions). When looking at each direction, we find there were no significant correlation for both $F_{x\to y}$ and $F_{y\to x}$ when GDP was considered as X and EMP was considered as Y. We do, however, find a notable correlation (up to 10% level of significance) for $F_{x\to y}$ when EMP was considered as X and GDP as Y. These suggest that GDP and EMP are significantly correlated, with most of the correlation taking place instantaneously between the two variables. However, there is also a possibility that a causal mechanism is taking place from EMP towards GDP.

Next, we discuss the correlation between the change in GRDP in the Hotels, Trade and Employment sub-sector (GDP) and Access to Electricity (ELEC). Similarly, we find a significant total correlation between GDP and ELEC in either direction ($F_{x,y}$ is significant at 1% level for both directions). Most of the correlation takes place instantaneously between GDP and ELEC ( $F_{x\cdot y}$ is significant at 1% level for both directions). When looking at each direction, we find no significant correlation for both $F_{x\to y}$ and $F_{y\to x}$ when ELEC was considered as X and GDP was considered as Y. We do, however, found a significant correlation (up to 5% level of significance) for $F_{y\to x}$ when GDP was considered as X and ELEC as Y. These suggest that GDP and ELEC are significantly correlated, with most of the correlation taking place instantaneously. However, there is also a possibility of causal mechanism going from ELEC to GDP.

In multi-variety analysis, both the independent variables (Y1 and Y2, or EMP and ELEC) are aggregated (as Y) and its correlation with the dependent variable (X, or GDP) is tested. The multi-variety results are presented in **Table 2**.

**Table 2**shows that when EMP and ELEC were combined, we find a significant total correlation between X (GDP) and Y (aggregate of EMP and ELEC) at the 1% level of significance. Slightly more than half of that correlation (0.4348 over 0.8329, or 52.2%) takes place instantaneously, while 43.7% of the correlation (0.3640 out of 0.8329) takes place from Y going towards X. Both the instantaneous correlation and the correlation going from Y towards X are significant the 1% level of significance. The correlation going from X towards Y, however, is not significant.

These findings suggest in the case of East Java, both Employment Rate and Access to Electricity contribute to a growing GRDP in the Trade, Hotel and Restaurant sub-sector, but not the other way around. While instantaneous correlation between the dependent and independent variables are found, we also found correlation going from the independent variables (EMP and ELEC) towards the dependent variable (GDP). The direction of causality is not two-way, as we did not find a significant correlation going from the dependent variable (GDP) towards the independent variables (EMP and ELEC).

## *5. Conclusion and Policy Implications*

As government officials attempt to revive Indonesia's growth level which has slowed down since 2014, it is important to better understand how growth has taken place in the country's major economic engines. This is a call for more sub-national analyses, and it corresponds with the country's decentralization policy(Hill 2014). The latest development of such policy is to re-strengthen the role of the province in coordinating various aspects at the supra-municipality level, including economic development (USAID 2009), as per Law No.12 of 2008.

In this context, this paper offered an empirical analysis of the determinants of growth in services sector of East Java using a Geweke causality framework. The Geweke causality analysis for East Java implies that both Access to Electricity and Employment Rate contribute positively to a growing GRDP in the Trade, Hotel, and Restaurant sub-sector, which helped the province to transition further into a service-based economy. This highlights the importance of both infrastructure and labour market conditions for economic development.

The quality of labour relations in East Java is generally favourable compared to that in many other provinces in Indonesia(Tan et al. 2013; Tan et al. 2015), especially in terms of employment opportunities, earnings for the employed, and bargaining(ILO 2013). However, more still could be done to improve the quality of the workforce.

The East Java provincial government is already taking promising steps by prioritizing the development of vocational education opportunities (ILO 2011; Abdullah 2014). Indonesia in general can improve its competitiveness by making the labour market more flexible, for example by easing hiring and firing requirements (World Bank 2014; Schwab and Sala-i-Martin 2014), but at the same time by providing better social security and public facilities(Republic of Indonesia 2004).

