

A Preliminary Study of Factors Affecting the Urban Transportation Energy Consumption of Urban Form in Taiwan

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Introduction

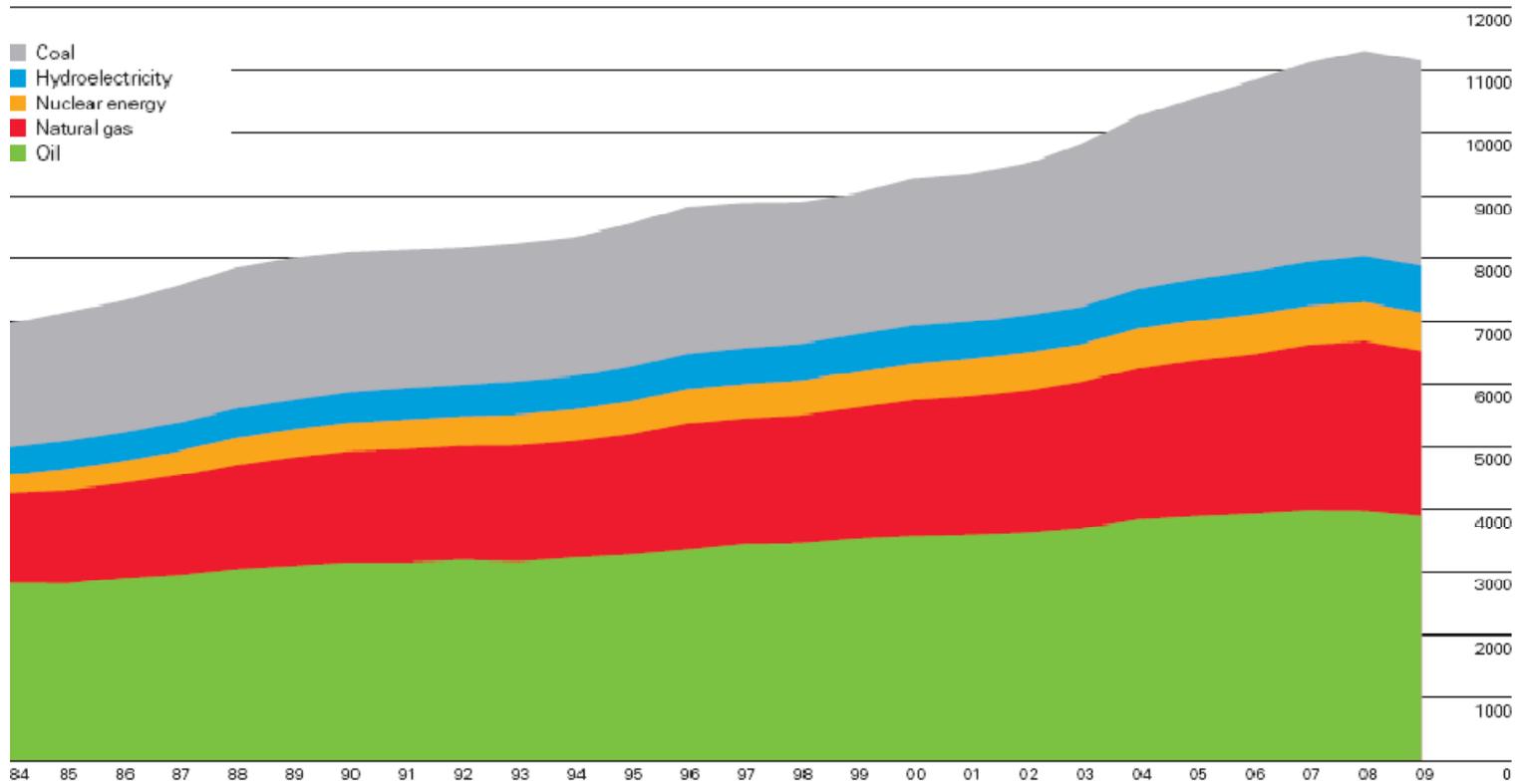
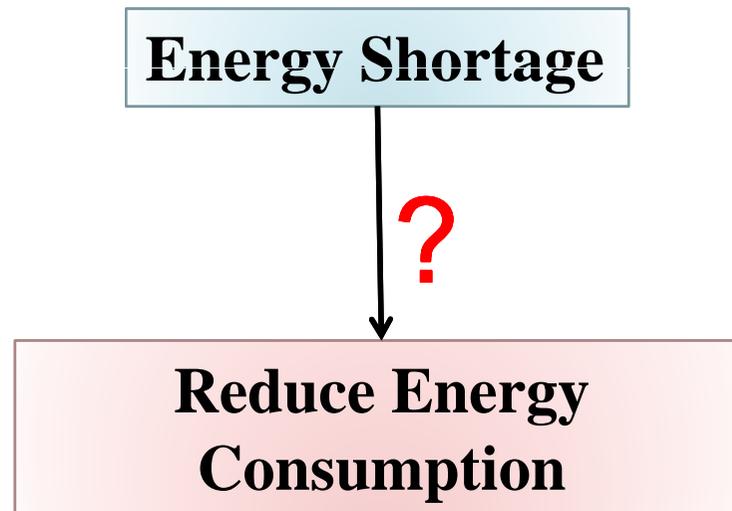


Fig1. The world's energy consumption

Introduction

To view the status of the Taiwan's energy development, dependence on imported energy has reached up to 99.3% in 2007.



Introduction



- 1987 Rickaby(1987) discusses the relatedness among the urban form and the energy use. He discovered that **no matter what kind of the urban development can save more energy consumption which compared to the original plan.**
- 1989 The studies of Newman and Kenworthy (1989) on the relationship between urban density and transportation energy conclude that **the Compact City is good for energy efficiency.**
- 1992 Breheny (1992) think that **compact city would be overcrowding,** lack of urban open space living environment, resulting in more energy consumption and the cost of pollution.
- 1995 Owen (1995) mentioned that the key issue of compact city is **what kind of forms of development and accessibility,** as well as how flexible combination of policies, financial and other tools to make sustainable development.

Introduction



2003

The impact of the transportation energy consumption would be different **with different compactness**. And the impact would be different because the city has different the public transportation, land use zoning, infrastructure and so on. (Yeh kuang-yi, et al., 2003)

Energy Shortage

Urban Planning

Reduce Energy Consumption

Question :

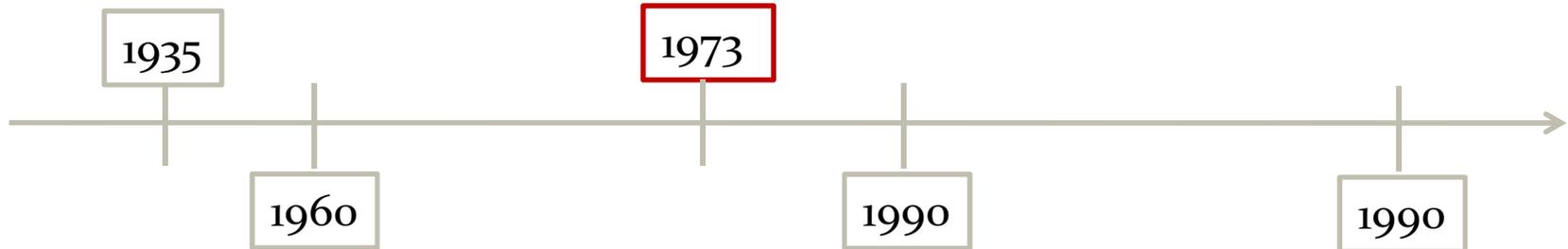
1. **What kind of urban forms** in order to reduce energy consumption to achieve sustainable development?
2. **How compact** dose it achieve to reduce transportation energy consumption and optimal urban development?

Development of Compact City



Le Corbusier proposed that enhanced the **urban density to solve the congestion.**

The compact city appears clearly most early by George Dantzig and Thomas L. the Saaty. These two mathematicians proposed about the spatial form ,spatial characteristic and **the function indicators of the compact city** in 1973.



Jane Jacobs positioned to maintain the **urban vigor and the urban multiplicity by the high density development.**

British policy guiding plan and so on research induced the **concept of the compact city** gradually.

Lots of search about **advantage and disadvantage** of Compact City.

