

26th September, 2018
Lembaga Demografi Seminar

Visualization of Time Series Demographic Data Change by Statistical Shape Analysis

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**Time Series Analysis on Indonesia Provinces
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Province** by Statistical Shape Analysis

Time Series Analysis on Indonesia Provinces Economic Development



The 5th Conference on Management
and Sustainability in Asia

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Hiroshima, Japan

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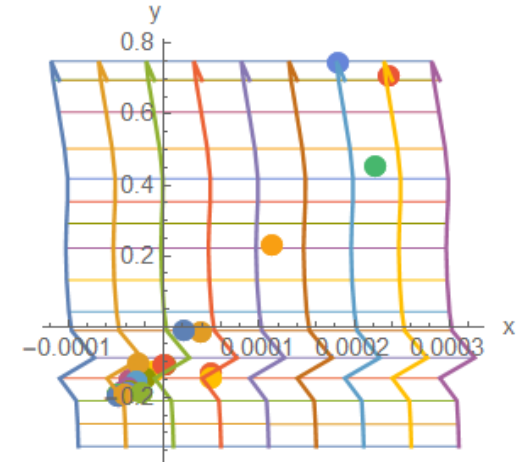
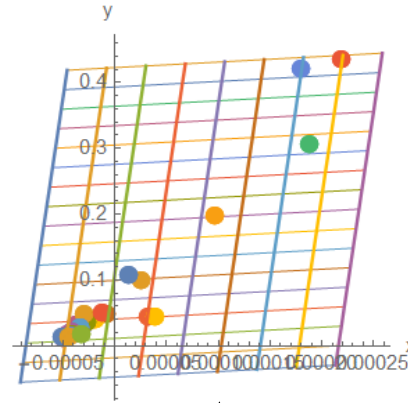
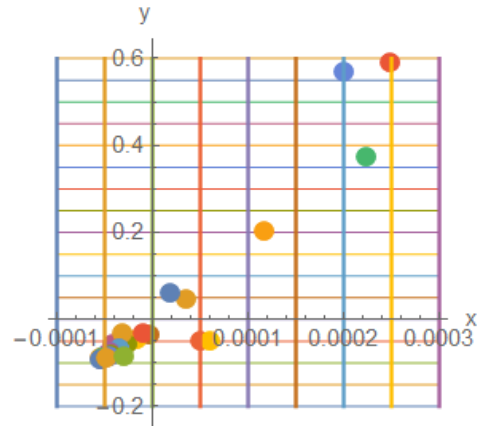
Faculty of Commerce and Economics
Chiba University of Commerce

High GDP Provinces

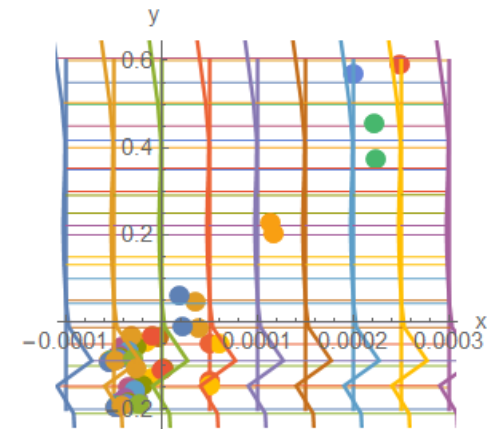
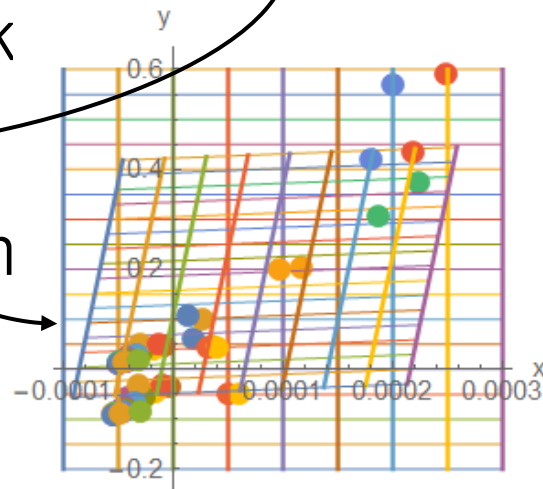


Statistical Shape Analysis

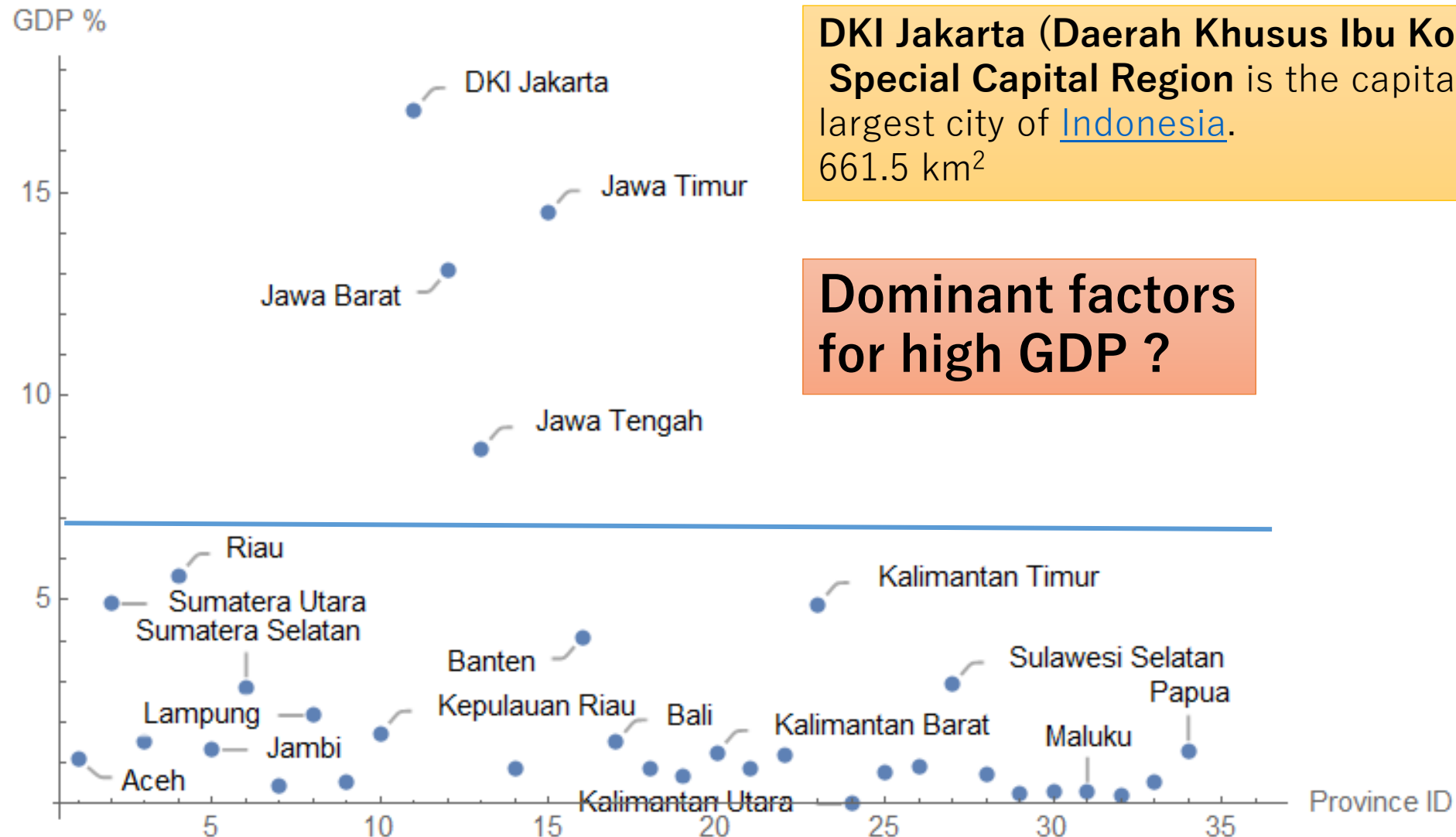
extract local movements as non-Affine transformation



- A province is a landmark
- Affine: whole trend
- Non-affine: local movement



Percentage Distribution of Gross Regional Domestic Product at Current Market Prices by Provinces, 2015

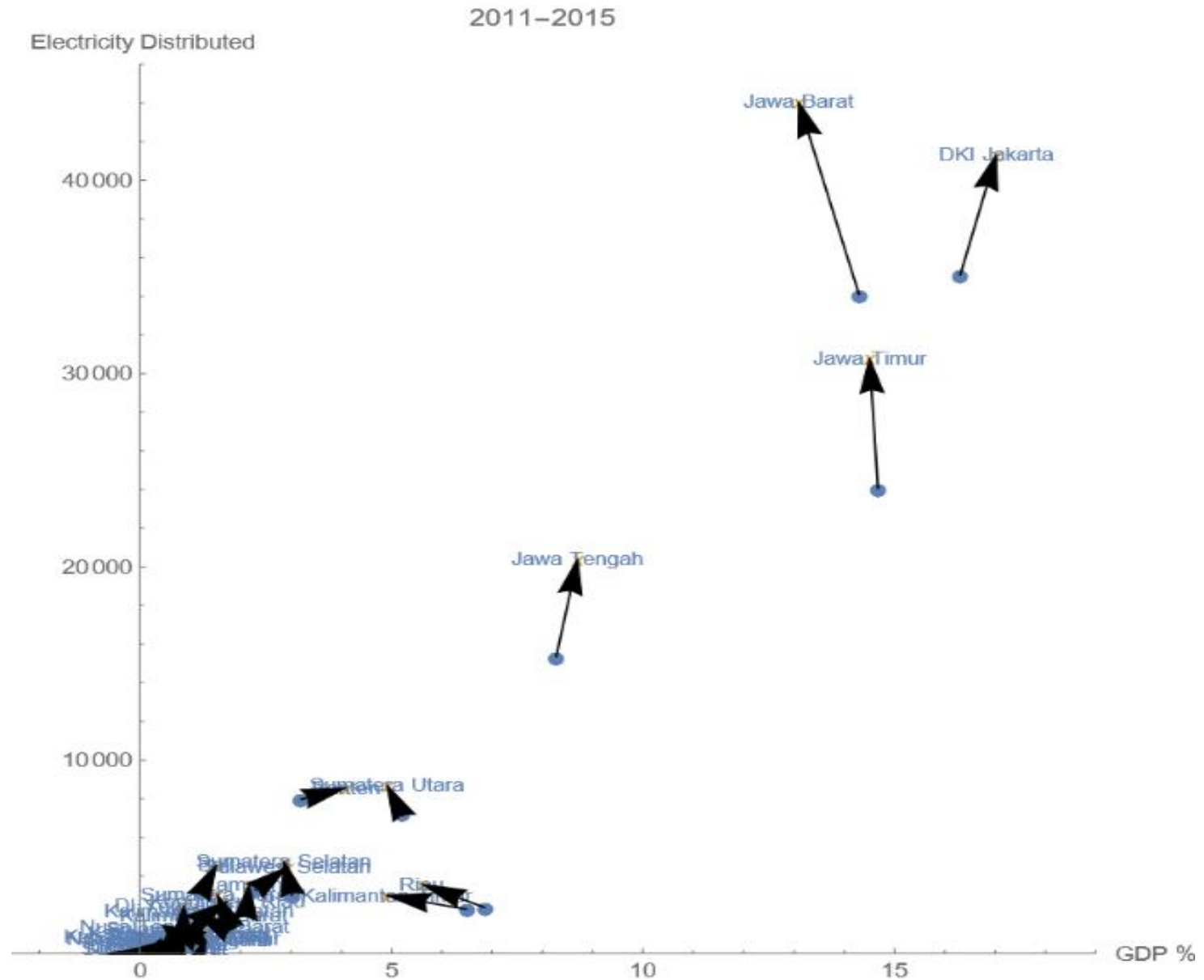


DKI Jakarta (Daerah Khusus Ibu Kota Jakarta)
Special Capital Region is the capital and the largest city of [Indonesia](#).
661.5 km²

Dominant factors for high GDP ?