In terms of infrastructure, the national and provincial government have taken commendable steps in recent years by expanding the main seaport to Teluk Lamong, and developing new industrial zones such as those in Mojokerto and Gresik (Oxford Business Group 2014b; JIIPE 2015). East Java, however, still faces challenges in terms of the development of technological infrastructure. Access to computers and the internet was relatively low and was ranked as average among Indonesia's 33 provinces (Tan et al. 2015).

To conclude, this research has aimed to contribute to fill the literature gap on Indonesia's second largest sub-national economy, and added value to the general literature on economic growth through time-series analysis. The analysis, however, faced challenges in terms of quality and availability of data. Lack of sufficient number of data points originating from formal sources led to the interpolation of yearly data into quarterly data, which perhaps affected data quality. Furthermore, by focusing on time series analysis of a small number of variables, omitted variable bias may be an issue. Further research on the issue would benefit greatly from a more consistent and frequent tracking of the relevant data by officials.

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## Appendix: The methodology of Geweke causality analysis

### *Distribution of Statistics*

Under the null hypothesis that there is no unidirectional causality running from Y to X:

i.e. if $F_{Y\to X} = 0$, then $n\,\hat{F}_{Y\to X} \sim \chi^2(klp)$ (A1)
If $F_{X\to Y} = 0$, then $n\,\hat{F}_{X\to Y} \sim \chi^2(klp)$ (A2)
If $F_{X\cdot Y} = 0$, then $n\,\hat{F}_{X\cdot Y} \sim \chi^2(kl)$ (A3)

Since these tests are tests of nested hypotheses, $\hat{F}_{Y\to X}$, $\hat{F}_{X\to Y}$, and $\hat{F}_{X\cdot Y}$ are asymptotically independent. The measure of linear feedback between $X$ and $Y$,$F_{X,Y}$, can be tested at once:
If $F_{X,Y} = 0$.
$n\,\hat{F}_{X,Y} \sim \chi^2(kl(2p+1))$ (A4)

### *Confidence Interval*

The 95 percent confidence interval (CI) could be calculated approximately as follows:

For $\hat{F}_{Y\to X}$,
$$\left\{\left[\left(\hat{F}_{Y\to X} - \frac{klp-1}{3n}\right)^{1/2} - \frac{1.96}{\sqrt{n}}\right]^2 - \frac{2klp+1}{3n}, \left[\left(\hat{F}_{Y\to X} - \frac{klp-1}{3n}\right)^{1/2} + \frac{1.96}{\sqrt{n}}\right]^2 - \frac{2klp+1}{3n}\right\} \text{(A5)}$$
For $\hat{F}_{X\to Y}$,
$$\left\{\left[\left(\hat{F}_{X\to Y} - \frac{klp-1}{3n}\right)^{1/2} - \frac{1.96}{\sqrt{n}}\right]^2 - \frac{2klp+1}{3n}, \left[\left(\hat{F}_{X\to Y} - \frac{klp-1}{3n}\right)^{1/2} + \frac{1.96}{\sqrt{n}}\right]^2 - \frac{2klp+1}{3n}\right\} \text{(A6)}$$

For $\hat{F}_{X\cdot Y}$,

$$\left\{\left[\left(\hat{F}_{X\cdot Y}-\frac{kl-1}{3n}\right)^{1/2}-\frac{1.96}{\sqrt{n}}\right]^2-\frac{2kl+1}{3n},\left[\left(\hat{F}_{X\cdot Y}-\frac{kl-1}{3n}\right)^{1/2}+\frac{1.96}{\sqrt{n}}\right]^2-\frac{2kl+1}{3n}\right\} \quad \text{(A7)}$$