Definition of Compact City

| Scholar | Year | Definition |
|----------------|------|---|
| Williams | 1999 | The compact city paradigm is based on concepts of efficient land use and urban containment, but includes alongside this a number of goals and parameters. |
| Jenks ,Burgess | 2001 | He believes that the spatial characteristics should be moving in a dense continuous improvement caused by economic development, in order to achieve economic, environmental and social sustainability. |
| Burton | 2002 | He pointed out the compact city was usually described as one or other or all of three types of city, two that are related to 'product': 1. the high-density city, 2. the mixed-use city, 3. the intensified city, it is related to process. |

Methodology

- This research uses **Curve Estimation** analysis, carries on the examination in view of the urban form to influence of the energy use.

Calculates various cities energy use and compactness.



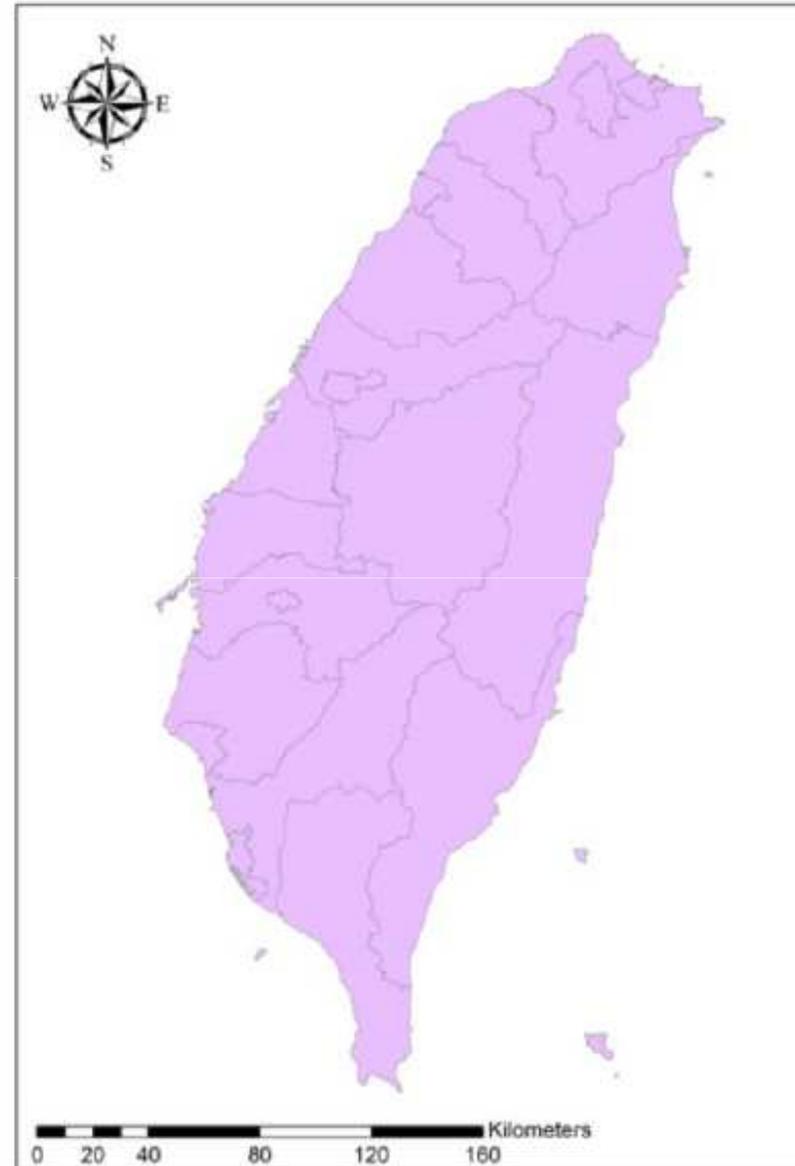
The compactness of various cities will divide into two groups, a group for the high compactness city, and a group for the low compactness city.



Analyze the energy consumption impact belong to urban compactness and urban form.

Study Area

- Taiwan is located in the Southwest part of the island, an average density of 547.79 persons/km, and total area is approximately 2016 km².
- The study areas are 22 cities in Taiwan.



Variables and Indicators

| Dimension | Variable | Indicator |
|-------------|--------------------------------------|--|
| Compactness | Density | <ul style="list-style-type: none"> •Population per hectare •Develop household of number the land per hectare |
| | Mix Use | <ul style="list-style-type: none"> •The proportion of Housing and non-housing •Entropy •Retail trade number per hectare |
| Energy | Energy Consumption | <ul style="list-style-type: none"> •Average each gasoline and diesel oil consumption |
| Urban Form | Urban Service Function | <ul style="list-style-type: none"> •Industry and commerce factory number |
| | Development Degree of Transportation | <ul style="list-style-type: none"> •The utilization ratio of Transportation |
| | Information circulation | <ul style="list-style-type: none"> •The Rate of Internet Surfer |
| | Knowledge education level | <ul style="list-style-type: none"> •Above 15 years old of education level structure - technical college population and above |

Compactness of Taiwan Cities Development

- There are twenty-two cities in Taiwan. The urban compactness and the average energy per person consumption, as we can see in Figure.2 and Figure.3.
- By Figure.2, the higher compactness cities mainly distributes in the north and south two main cities.

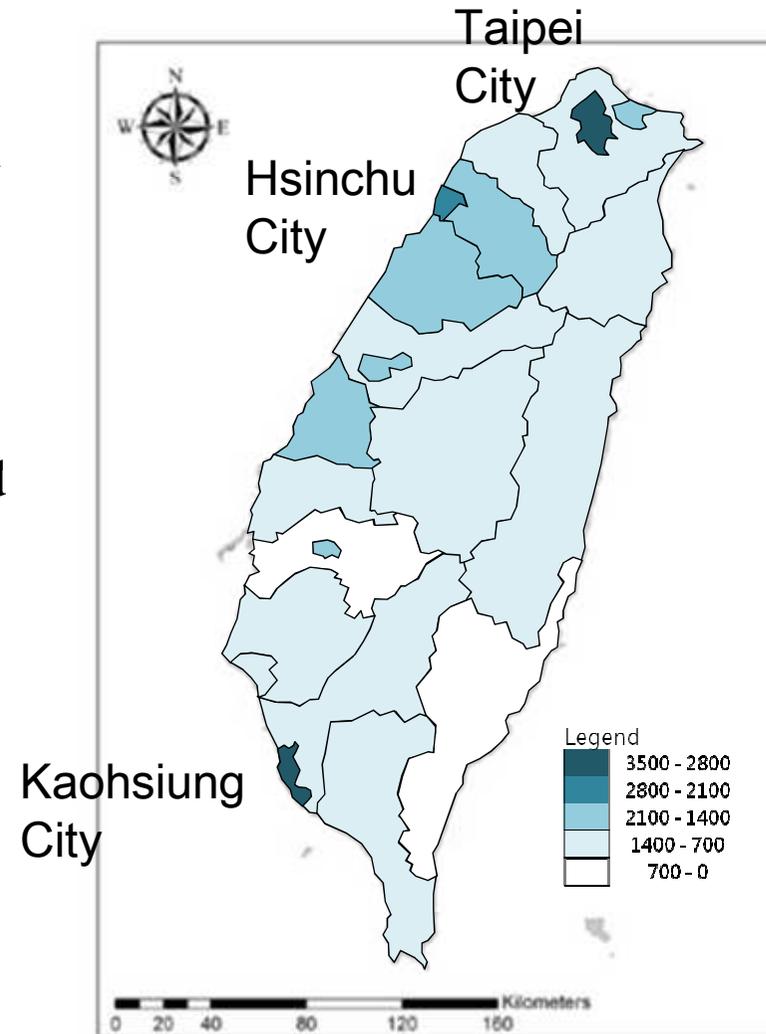


Fig.2. Urban Compactness in Taiwan

Energy Consumption of Taiwan Cities Development

- By Figure.3, the higher energy consumption cities mainly distributes in the north and south two main cities. But it is not the same cities with the higher compactness cities in Figure.2.
- To compare these two figures, it appears that the higher compactness cities in Figure.2 instead is the average each person of energy use is lowest in Figure.3.