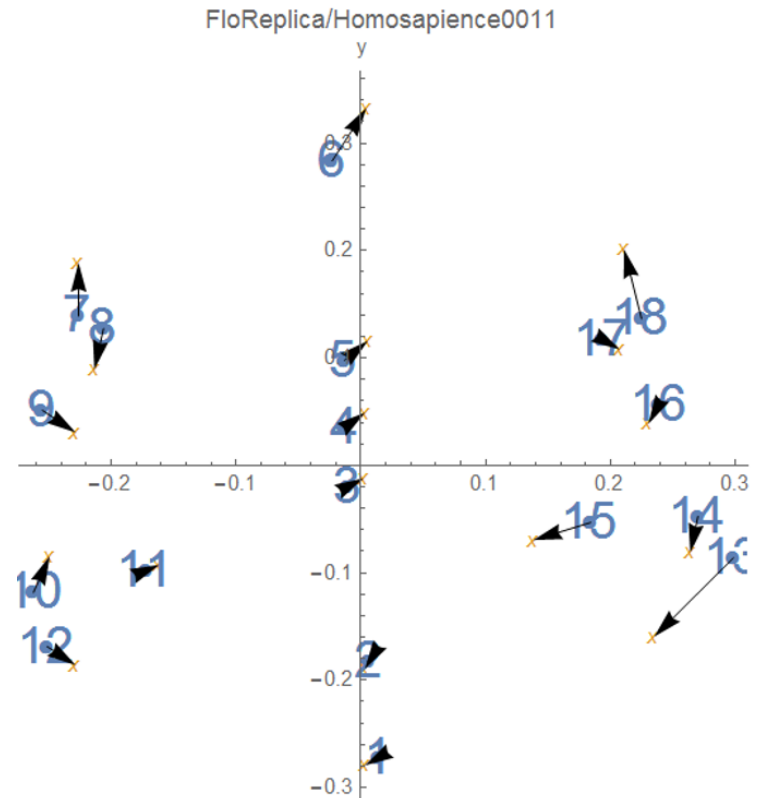
Change of GDP% and Distributed Electricity by Provinces from 2011 to 2015

- Raw data plot
(No pre-shape)



Pre-Shape

Both axis have
no dimension
after scaling.



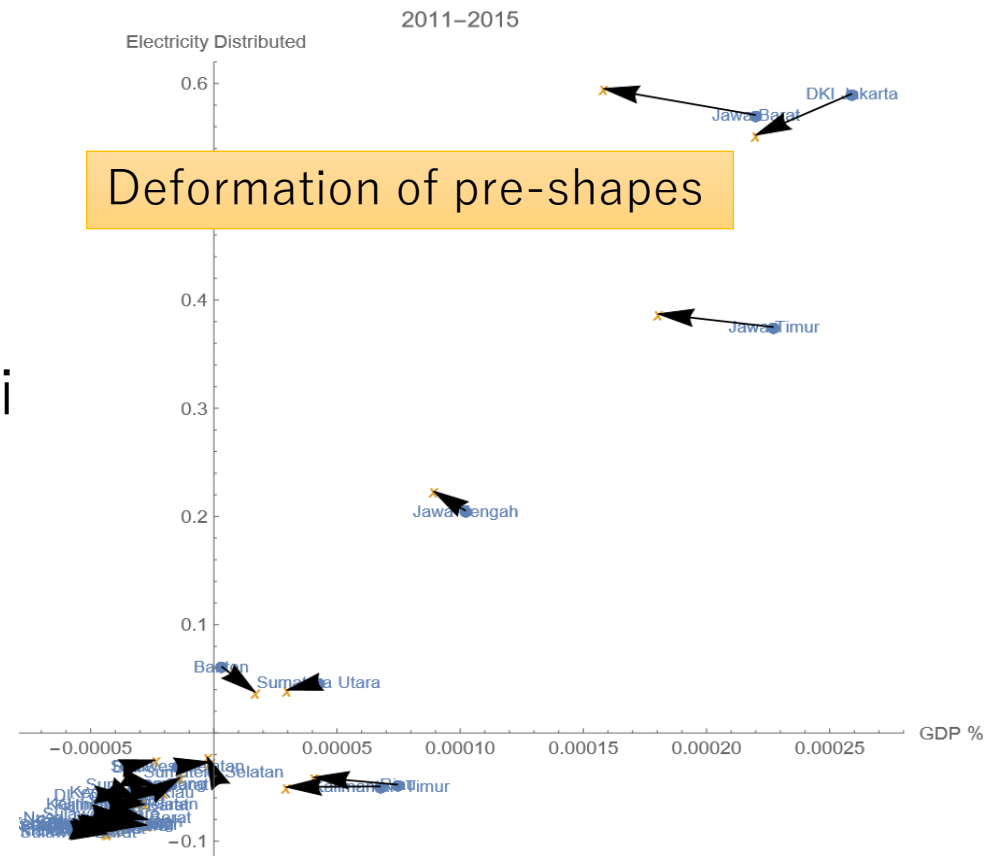
Centroid size

$$s(X) = \sqrt{\sum_{j=1}^{18} \|(X)_j - \bar{X}\|^2}$$

- First, the given configuration must be moved to the centre (centering) and then **divided by the centroid size** (scaling). The resulting shape is called a pre-shape.

Statistical Shape Analysis on GDP% versus electricity change from 2011 thru 2015

1. Transformed to **pre-shapes**
2. For the deformation, make the **bending matrix**
3. Find the **eigenvectors** of the bending matrix
 - # of eigenvectors is in this case $34 - 3 = 31$.
4. The eigenvector is called a **partial warp eigenvector**



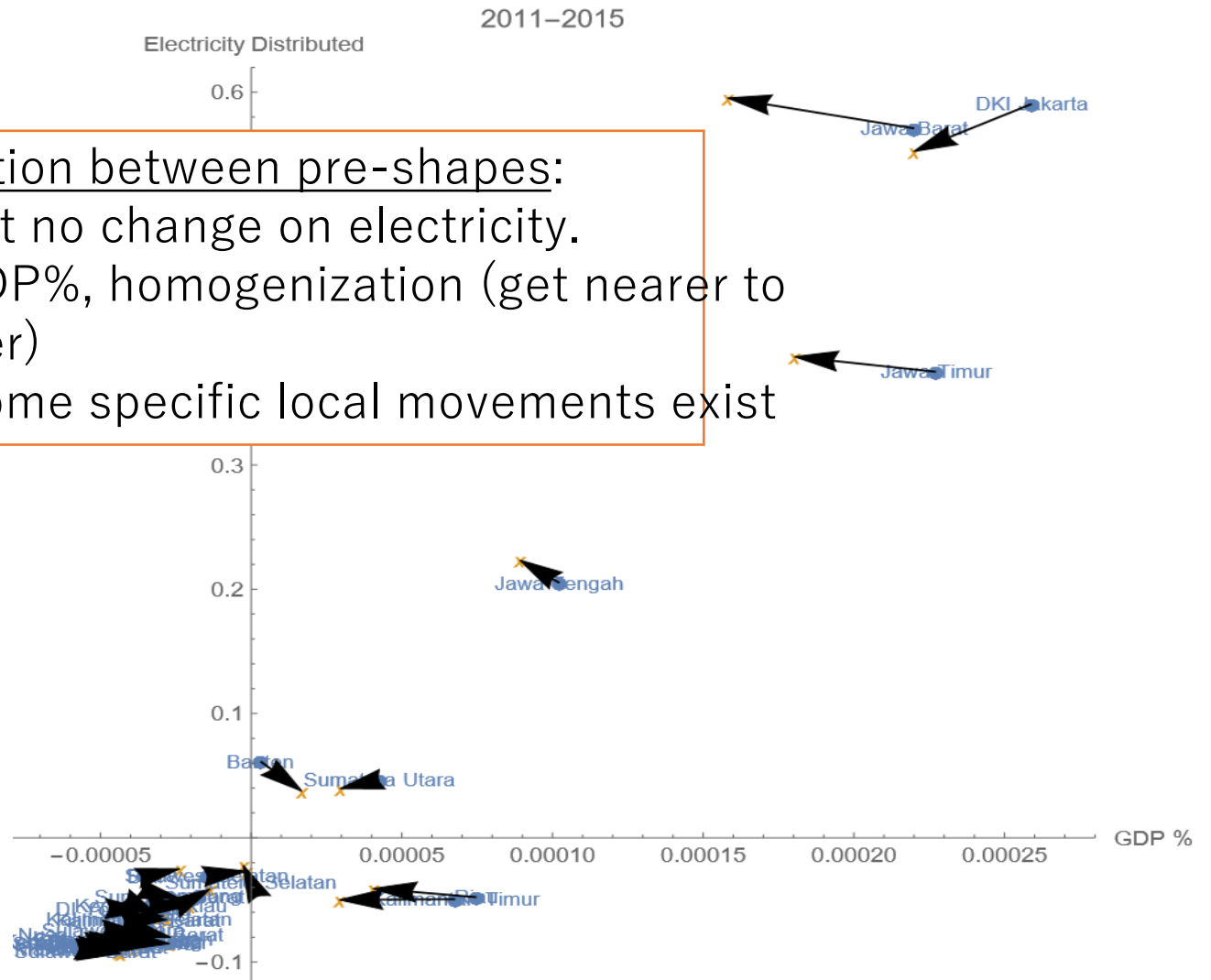
Pre-shape change of GDP% and electricity distribution by provinces from 2011 to 2015

Electricity Distributed
2011-2015

Deformation between pre-shapes:

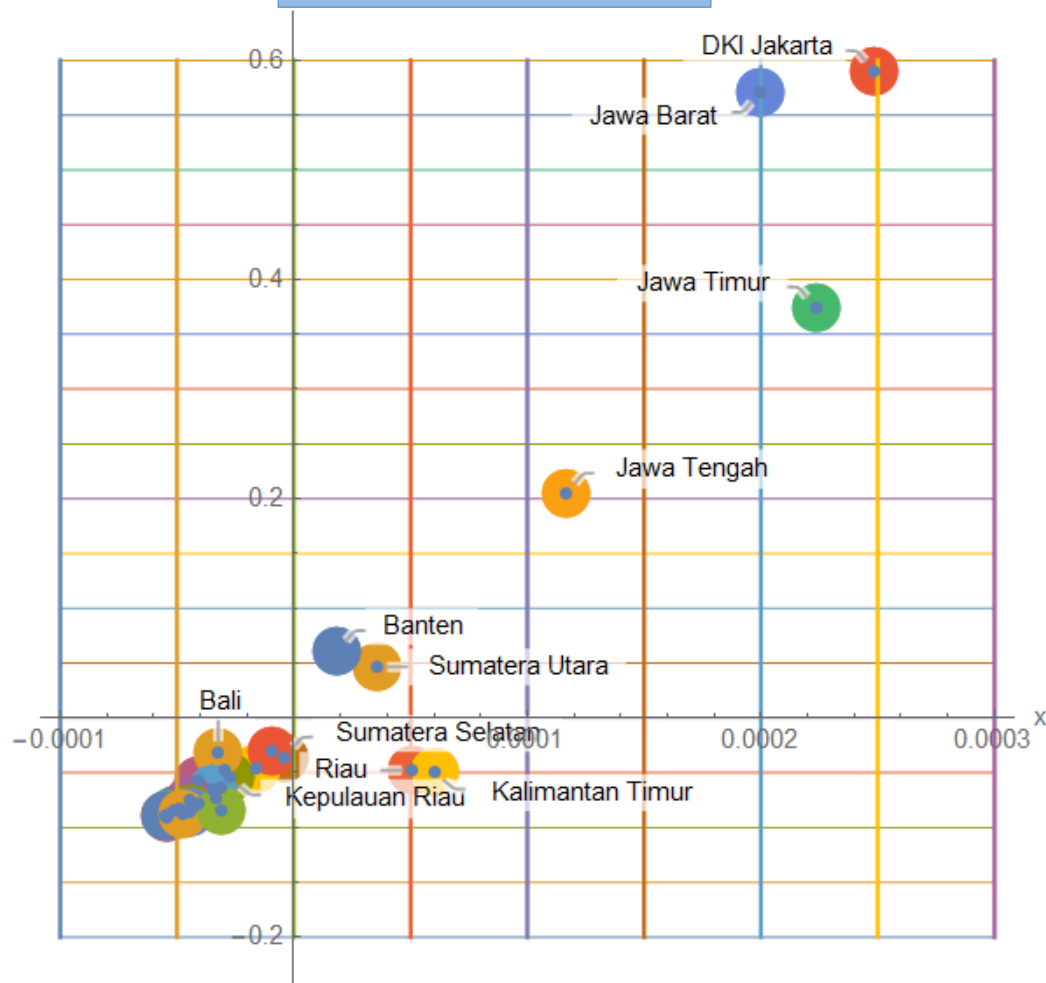
- Almost no change on electricity.
- On GDP%, homogenization (get nearer to the center)
- But some specific local movements exist

- Why we use **pre-shapes** ?
We become able to compare the **scale** **different data**.
We can see the **relative position** to others.