For $\hat{F}_{X,Y}$,

$$\left\{\left[\left(\hat{F}_{X,Y}-\frac{kl(2p+1)-1}{3n}\right)^{\frac{1}{2}}-\frac{1.96}{\sqrt{n}}\right]^2-\frac{2kl(2p+1)+1}{3n},\left[\left(\hat{F}_{X\cdot Y}-\frac{kl(2p+1)-1}{3n}\right)^{\frac{1}{2}}+\frac{1.96}{\sqrt{n}}\right]^2-\frac{2kl(2p+1)+1}{3n}\right\} \quad \text{(A8)}$$

### *Tables and Figures*

**Table 1: Estimated measures of bi-directional feedbacks Change of GRDP in Trade, Hotels and Restaurants (GDP), Employment Rate (EMP) and Access to Electricity (ELEC) for East Java, Indonesia, 2000-2011[a]**

| Economic aggregates | | $H_0(F_{x,y} = F_{x\to y} + F_{y\to x} + F_{x\cdot y})$ | | | |
|---|---|---|---|---|---|
| $x$ | $y$ | $F_{x,y}$ | $F_{x\to y}$ | $F_{y\to x}$ | $F_{x\cdot y}$ |
| GDP | EMP | 0.4202*** (0.0029) | 0.0168 (0.6974) | 0.1049 (0.1049) | 0.2985*** (0.0003) |
| EMP | GDP | 0.4450*** (0.0018) | 0.1234* (0.0704) | 0.0230 (0.6097) | 0.2985*** (0.0003) |
| GDP | ELEC | 0. 4184 *** (0.0030) | 0.0013 (0.9726) | 0.1541** (0.0364) | 0.2630*** (0.0008) |
| ELEC | GDP | 0.3502** (0.0101) | 0.0860 (0.1573) | 0.0012 (0.9746) | 0.2630*** (0.0008) |

[a] *, ** and *** denote 10%, 5% and 1% level of significance, respectively.
Source: Authors

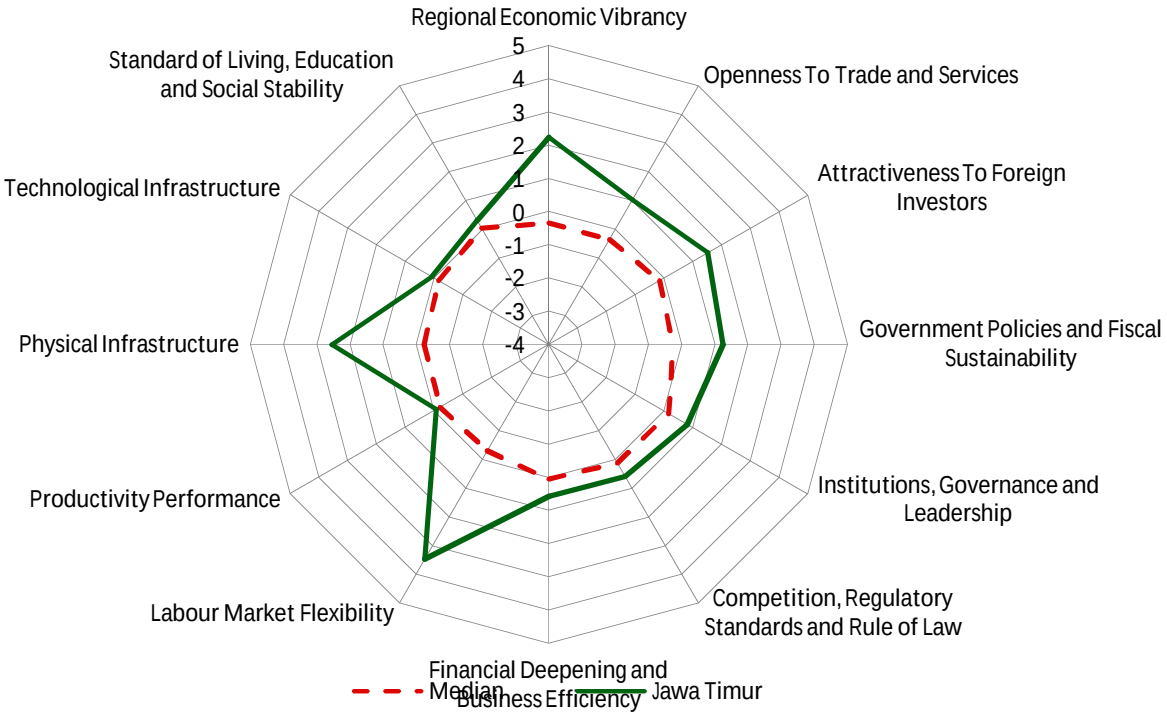
**Table 2: Estimated measures of multi-directional feedback between Change of GRDP in trade, hotel and restaurant (GDP), Employment Rate (EMP) and Access to Electricity (ELEC) for East Java, Indonesia, 2000-2011[a]**