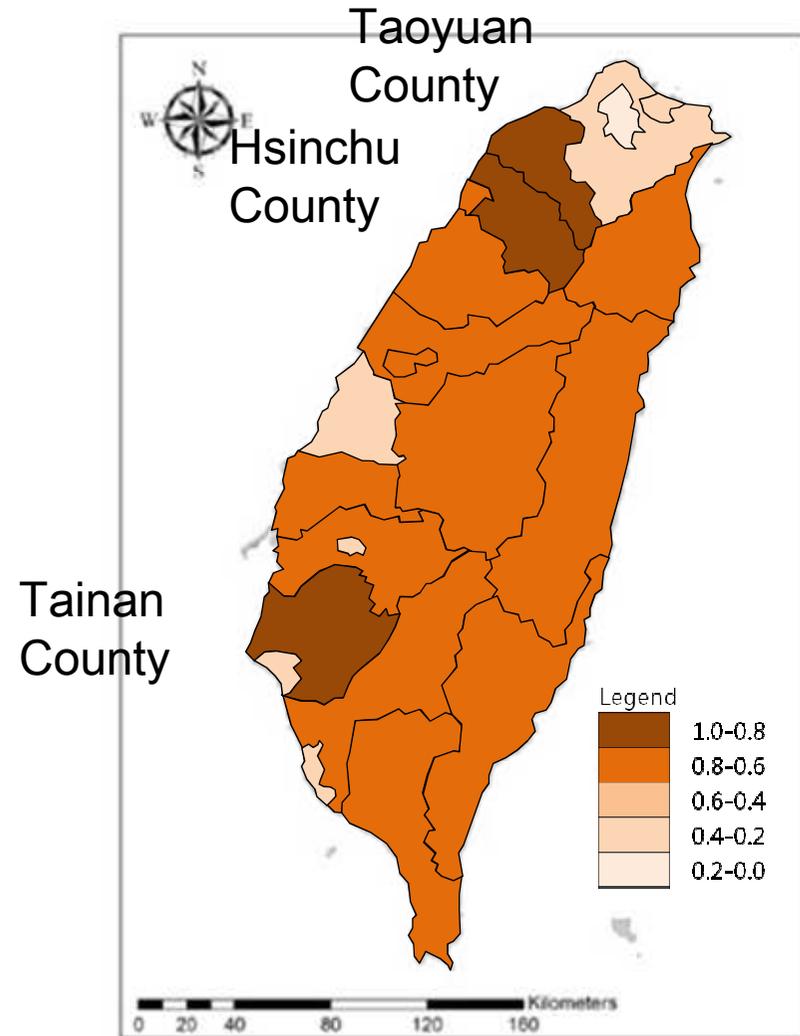
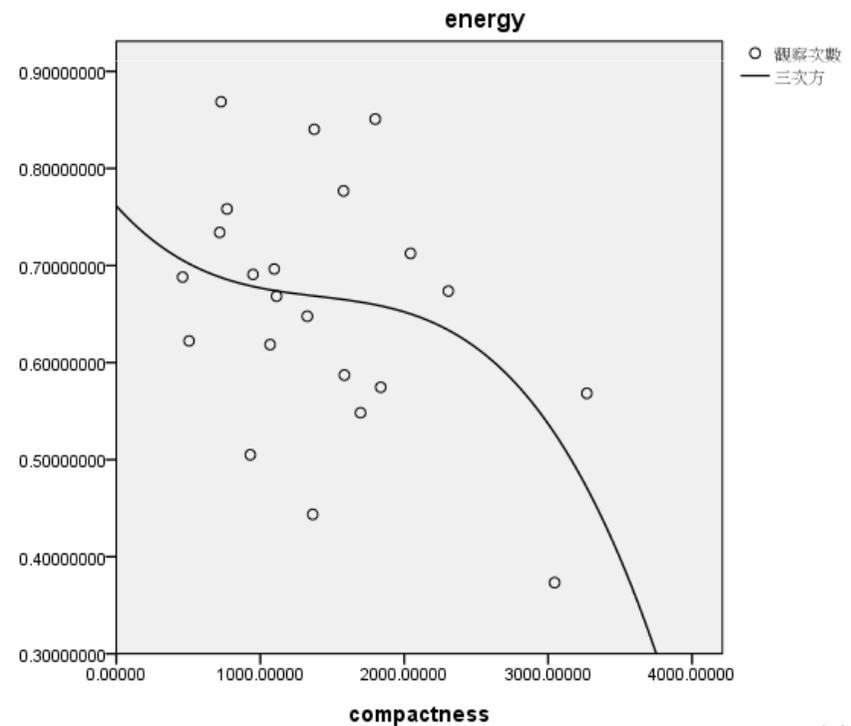
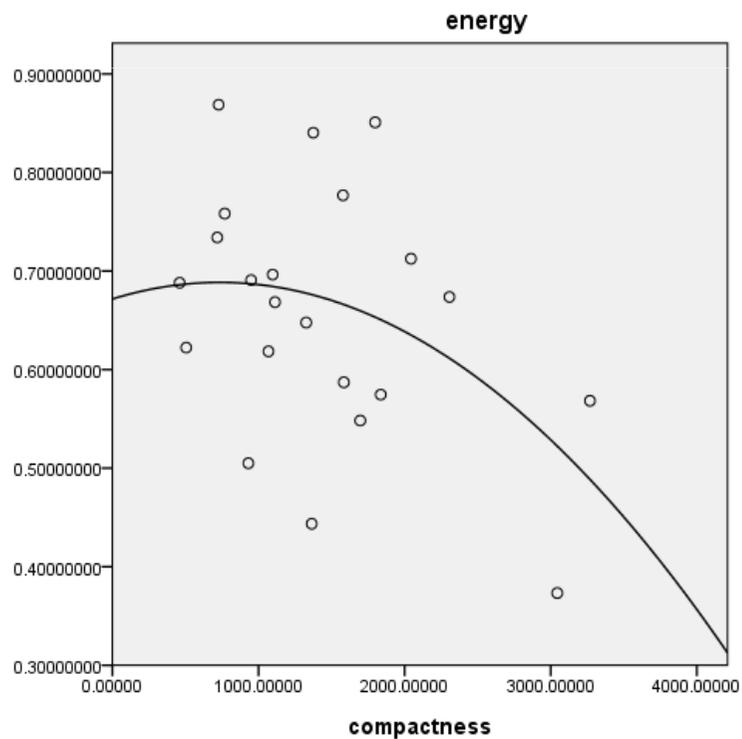