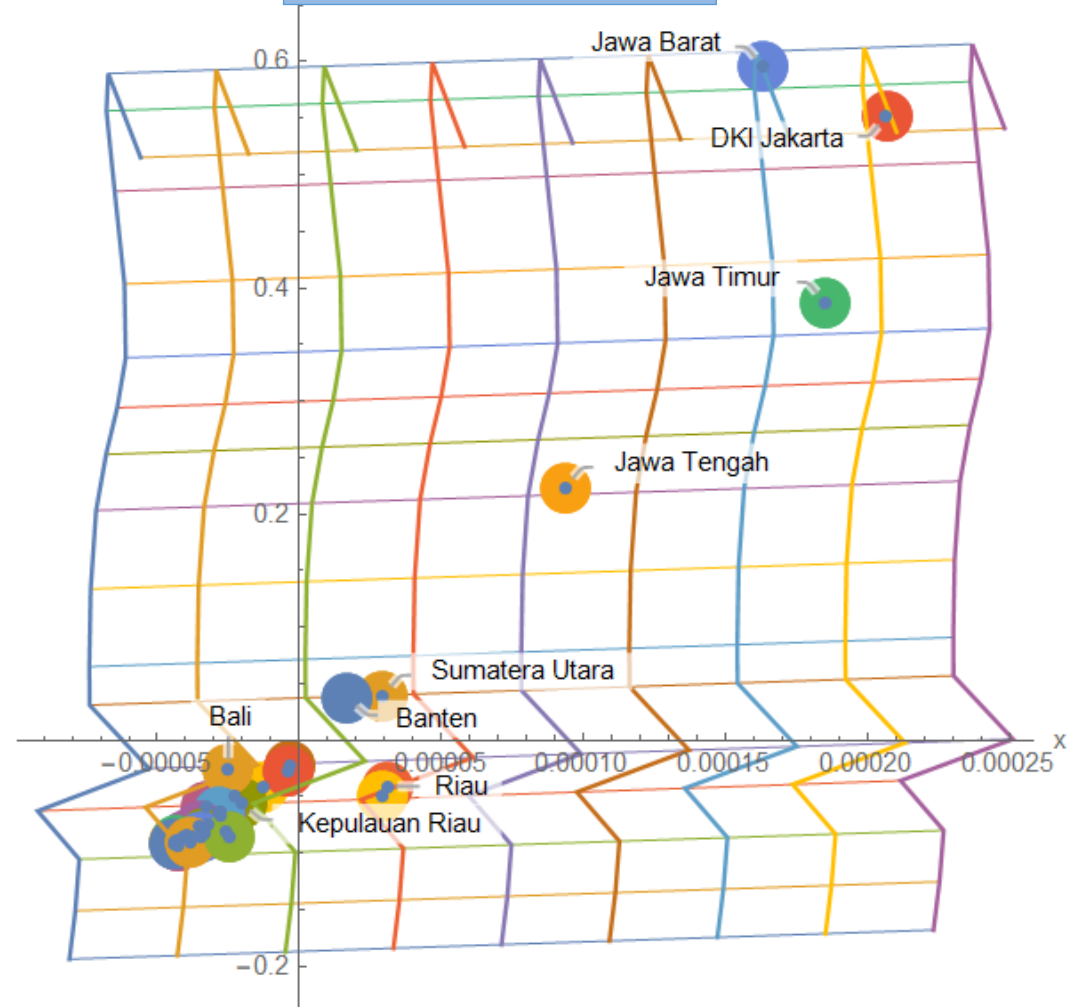


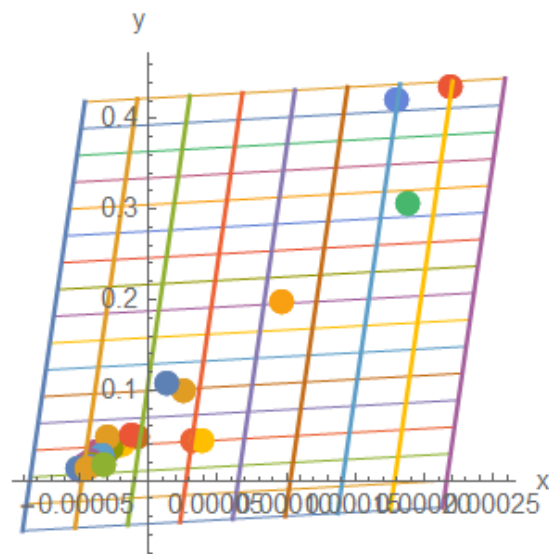
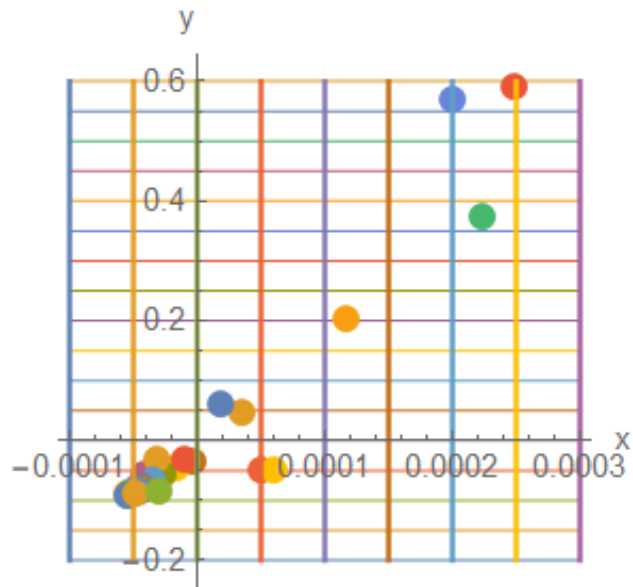
Transformation Grids to Express the Bending

Pre-shape 2011

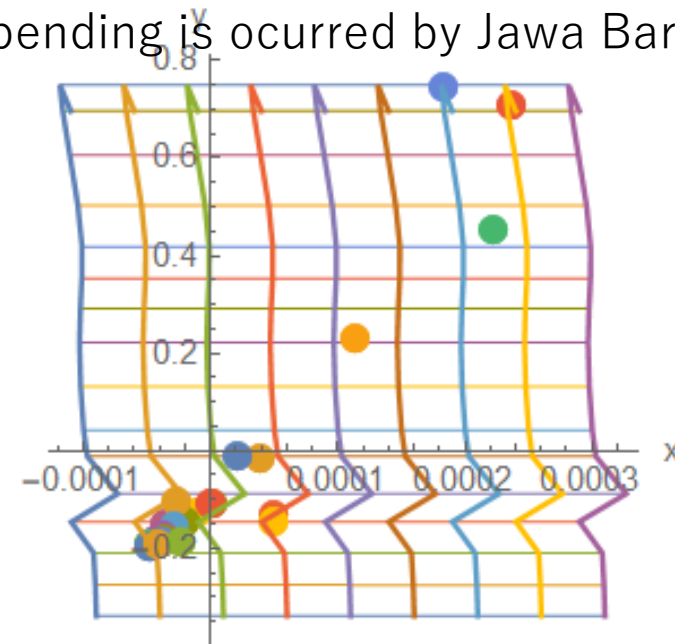


Pre-shape 2015





This bending is occurred by Jawa Barat

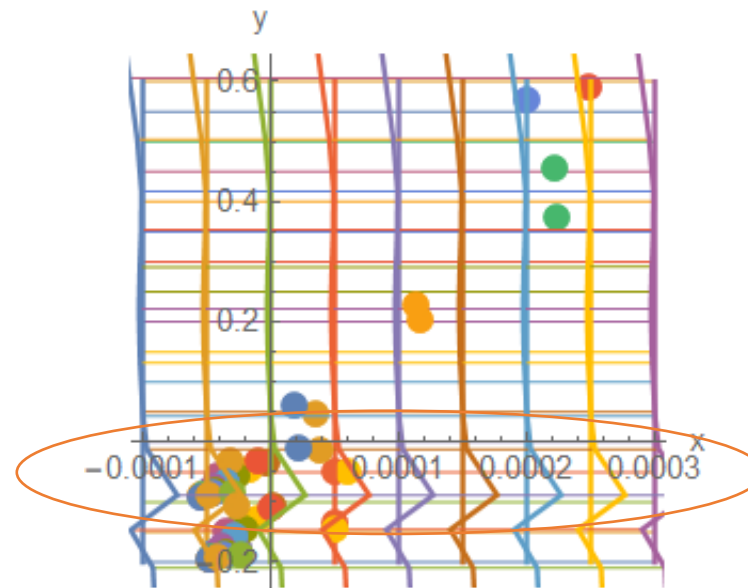
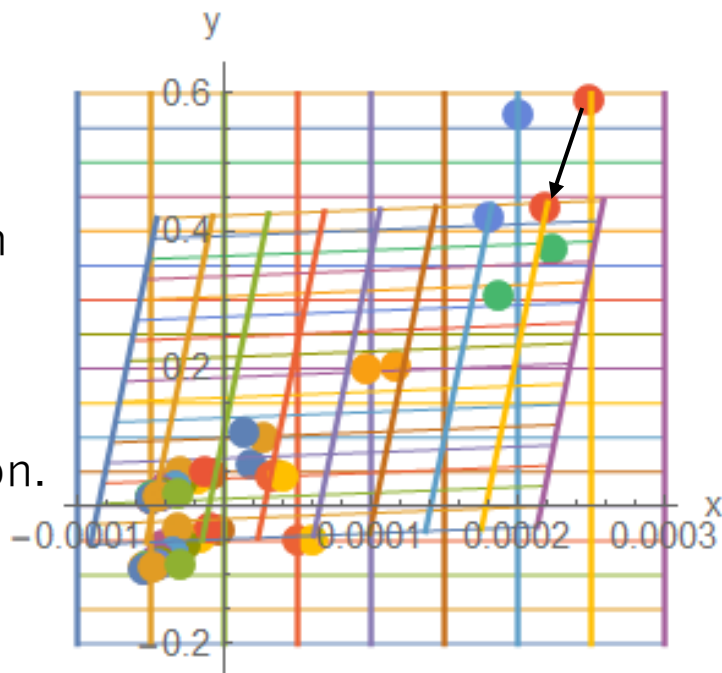


Affine transformation

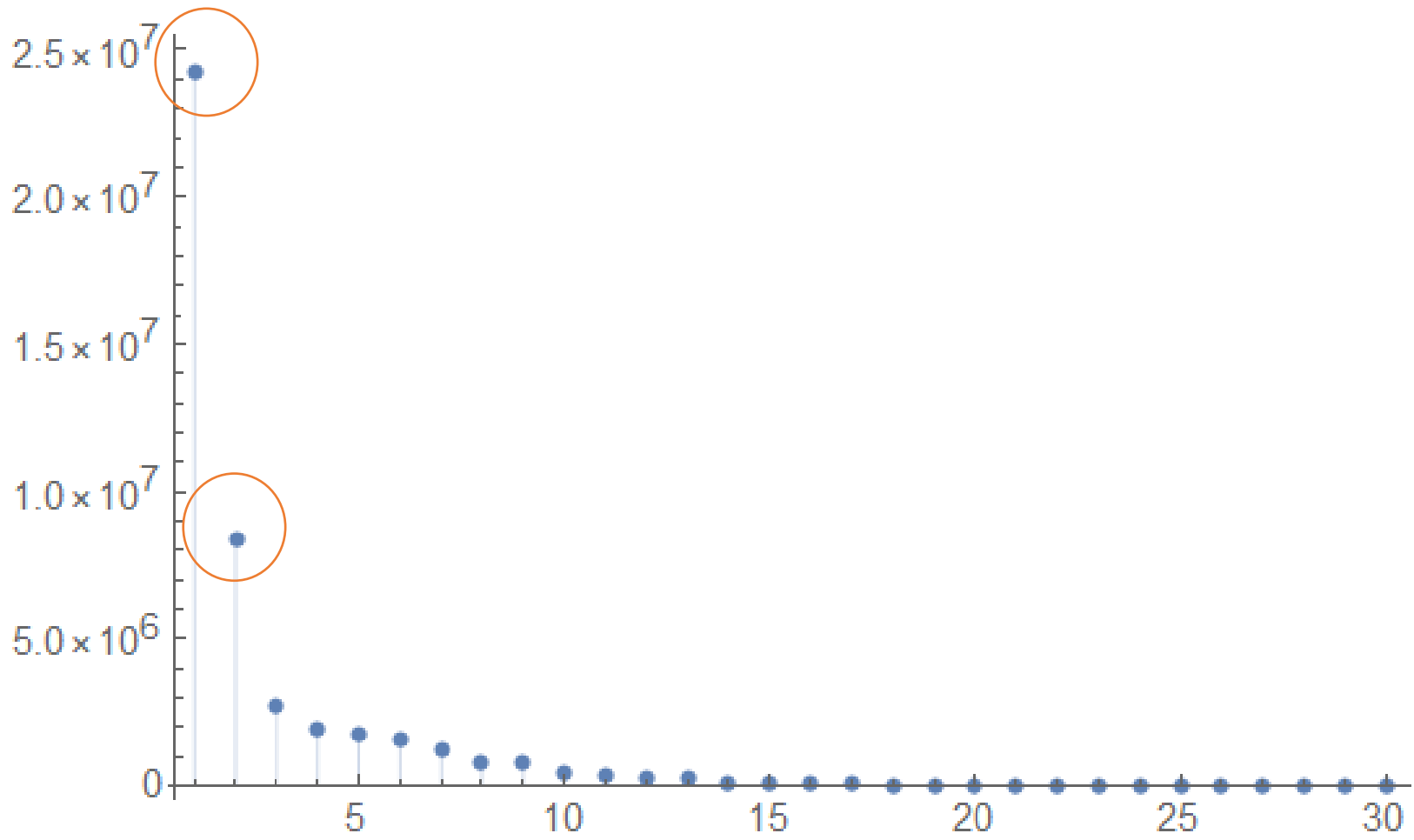
In both axes, homogenization

Non-Affine transformation

Some provinces make the local GDP growth acceleration.
Which provinces ?