| Economic aggregates | | $H_0(F_{x,y} = F_{x\to y} + F_{y\to x} + F_{x\cdot y})$ | | | |
|---|---|---|---|---|---|
| $x$ | $y$ | $F_{x,y}$ | $F_{x\to y}$ | $F_{y\to x}$ | $F_{x\cdot y}$ |
| GDP | EMP | 0.8329 *** (0.0001) | 0.0341 (0. 8326) | 0. 3640*** (0. 0035) | 0. 4348*** (0.0001) |
| | ELEC | | | | |

[a] *, ** and *** denote 10%, 5% and 1% level of significance, respectively.

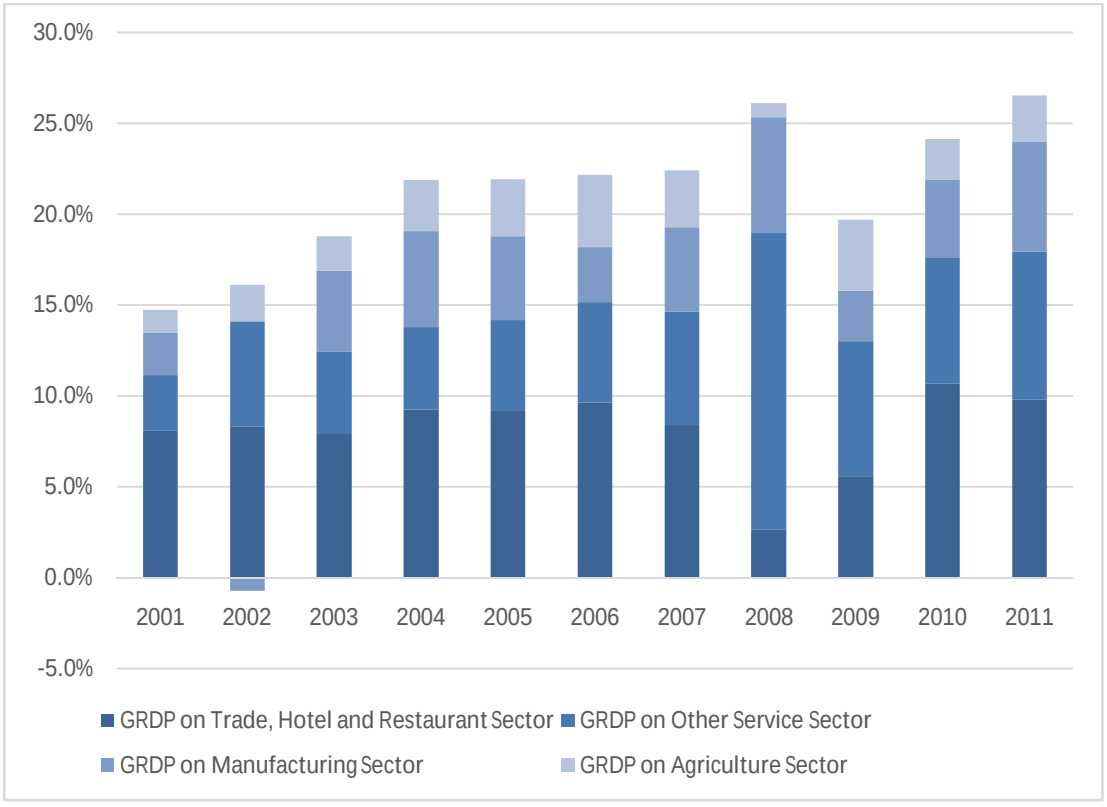