Fig.3. Average Energy per person Consumption in Taiwan

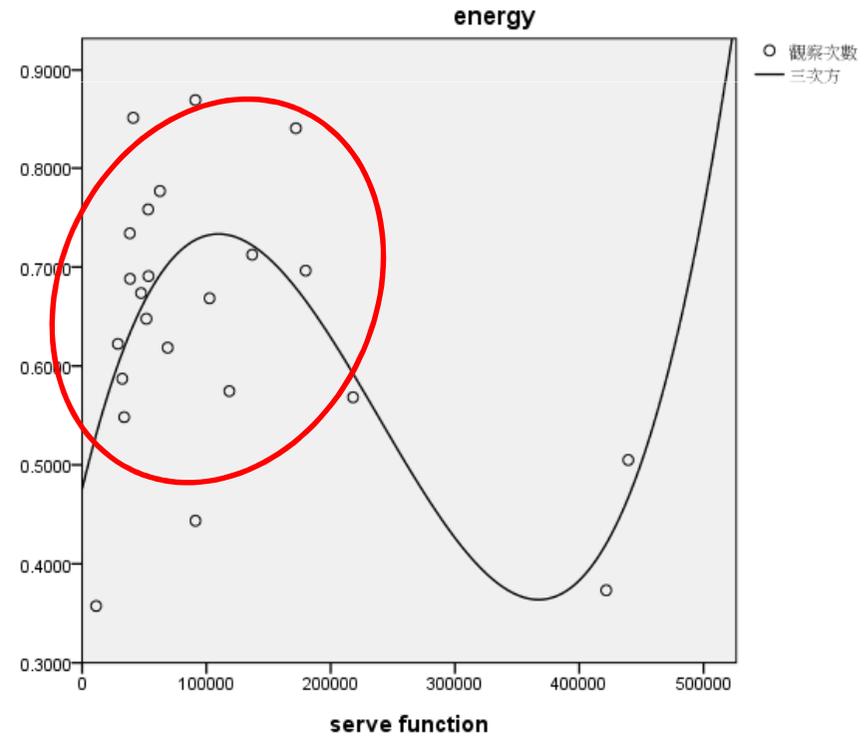
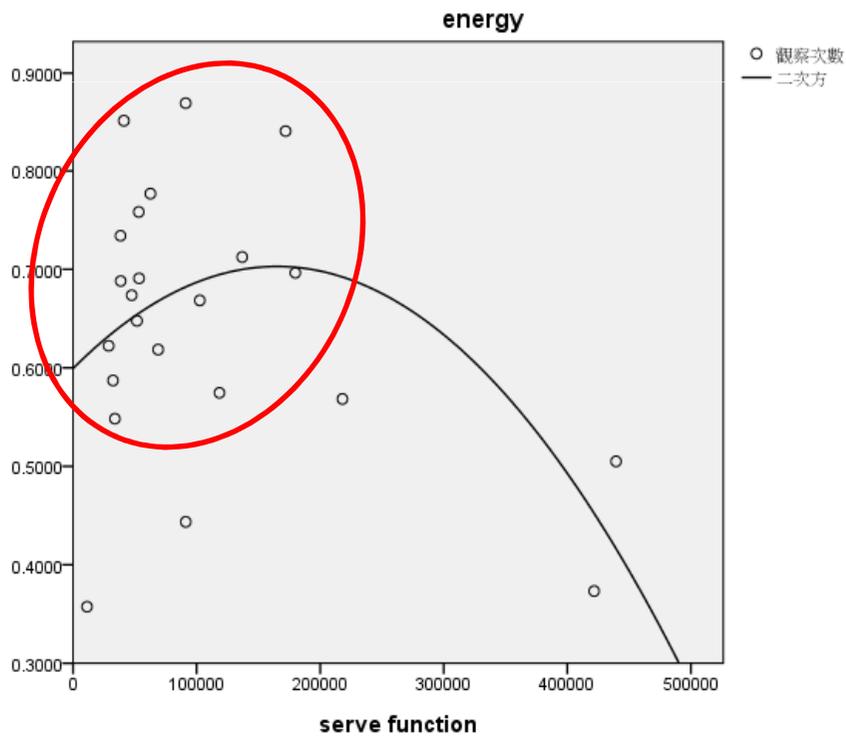
Compactness vs. Energy Consumption

| Equation | Model Summary | | | | | Parameter Estimate | | | |
|-----------|---------------|-------|-----|-----|------|--------------------|------|------|------|
| | R Square | F | df1 | df2 | Sig | Constant | b1 | b2 | b3 |
| Quadratic | .176 | 2.023 | 2 | 19 | .160 | .672 | .000 | .000 | |
| Cubic | .183 | 1.340 | 3 | 18 | .293 | .761 | .000 | .000 | .000 |



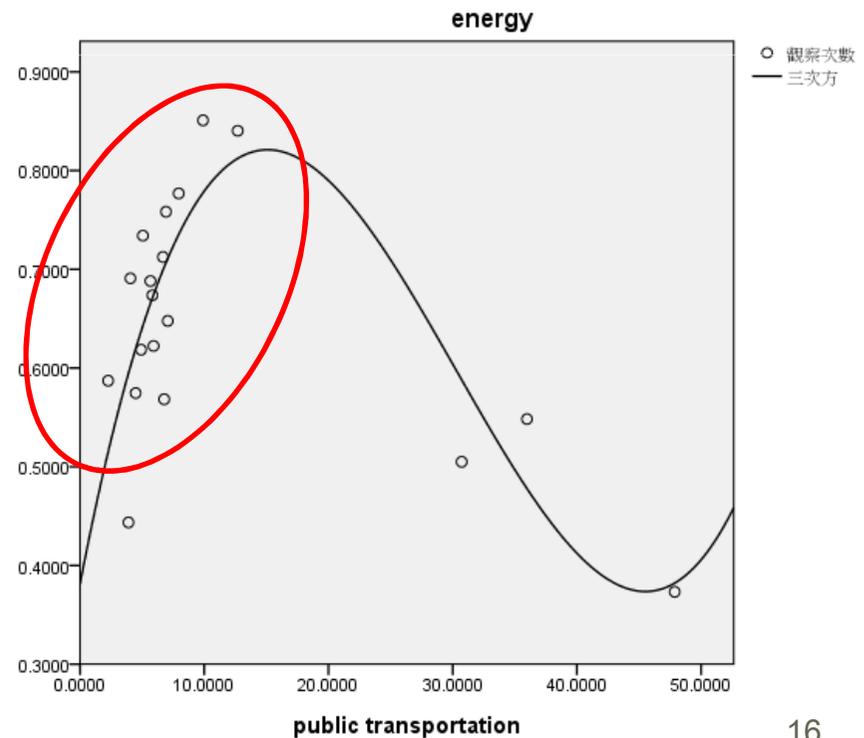
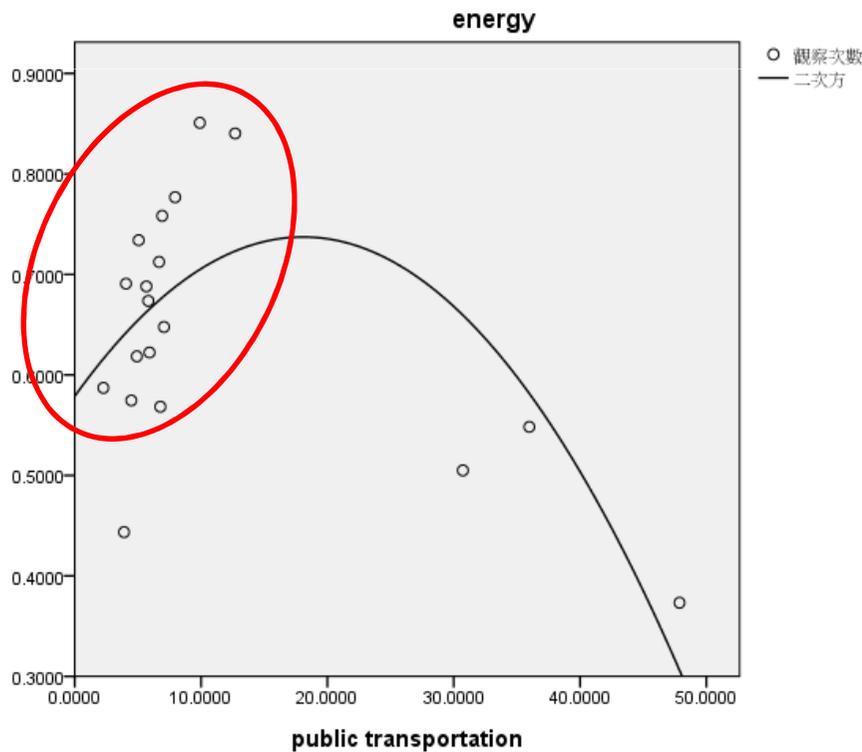
Urban Service Function vs. Energy Consumption

| Equation | Model Summary | | | | | Parameter Estimate | | | |
|-----------|---------------|-------|-----|-----|------|--------------------|------|------|------|
| | R Square | F | df1 | df2 | Sig | Constant | b1 | b2 | b3 |
| Quadratic | .262 | 3.554 | 2 | 20 | .048 | .599 | .000 | .000 | |
| Cubic | .345 | 3.339 | 3 | 19 | .041 | .476 | .000 | .000 | .000 |