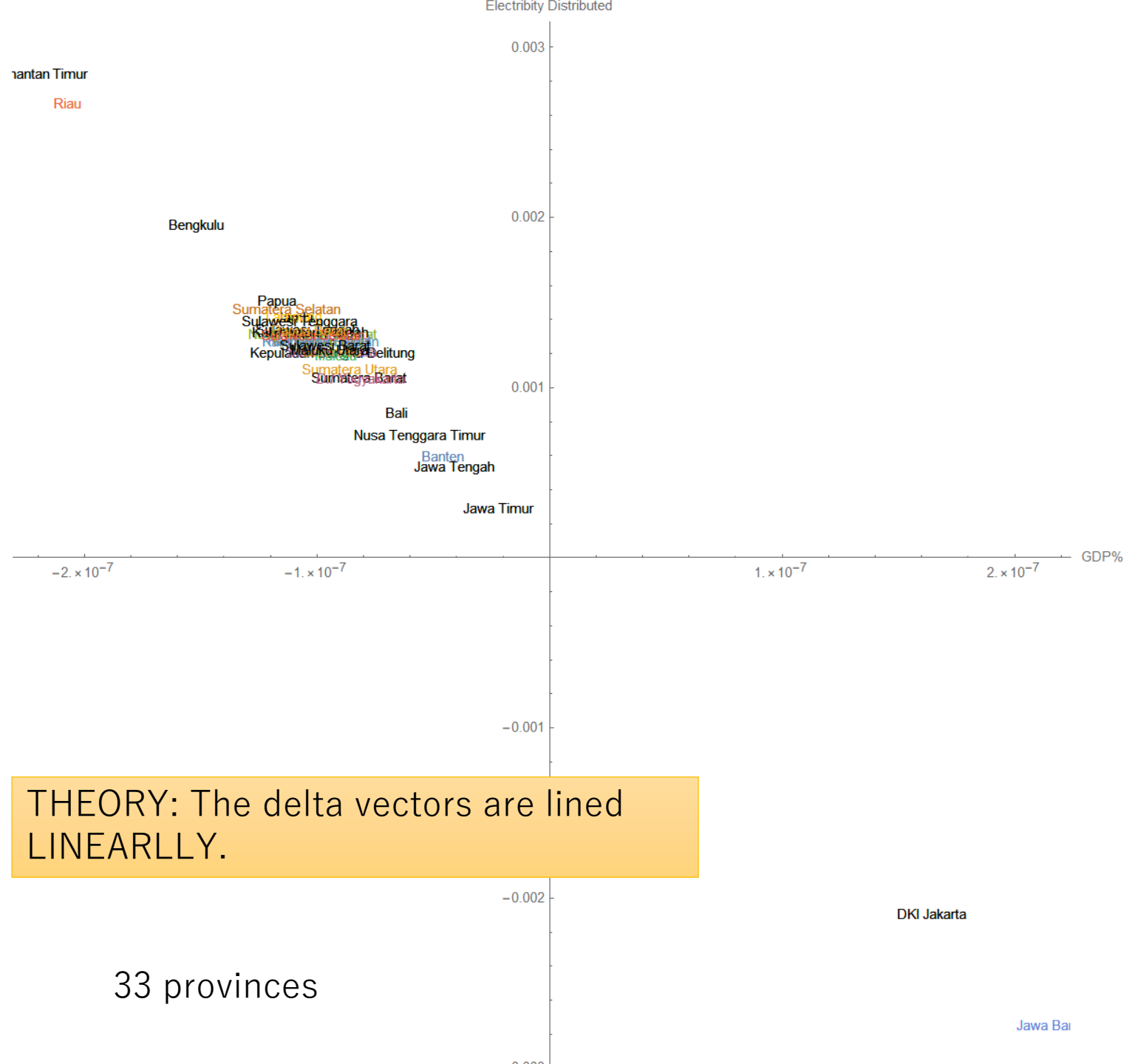


Amplitude of Eigenvalues



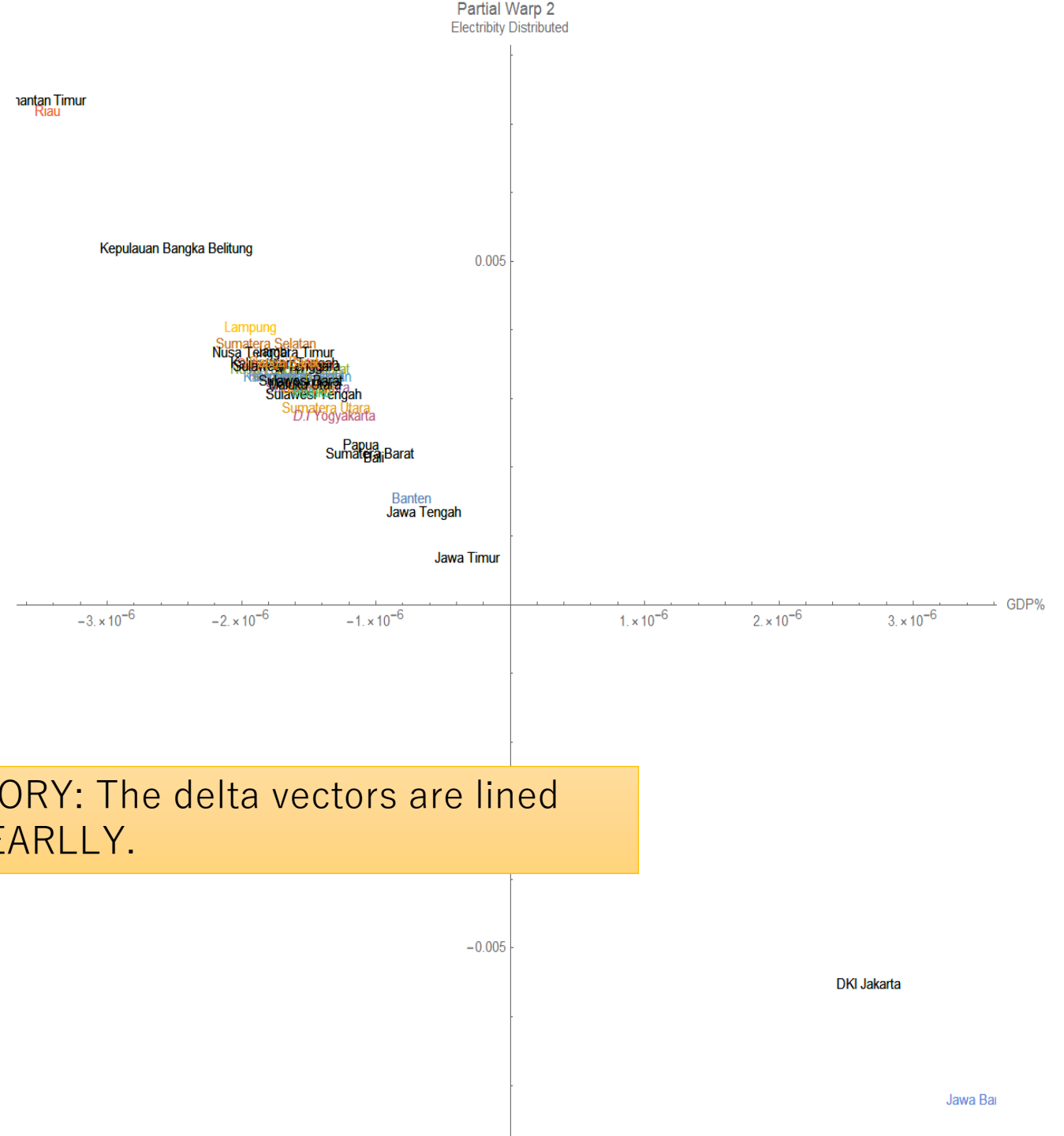
Partial Warp #1 of deformation

- GDP% Almost No Change
 - Jawa Barat ++
 - DKI Jakarta ++
 - Bengkulu-
 - Riau --
 - Kalimantan Timur --
- Electricity
 - Kalimantan Timur ++
 - Riau ++
 - Bengkulu+
 - DKI Jakarta --
 - Jawa Barat --



Partial Warp #2 of deformation

- GDP% Almost No Change
 - Jawa Barat ++
 - DKI Jakarta ++
 - Kepulauan Bangka Belitung-
 - Riau --
 - Kalimantan Timur --
- Electricity
 - Kalimantan Timur ++
 - Riau ++
 - Kepulauan Bangka Belitung+
 - DKI Jakarta --
 - Jawa Barat --



THEORY: The delta vectors are lined LINEARLY.

Conclusions

- **Statistical shape analysis** can express the local movement.
- Data electricity versus GDP% in 2011 and 2015
- From Affine transformation we can see the **homogenization of GDP%** and **no relative change on the electricity**.
- But **DKI Jakarta and Jawa Barat GDP growth rate is much higher** than others including Jawa Timur and Jawa Tengah.
- Concerning electricity, the others growth rate is higher than DKI Jakarta and Jawa Barat.



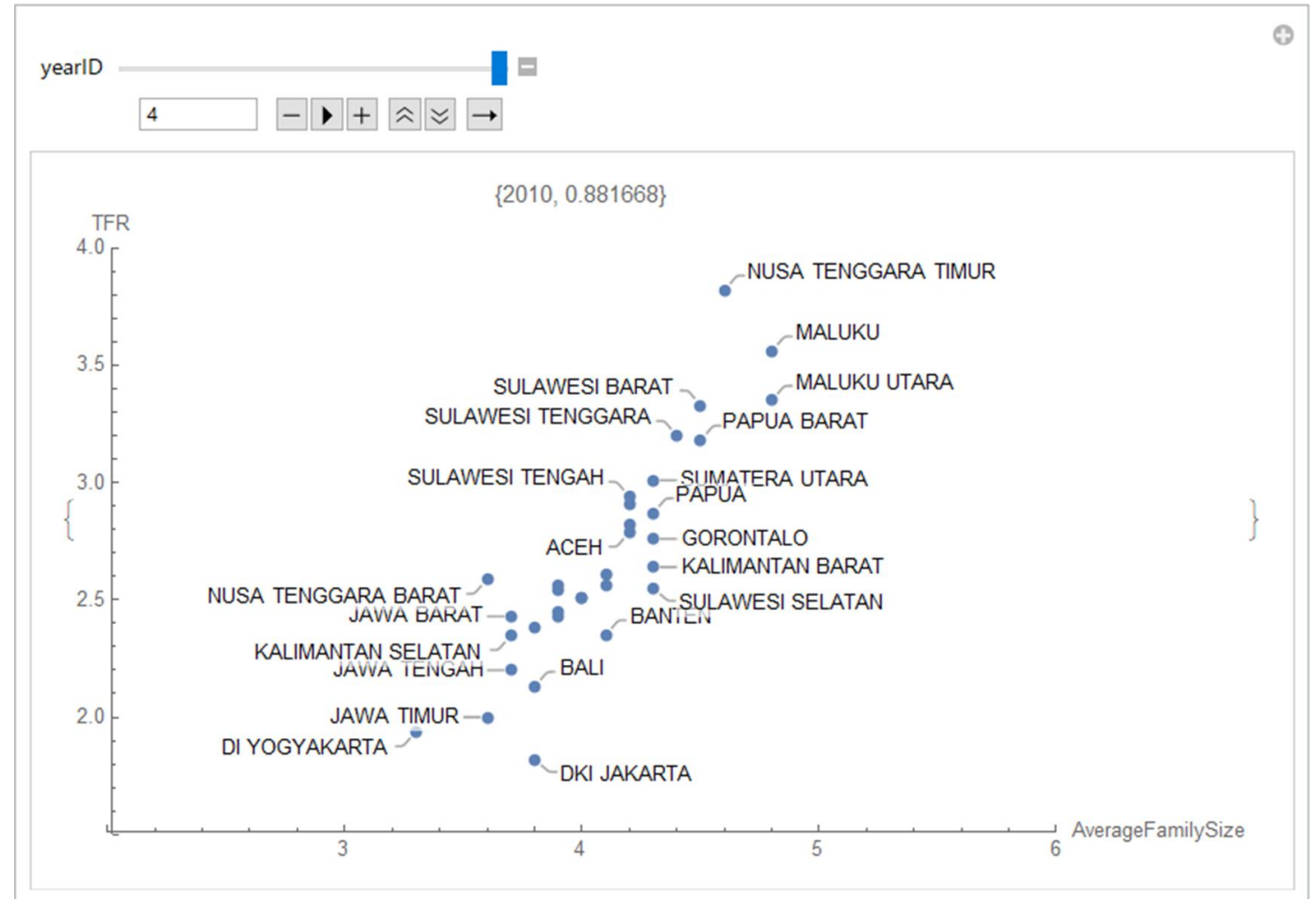
Correlation between TFR and Average Family Size by Province

Data I used

- Data cited from “Statistics Indonesia” web site
 - Total Fertility Rate (TFR) by Province, { 1971, 1980, 1985, 1990, 1991, 1994, 1997, 1998, 1999, 2000, 2002, 2007, 2010, and 2012}, updated on 20 Aug 2014
 - Average Household Size by Province, {2000-2015}, updated on 02 Mar 2017