**Source:** Authors

**Figure 1: East Java's "Median Competitiveness Web" compares the standardized scores obtained by East Java to the median scores obtained by 33 Indonesian provinces across 12 competitiveness sub-environments**



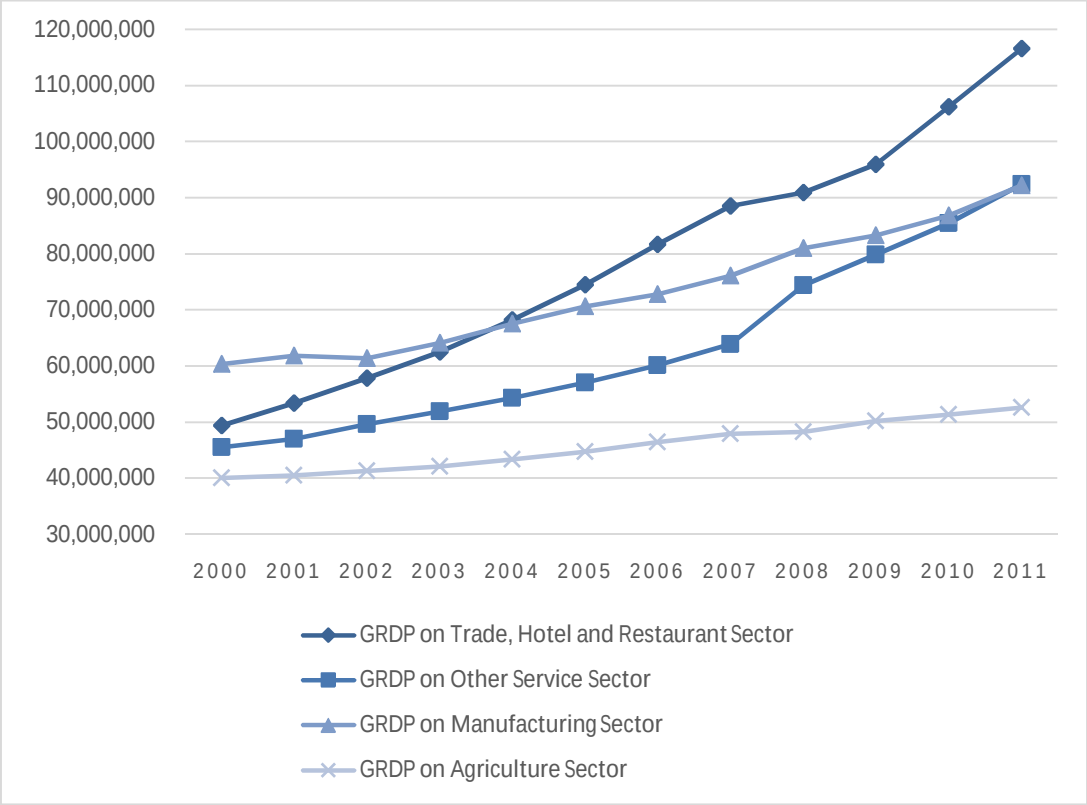

**Source:** *Tan et al. 2015*

**Figure 2: East Java's GRDP Growth Rate by Major Sectors: 2000-2011**




**Source:** Authors based on Indo DAPOER data

**Figure 3: East Java Gross Regional Domestic Product (GRDP) by Major Sectors: 2000-2011**




**Source:** Authors based on Indo DAPOER data