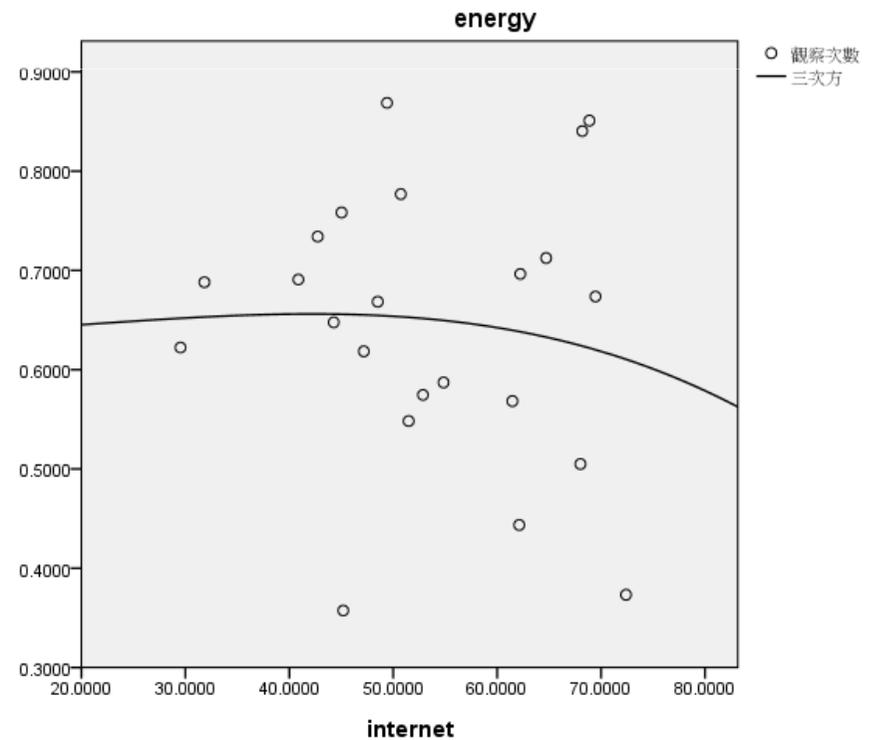
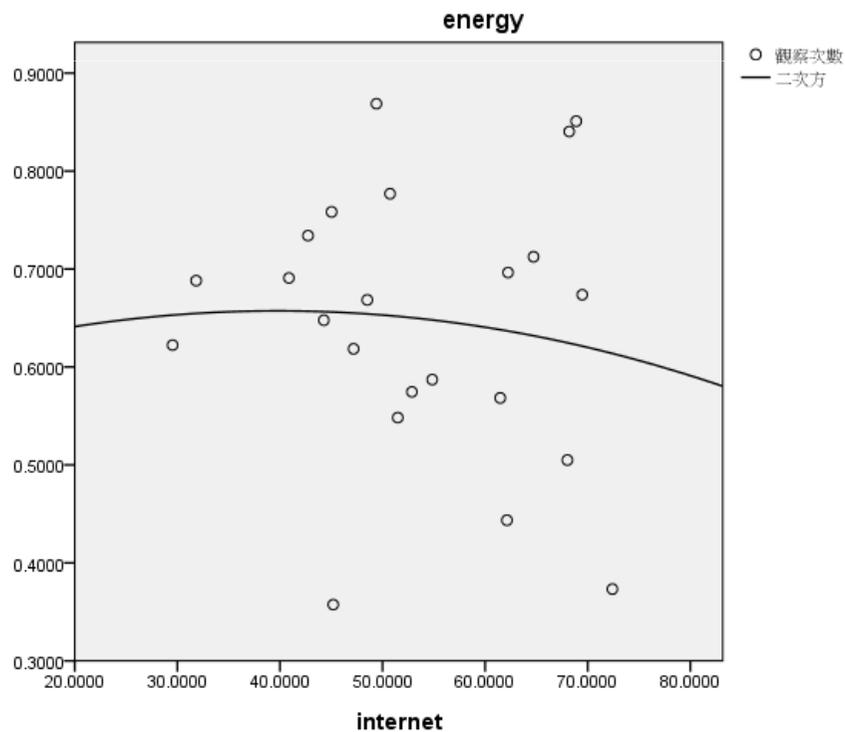
Development Degree of Transportation vs. Energy Consumption

| Equation | Model Summary | | | | | Parameter Estimate | | | |
|-----------|---------------|--------|-----|-----|------|--------------------|------|-------|------|
| | R Square | F | df1 | df2 | Sig | Constant | b1 | b2 | b3 |
| Quadratic | .476 | 7.281 | 2 | 16 | .006 | .579 | .018 | .000 | |
| Cubic | .670 | 10.167 | 3 | 15 | .001 | .381 | .066 | -.003 | .000 |



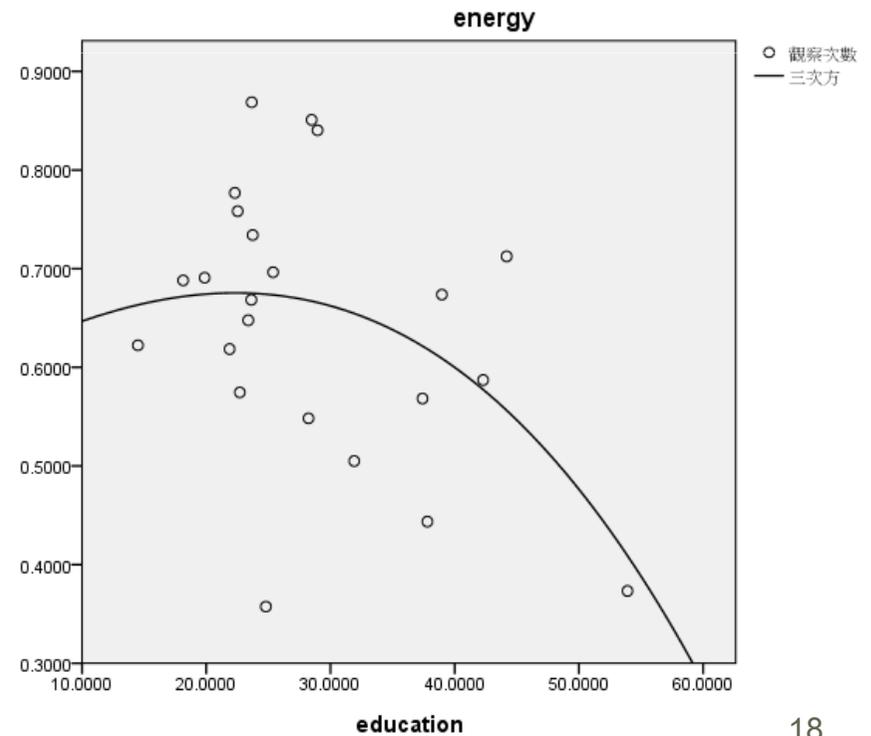
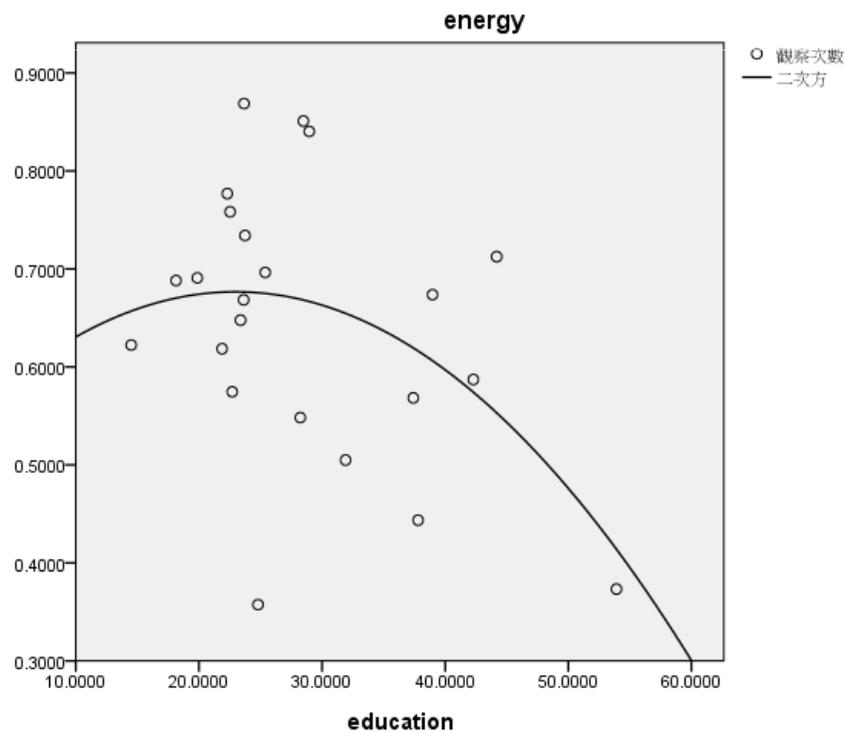
Information circulation vs. Energy Consumption

| Equation | Model Summary | | | | | Parameter Estimate | | | |
|-----------|---------------|------|-----|-----|------|--------------------|------|------|------|
| | R Square | F | df1 | df2 | Sig | Constant | b1 | b2 | b3 |
| Quadratic | .010 | .106 | 2 | 20 | .900 | .593 | .003 | .000 | |
| Cubic | .011 | .111 | 2 | 20 | .895 | .636 | .000 | .000 | .000 |