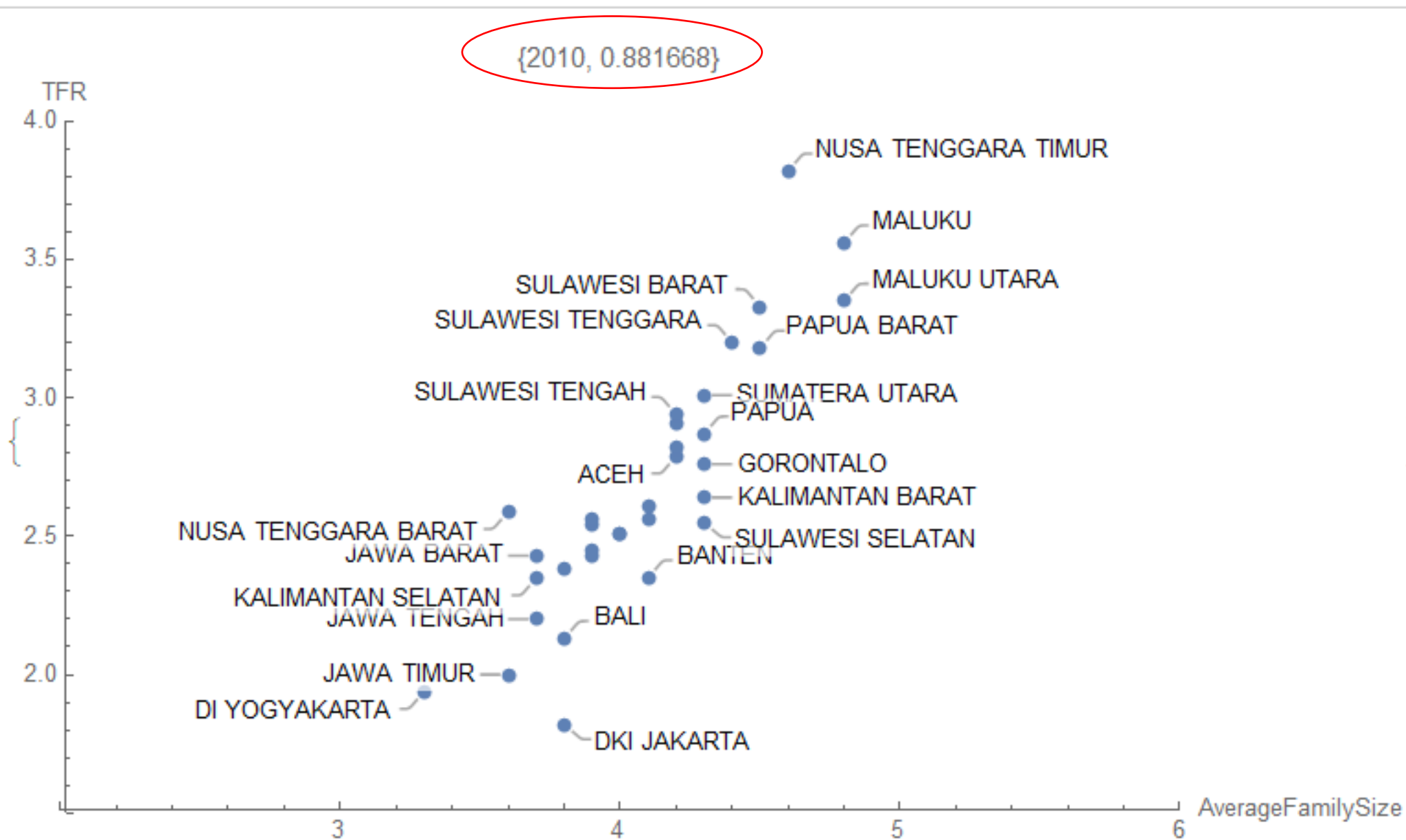
Hypothesis: A province with a big average family size will have a high TFR

- Can we verify the hypothesis ?

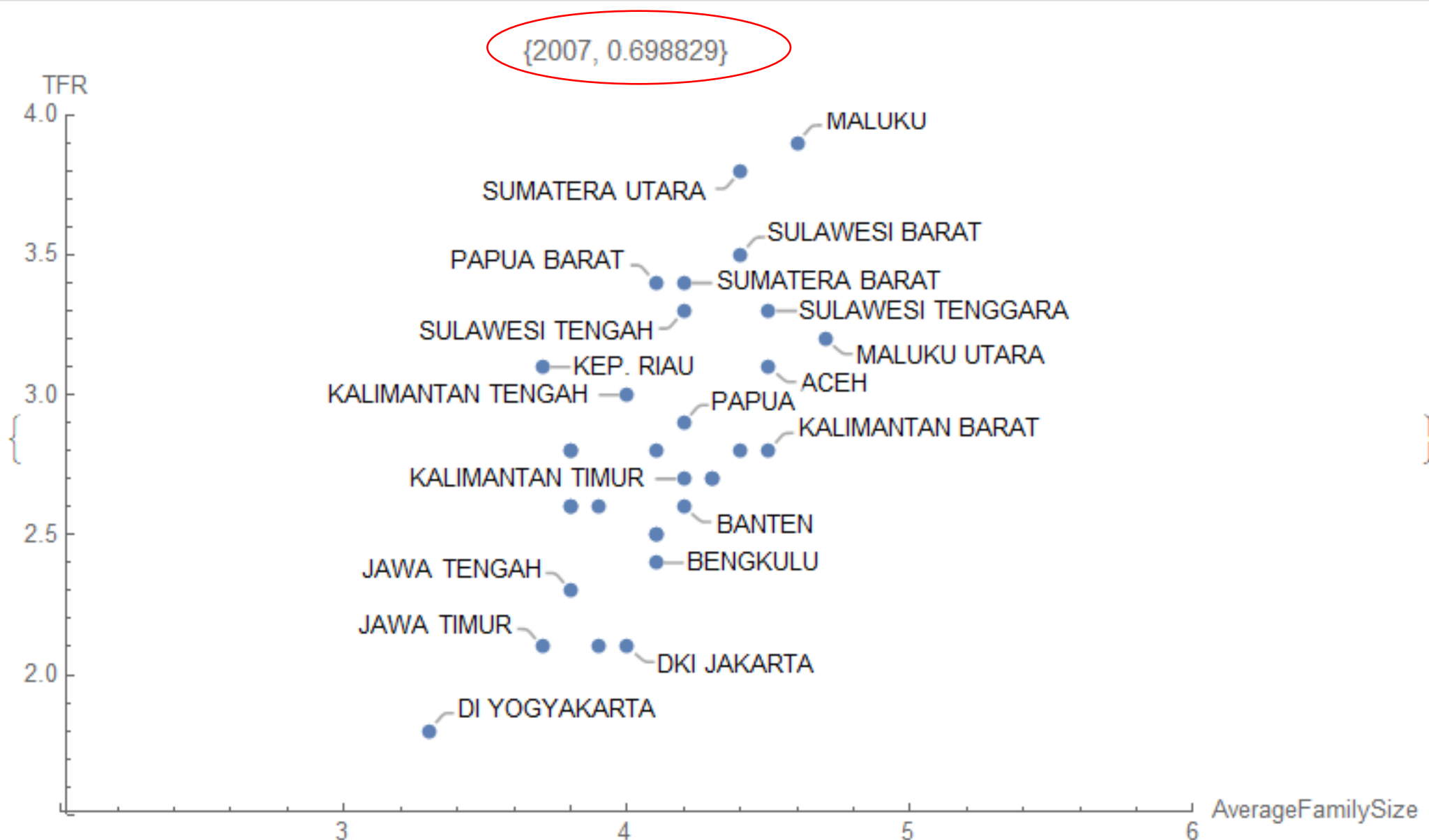


Correlation Coefficient

yearID



yearID



yearID

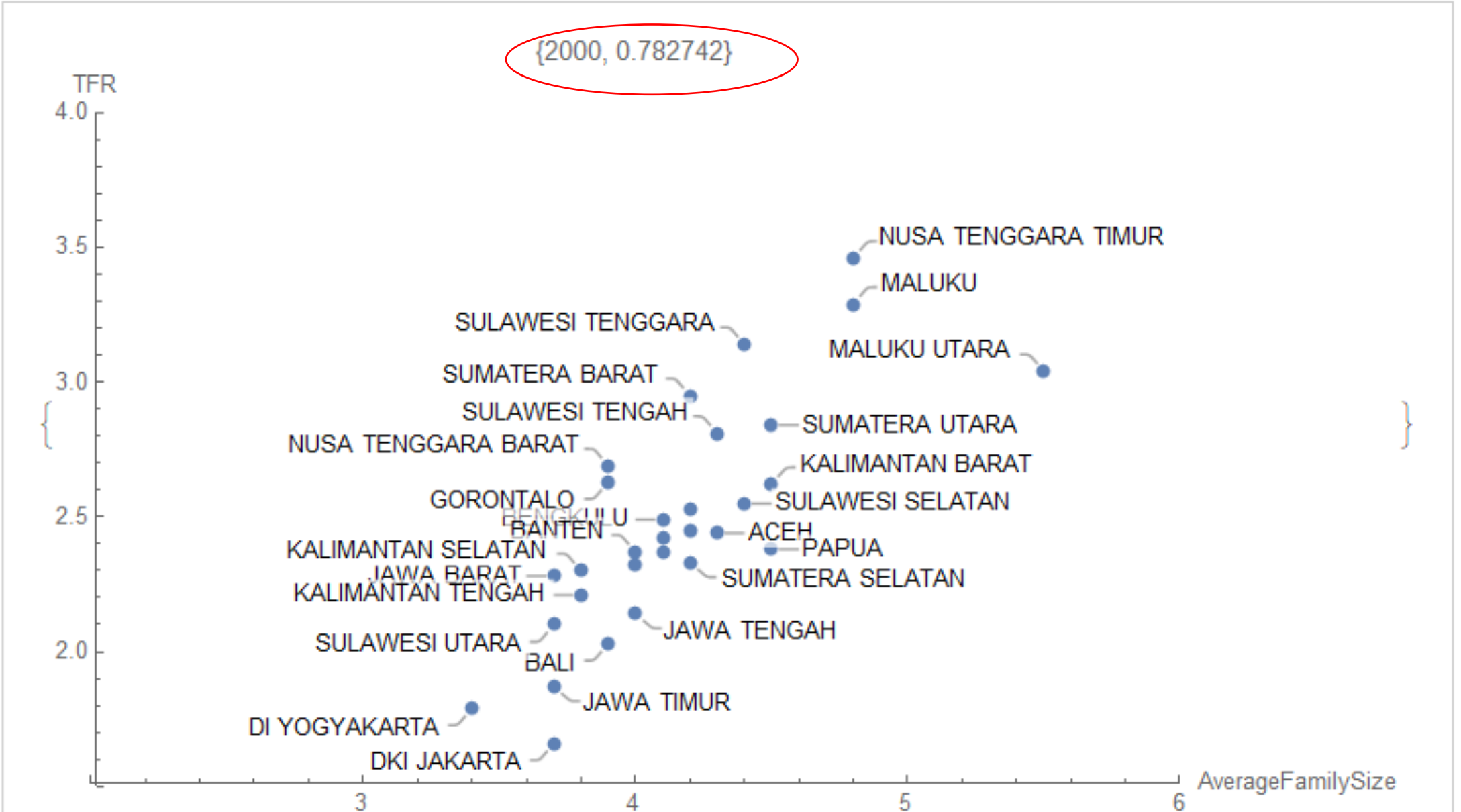
2



{2002, 0.567798}

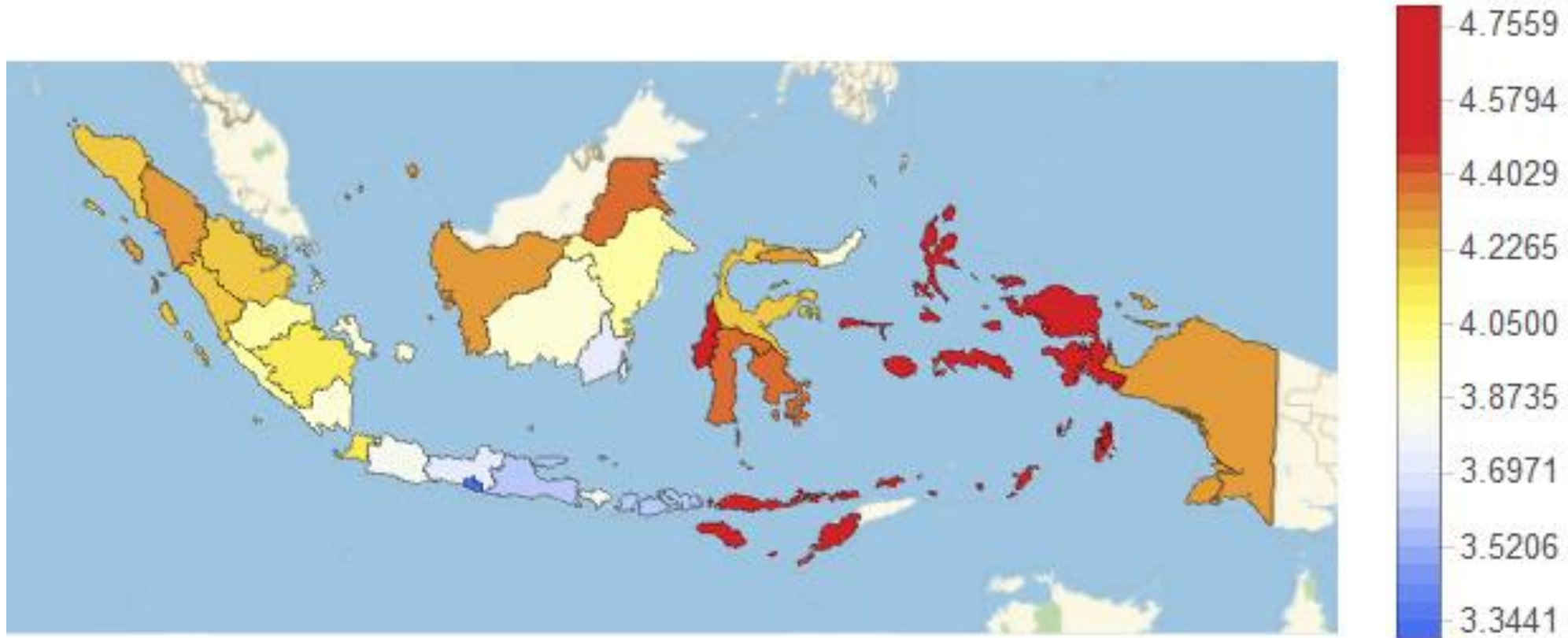


yearID

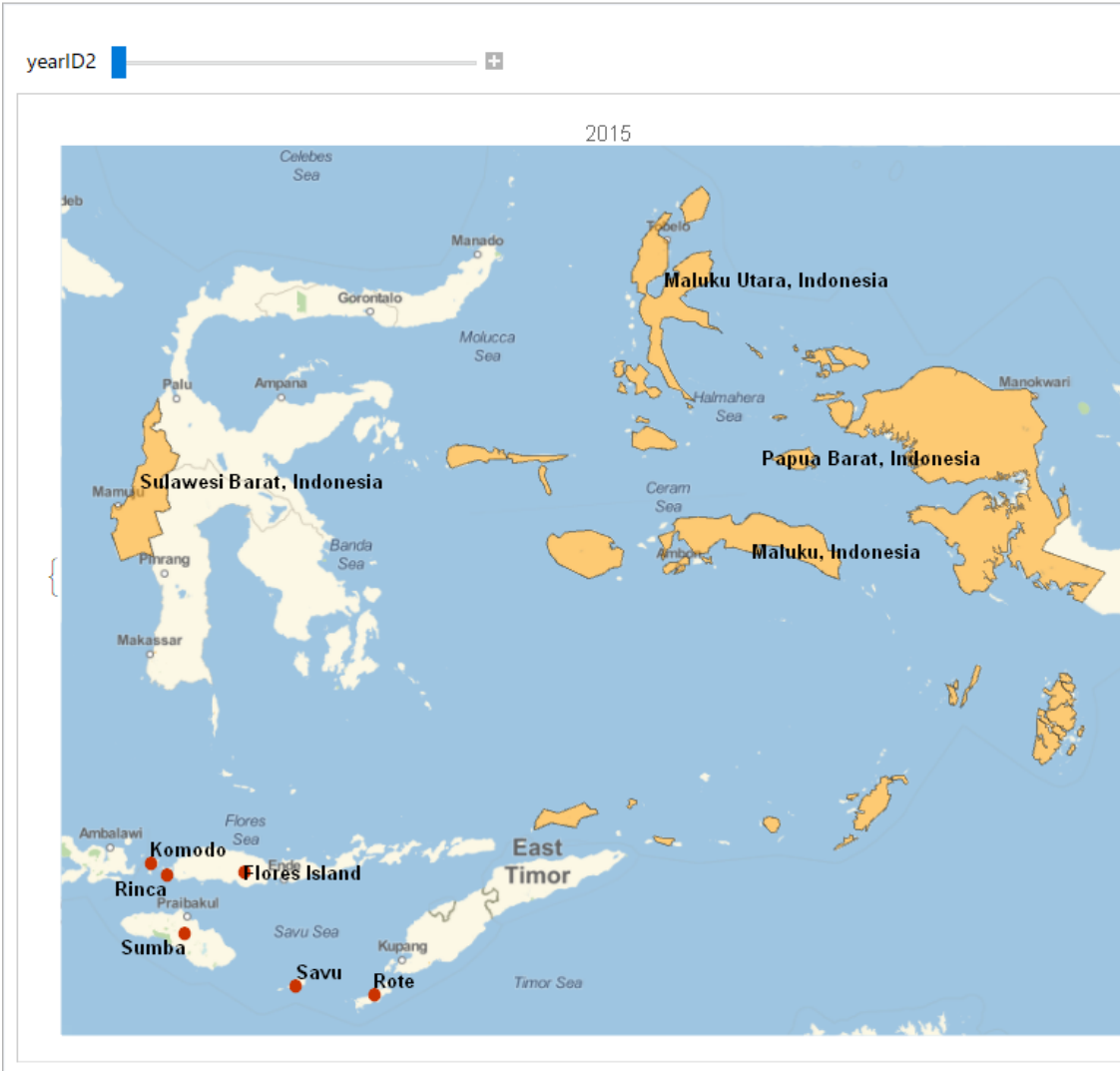


Provinces with high
average family size values

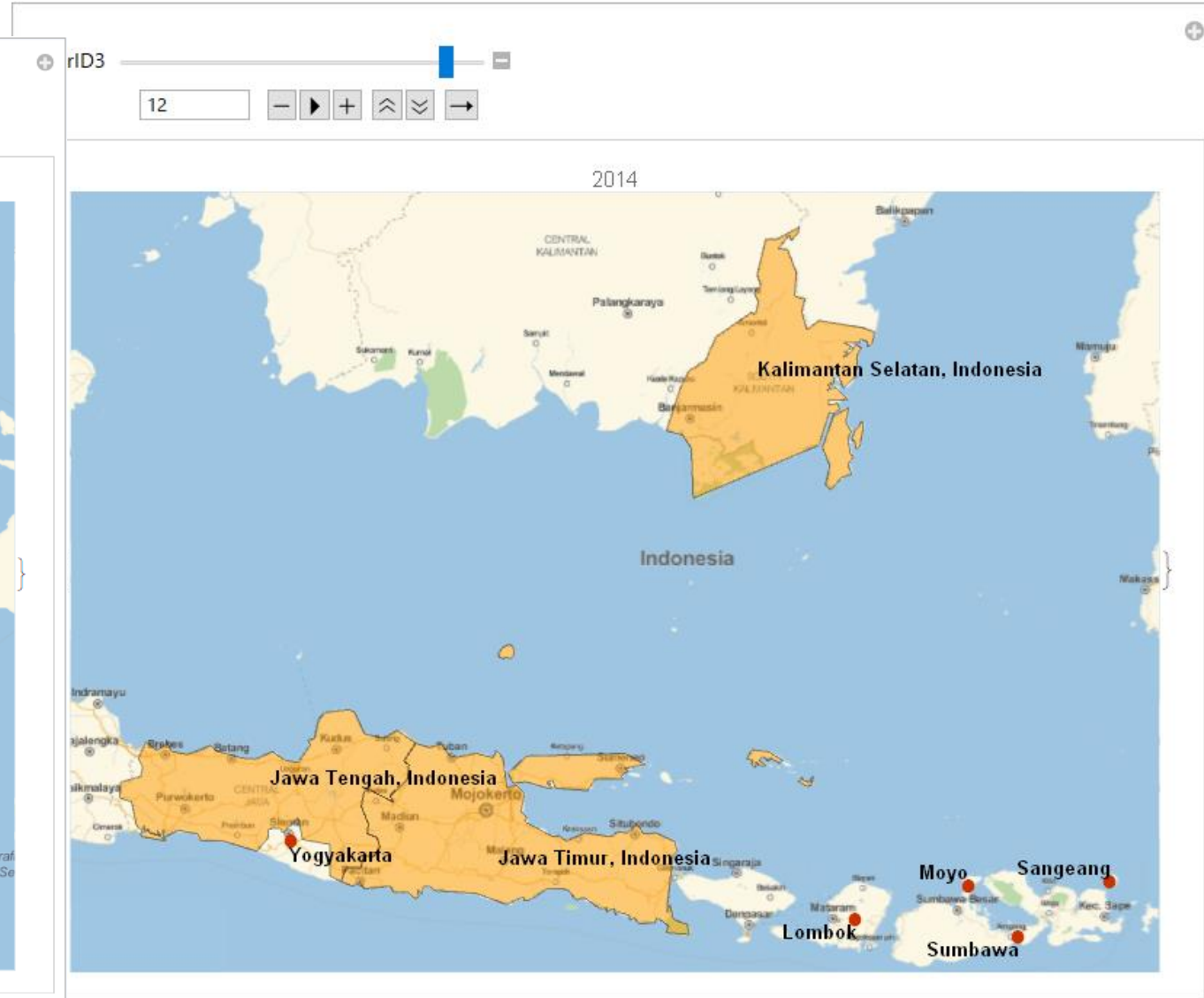
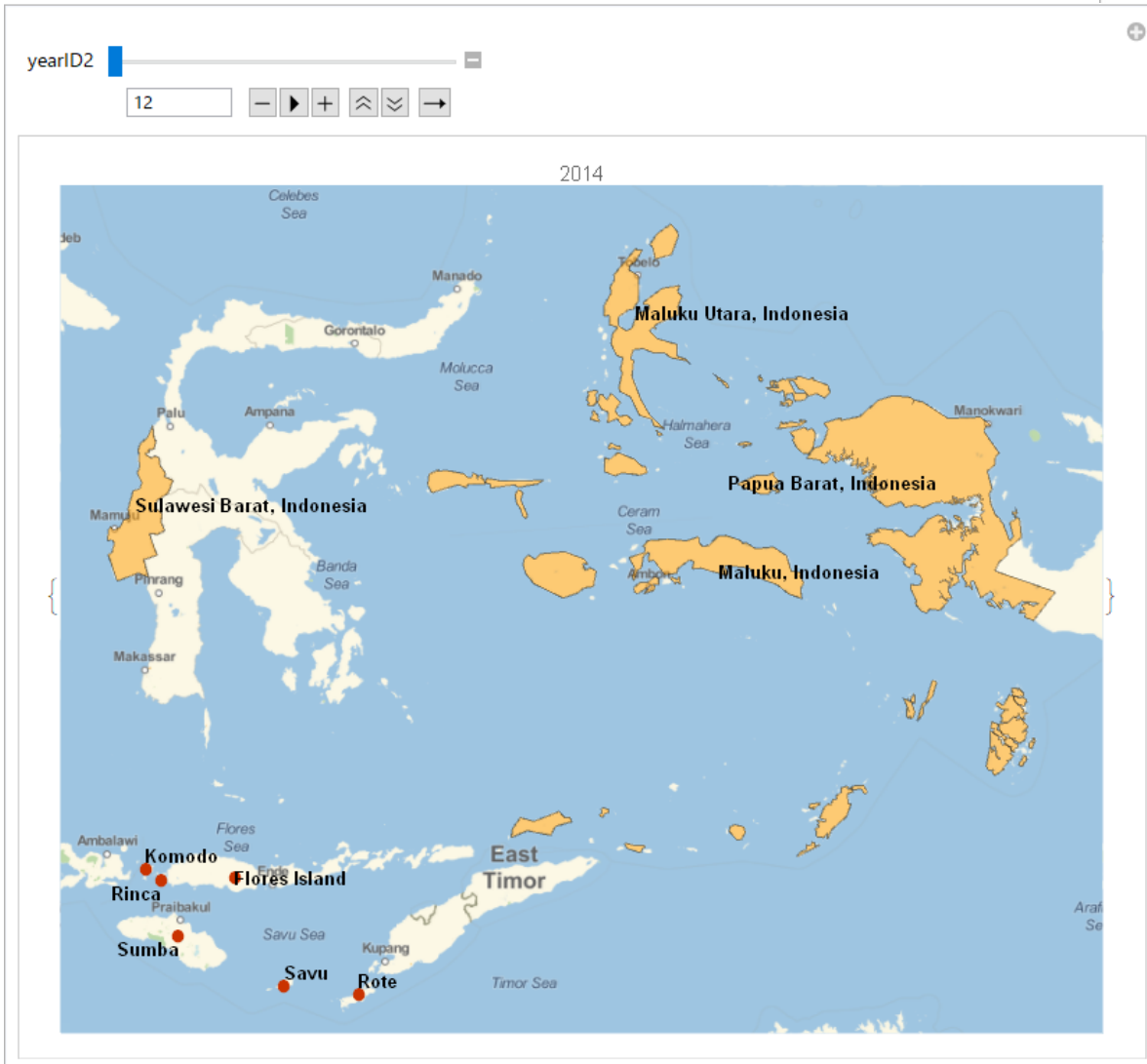
2015 Average Family Size