Knowledge Education Level vs. Energy Consumption

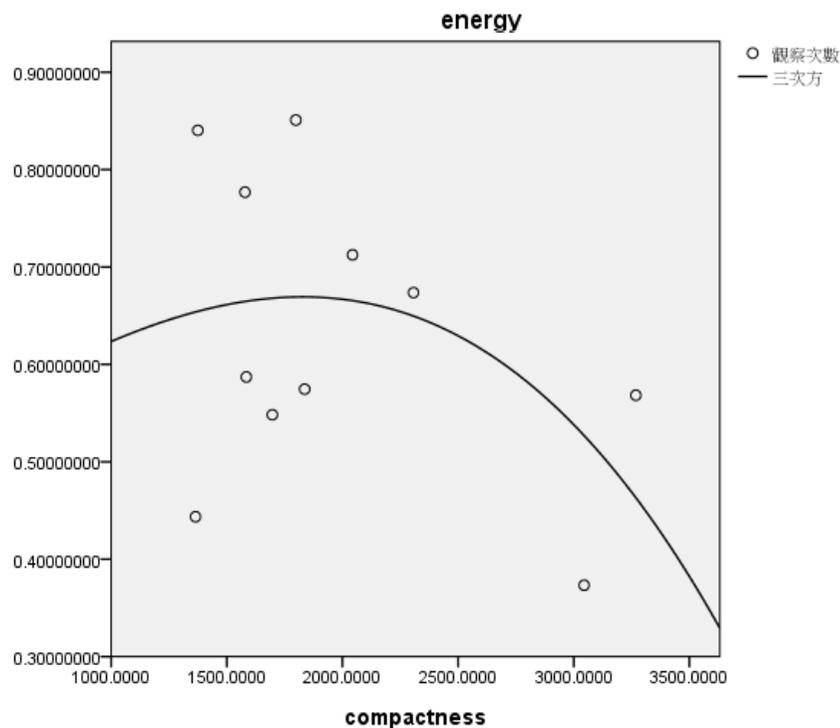
| Equation | Model Summary | | | | | Parameter Estimate | | | |
|-----------|---------------|-------|-----|-----|------|--------------------|------|------|------|
| | R Square | F | df1 | df2 | Sig | Constant | b1 | b2 | b3 |
| Quadratic | .196 | 2.439 | 2 | 20 | .113 | .532 | .013 | .000 | |
| Cubic | .196 | 1.547 | 3 | 19 | .235 | .591 | .007 | .000 | .000 |



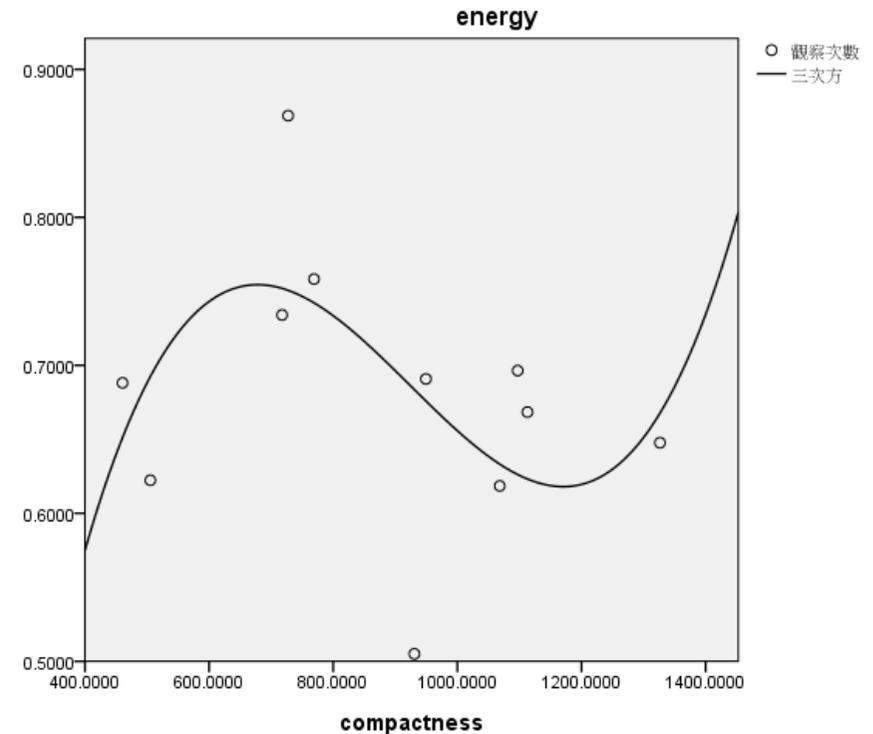
Compactness vs. Energy Consumption

| | Equation | Model Summary | | | | | Parameter Estimate | | | |
|--------|----------|---------------|-------|-----|-----|-------------|--------------------|------|------|------|
| | | R Square | F | df1 | df2 | Sig | Constant | b1 | b2 | b3 |
| Higher | Cubic | .201 | 1.008 | 2 | 8 | .407 | .494 | .000 | .000 | .000 |
| Lower | Cubic | .280 | .906 | 3 | 7 | .485 | -.733 | .005 | .000 | .000 |

Higher Compactness of Cities
vs. Energy Consumption



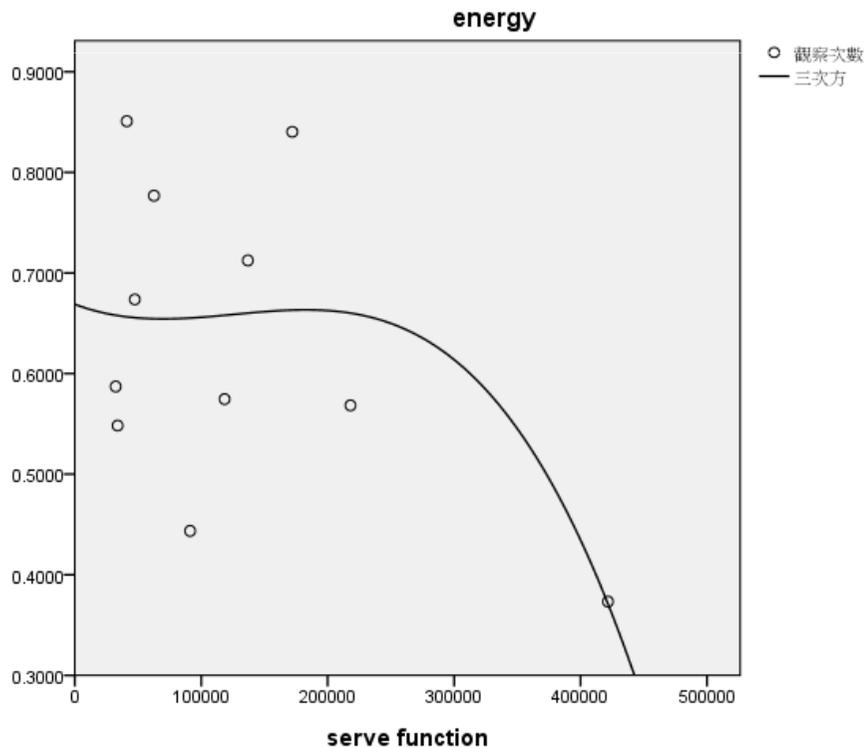
Lower Compactness of Cities
vs. Energy Consumption