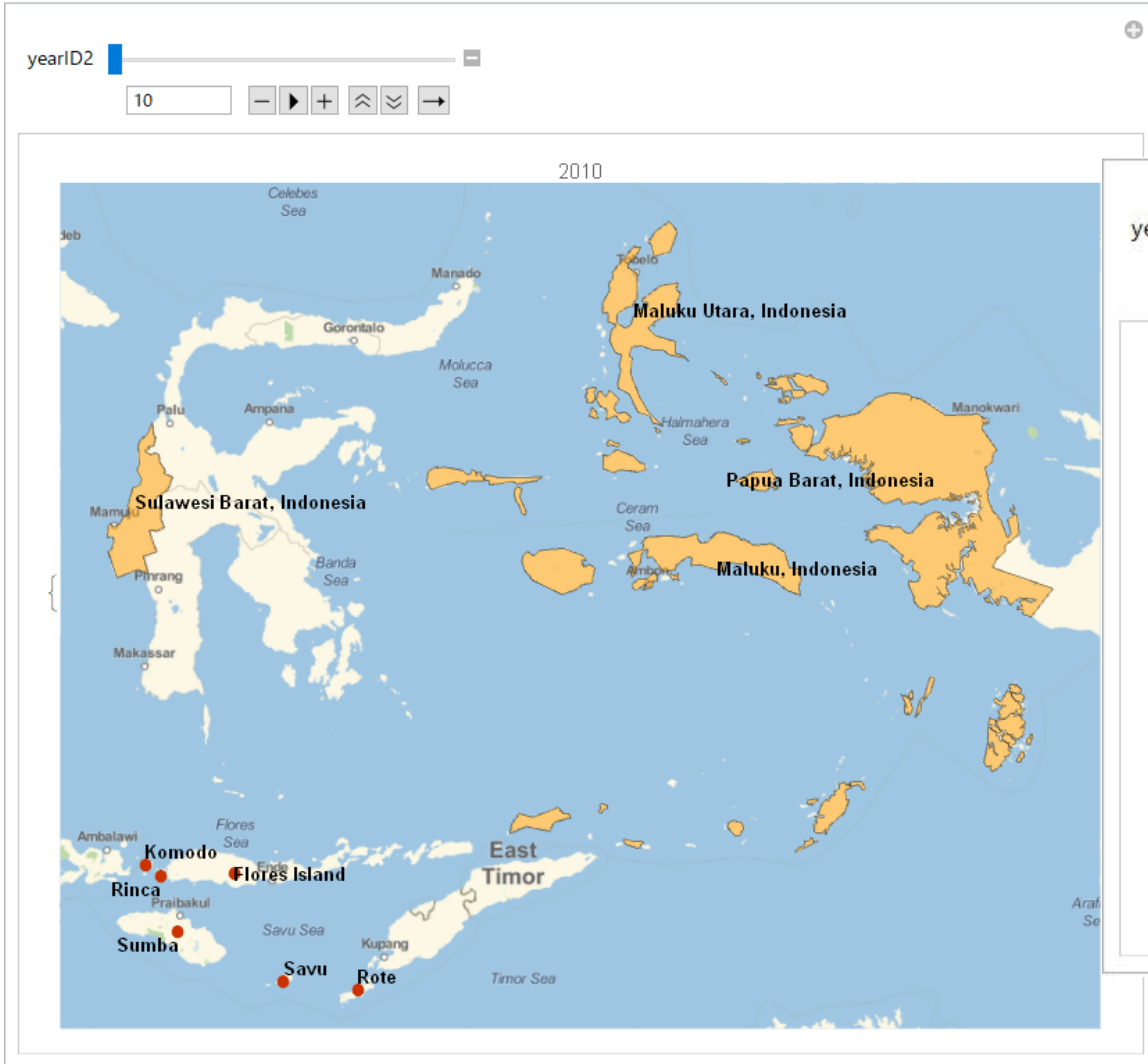
Average Family Size 2015 TOP 5 High and Low



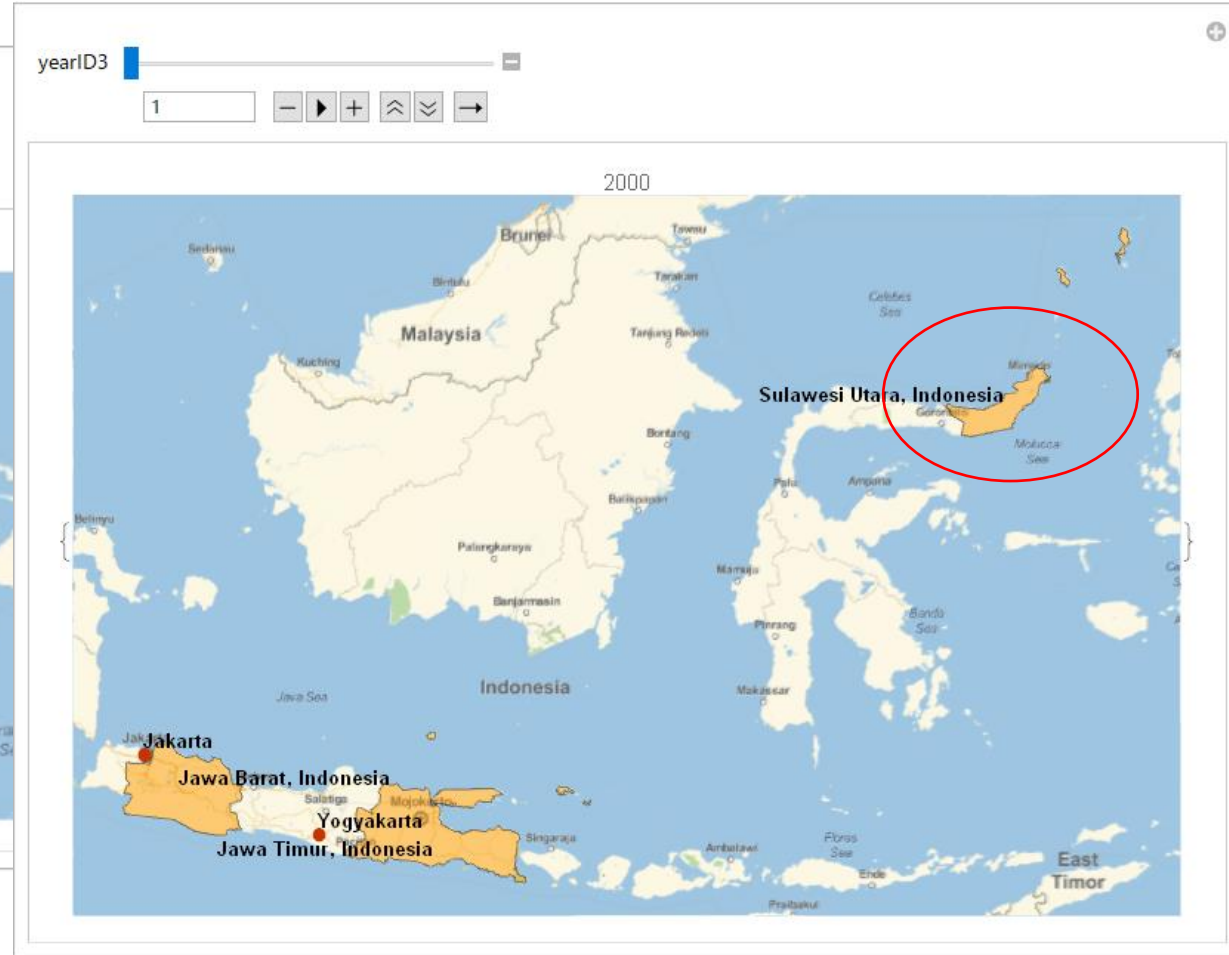
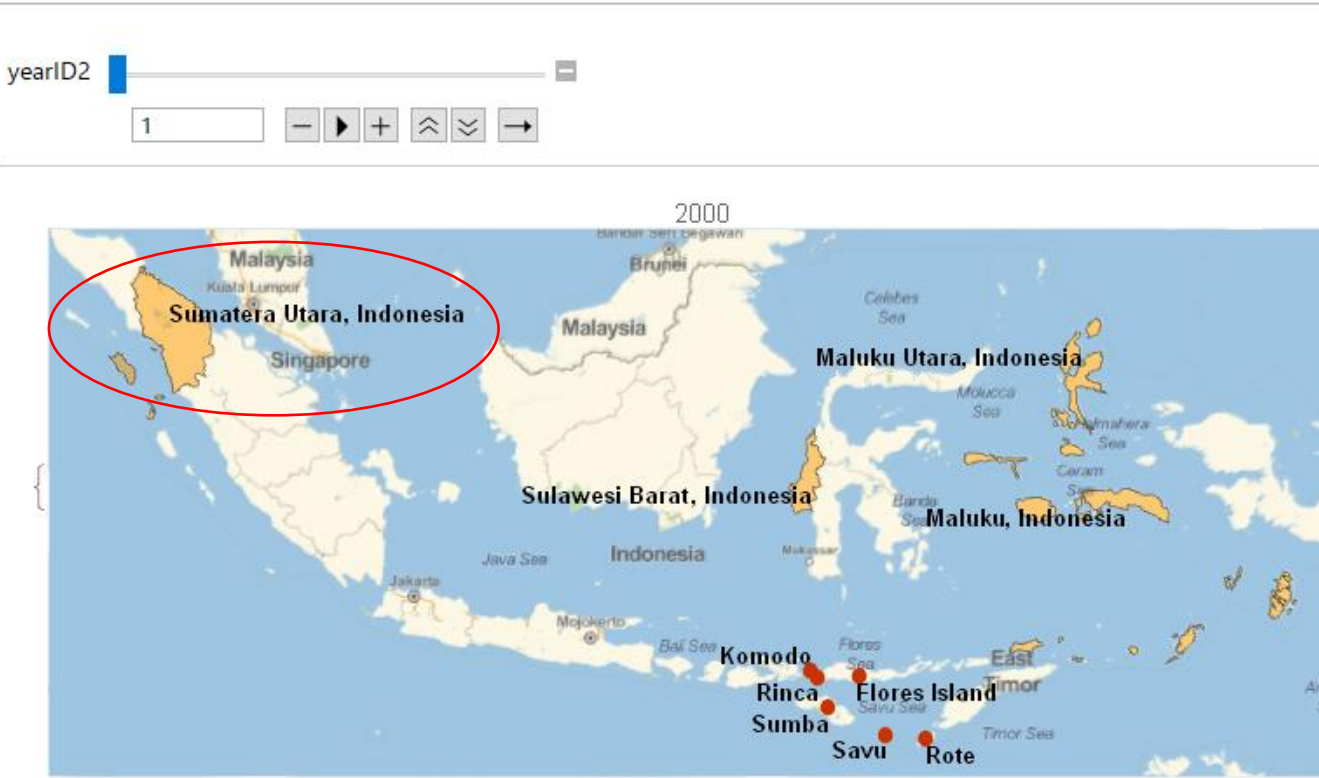
Average Family Size 2014 TOP 5 High and Low