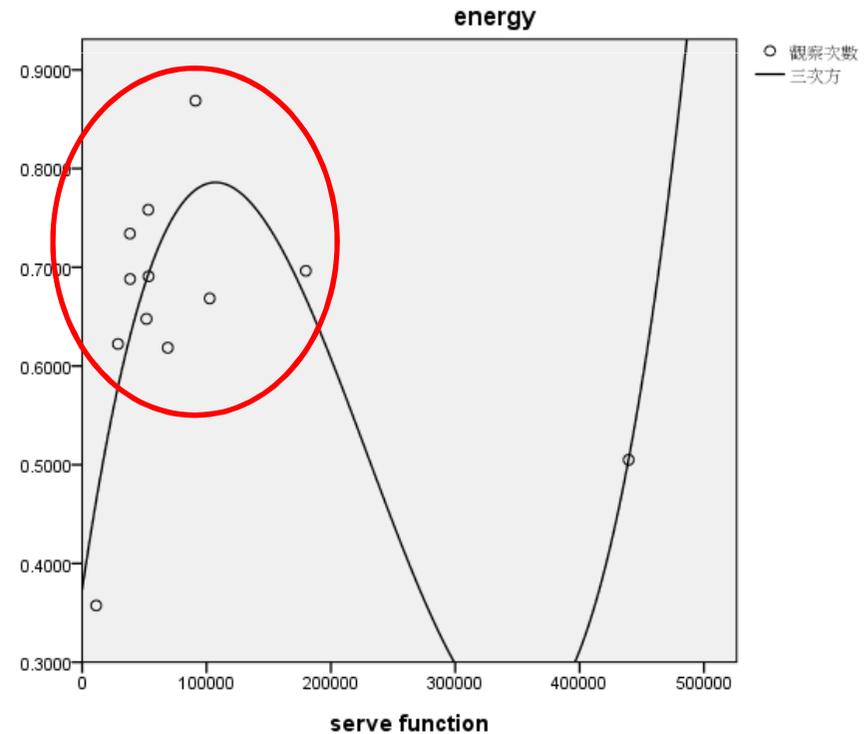
Urban Service Function vs. Energy Consumption

| | Equation | Model Summary | | | | | Parameter Estimate | | | |
|--------|----------|---------------|-------|-----|-----|------|--------------------|------|------|------|
| | | R Square | F | df1 | df2 | Sig | Constant | b1 | b2 | b3 |
| Higher | Cubic | .313 | 1.063 | 3 | 7 | .424 | .669 | .000 | .000 | .000 |
| Lower | Cubic | .607 | 4.125 | 3 | 8 | .048 | .374 | .000 | .000 | .000 |

Higher Compactness of Cities



Lower Compactness of Cities

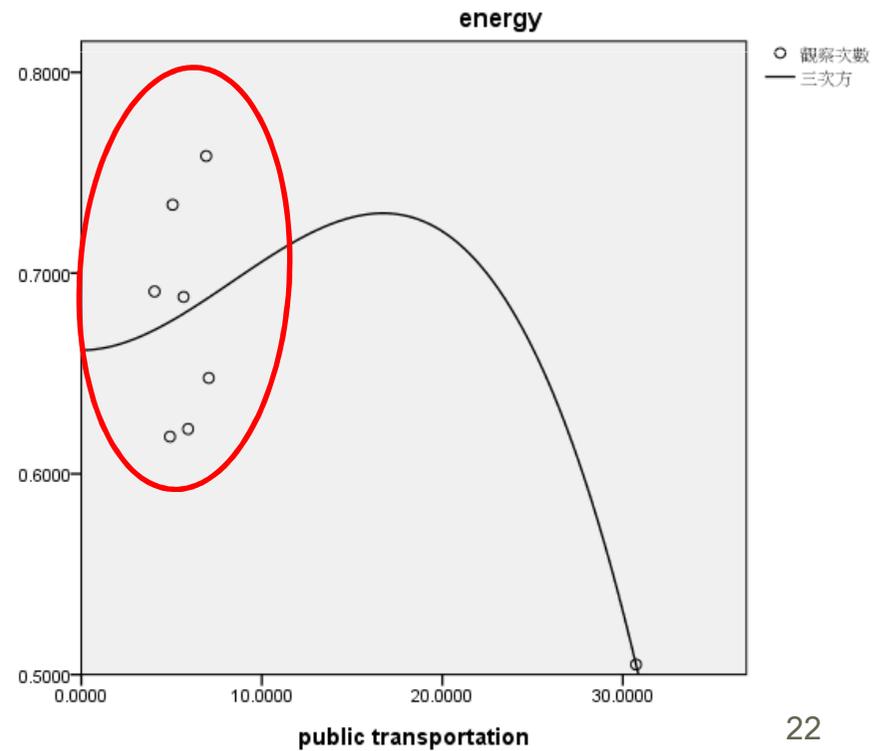
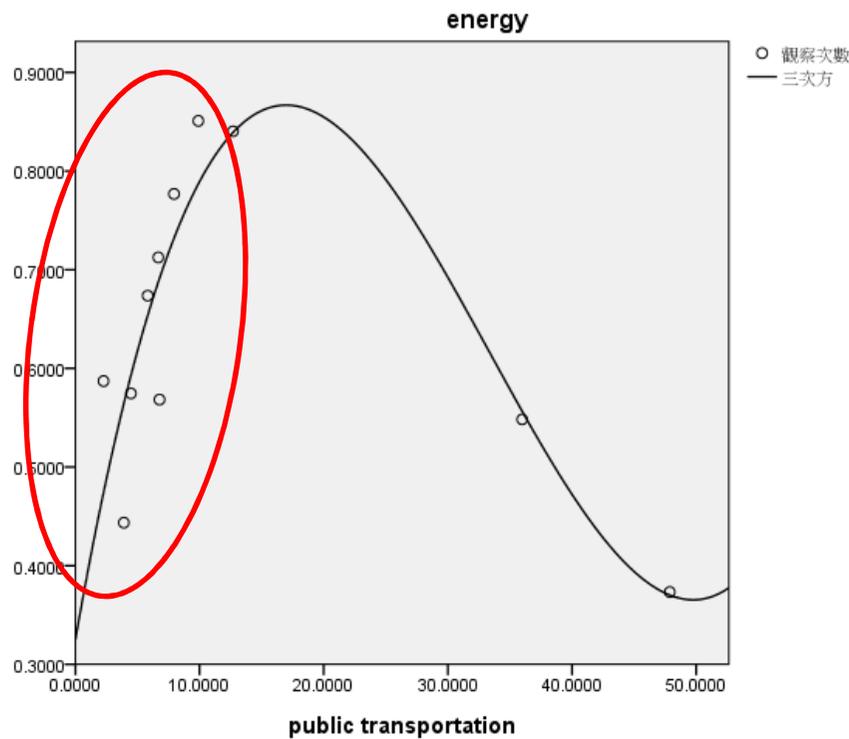


Development Degree of Transportation vs. Energy Consumption

| | Equation | Model Summary | | | | | Parameter Estimate | | | |
|--------|----------|---------------|-------|-----|-----|------|--------------------|------|-------|------|
| | | R Square | F | df1 | df2 | Sig | Constant | b1 | b2 | b3 |
| Higher | Cubic | .791 | 8.809 | 3 | 7 | .009 | .325 | .072 | -.003 | .000 |
| Lower | Cubic | .611 | 3.926 | 2 | 5 | .094 | .662 | .000 | .001 | .000 |