Average Family Size 2010 TOP 5 High and Low



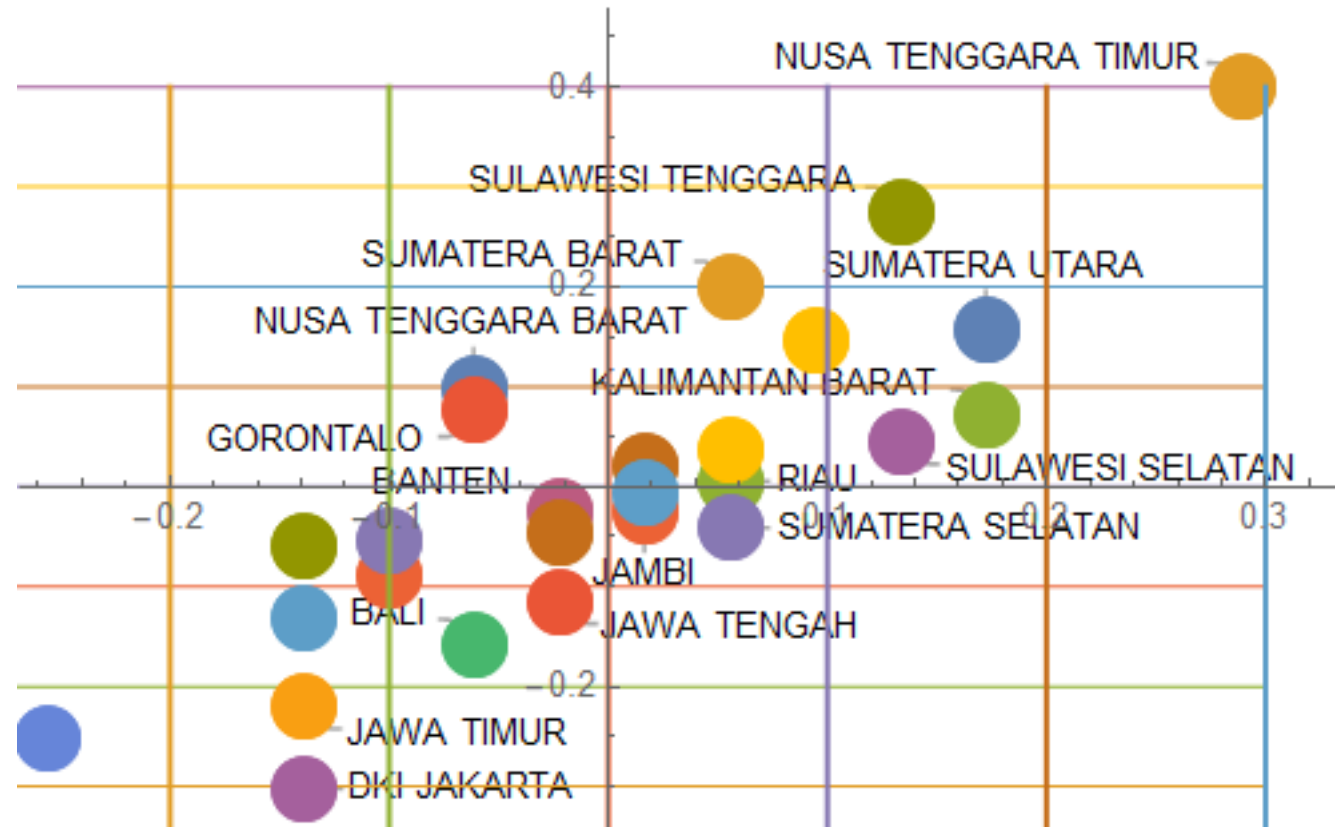
Average Family Size 2000 TOP 5 High and Low



Shape Analysis on the data

- Affine transformation: Total change trend
- Non-Affine transformation: Local movement
- Among the whole change trend, for example, Jakarta movement is larger than others or not ?

Original shape in 2000



Pre-shape
deformation 2000 to 2010
26 provinces

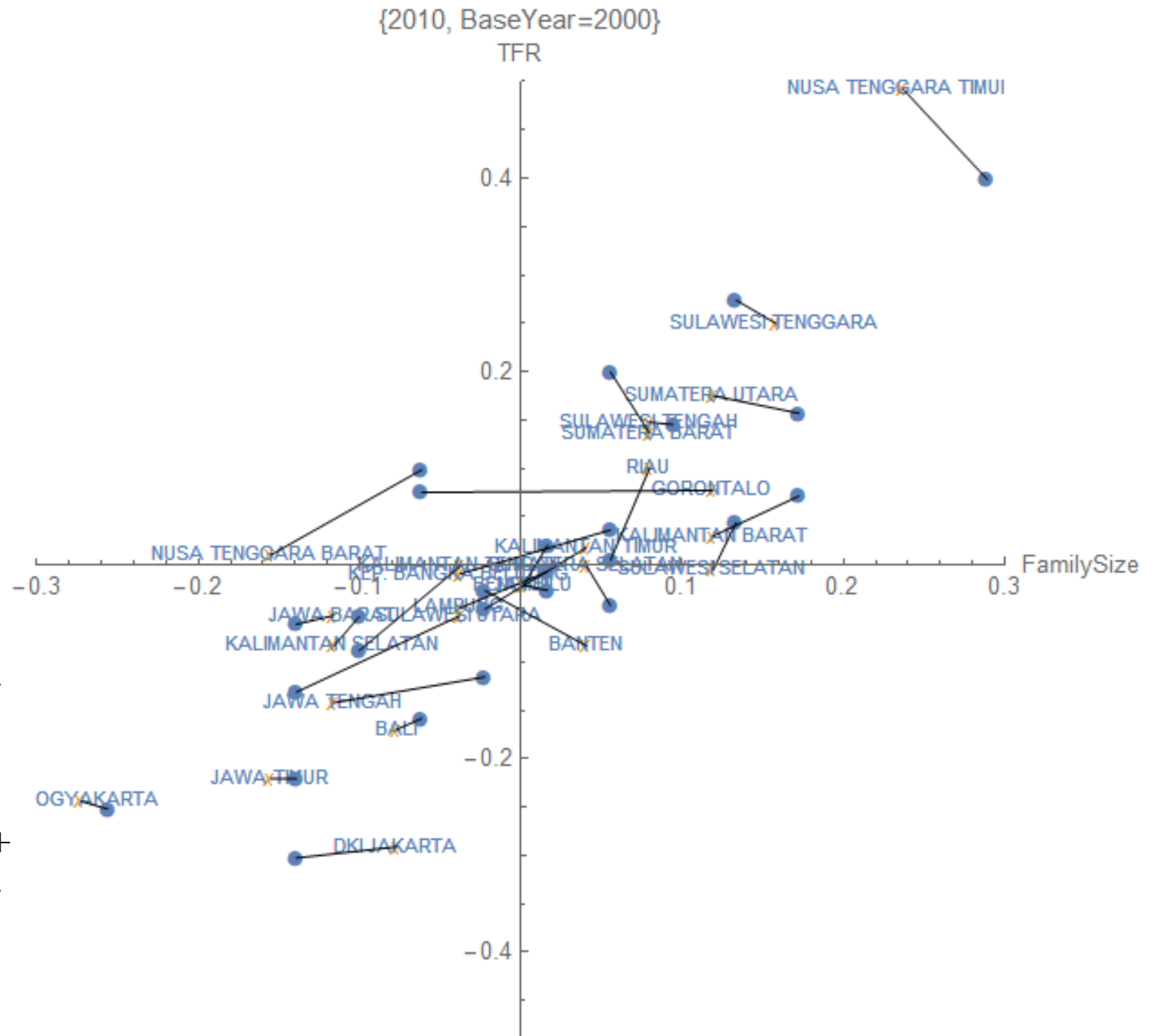
• Relative movement

◆ FamilySize

- GOLONTALO++
- SULAWESI UTARA ++
- DKI JAKARTA+
- JAWA TENGAH --
- NUSA TENGGARA BARAT --

◆ TFR

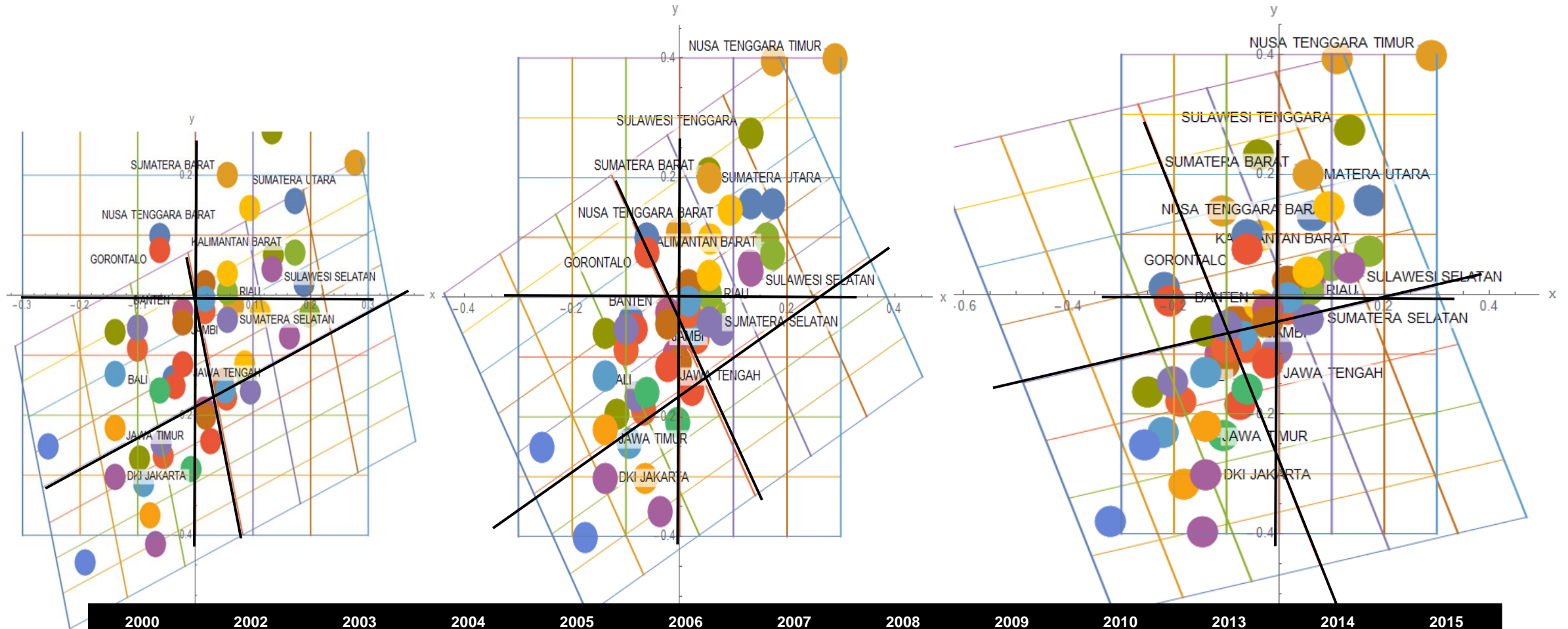
- NUSA TENGGARA TIMUR++
- NUSA TENGGARA BARAT --



Affine Transformation part
2000->2002,

2000->2007,

2000->2010



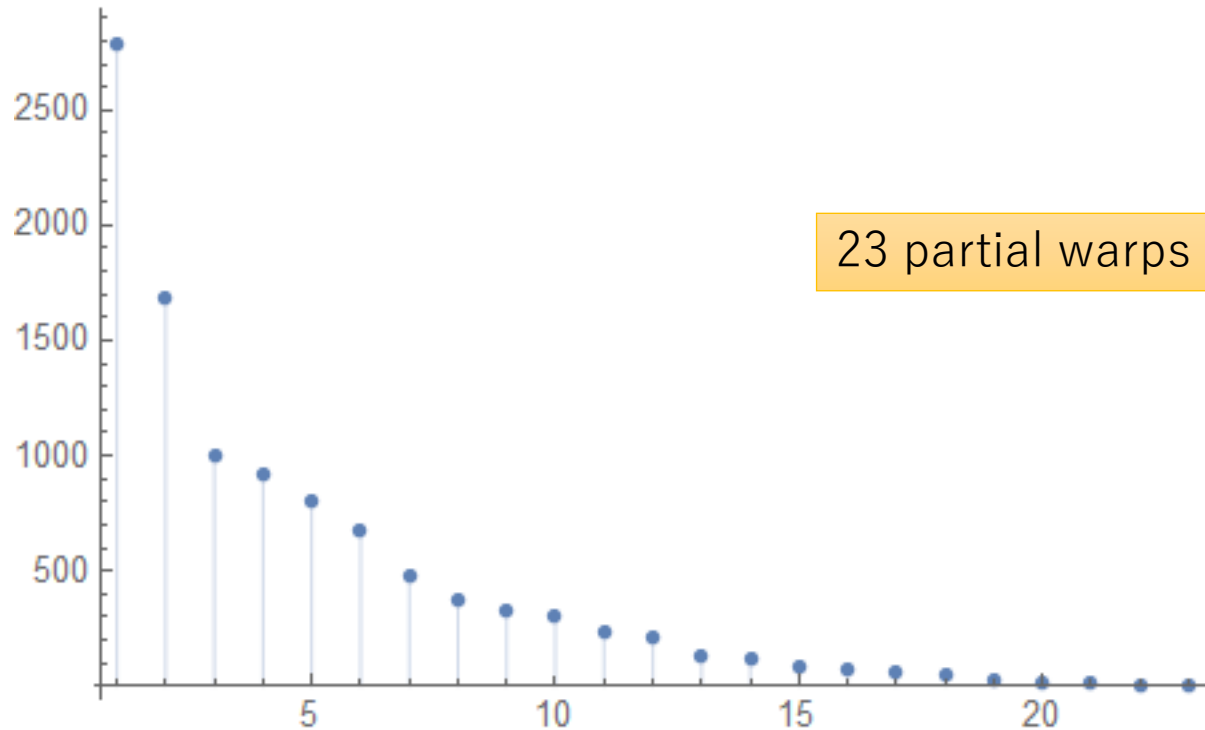
	2000	2002	2003	2004	2005	2006	2007	2008	2009	2010	2013	2014	2015
INDONESIA	3.9	3.9	3.8	3.7	4	4	4	4	4	3.9	3.9	3.9	3.9

INDONESIA	1971	1980	1990	1991	1994	1997	2000	2002	2007	2010	2012
IA	5.61	4.68	3.33	3	2.85	2.34	2.27 -		2.6	2.41	2.6

Non-Affine transformation

of eigenvectors : 26 provinces – 3 = 23

- Eigenvalue amplitude



Partial Warp #1

- JAMBI ++
- LUMPUNG --