Higher Compactness of Cities

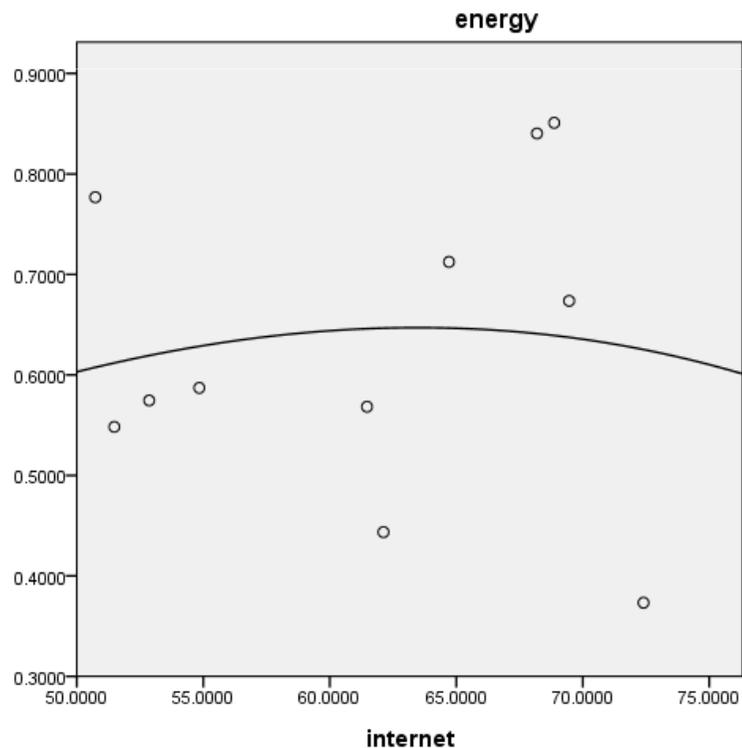
Lower Compactness of Cities



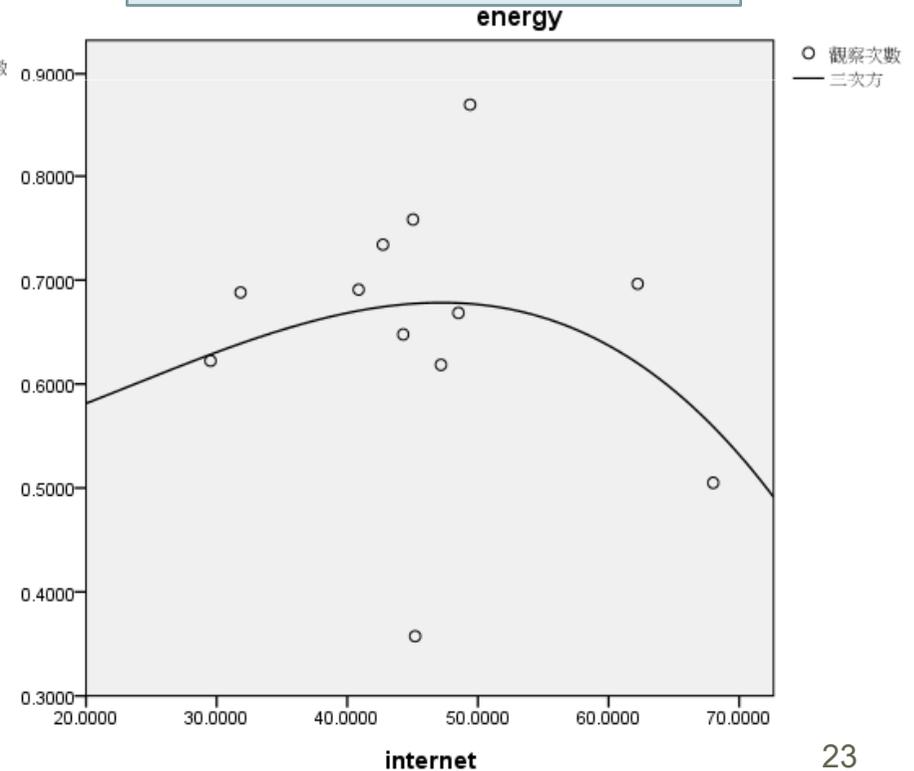
Information circulation vs. Energy Consumption

| | Equation | Model Summary | | | | | Parameter Estimate | | | |
|--------|----------|---------------|------|-----|-----|------|--------------------|------|------|------|
| | | R Square | F | df1 | df2 | Sig | Constant | b1 | b2 | b3 |
| Higher | Cubic | .008 | .034 | 2 | 8 | .967 | -.054 | .017 | .000 | .000 |
| Lower | Cubic | .083 | .409 | 2 | 9 | .676 | .520 | .000 | .000 | .000 |

Higher Compactness of Cities



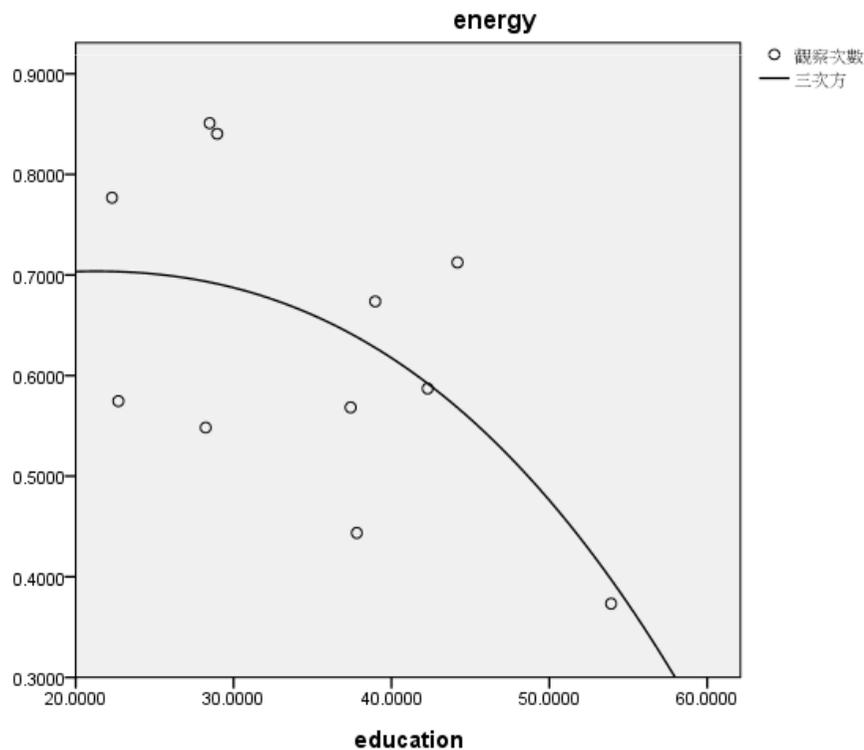
Lower Compactness of Cities



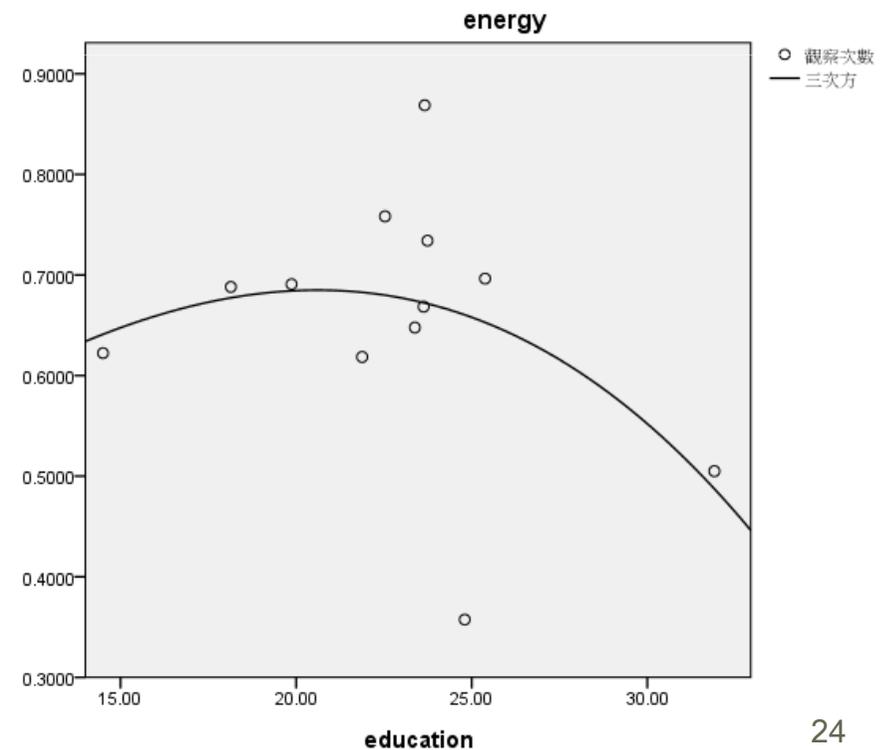
Knowledge Education Level vs. Energy Consumption

| | Equation | Model Summary | | | | | Parameter Estimate | | | |
|--------|----------|---------------|-------|-----|-----|------|--------------------|------|------|------|
| | | R Square | F | df1 | df2 | Sig | Constant | b1 | b2 | b3 |
| Higher | Cubic | .343 | 2.089 | 2 | 8 | .186 | .646 | .004 | .000 | .000 |
| Lower | Cubic | .179 | .982 | 2 | 9 | .411 | .315 | .027 | .000 | .000 |

Higher Compactness of Cities



Lower Compactness of Cities



Conclusion

- According to the above result and the analysis, it may understand that the **different urban form truly would affect the energy use**. But **in different compactness situation, it also will have the different influence energy consumption**. In order to achieve sustainable development, it should probably consider the **more urban variable** in the future.
- Transportation is one of the major energy consumption department. Many experts advocate to use alternative energy. However, this research prove that **various urban form and compactness would consume different energy**. Therefore, when urban planner will make the urban planning, they should consider the energy consumption impact of the urban form and compactness. Then the city can achieve the sustainable development.



Q & A

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