附件一

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近都市化與區域不均度

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中文摘要

關鍵詞：普瑞夫定理、吉伯特定理、冪次法則指數

都市的發展與成長會刺激經濟成長，國家或地區內的都市間的外在環境不同，成長的速度也不同，造成都市間的大小分配隨著都市的成長而逐漸改變。實證資料顯示，不同的經濟與社會體系中，都市的分配都傾向於接近一個一致的特性，稱之為普瑞夫定理（Zipf law)。這個特性是，都市大小的分配以冪次法則(power law)來衡量時，其冪次法則指數(power law exponent)會接近於一。吉伯特定理(Gibrat's law)能夠完整而有系統的解釋這個特性(Gabaix 1999)。吉伯特定理的主要概念是，區域內的一組隨機成長的都市，只要各都市的人口成長率的分配，有著同樣的平均數與變異數，就會導致符合普瑞夫定理的極限分配。普瑞夫定理中的冪次法則指數(power law exponent)，是城市分配的集中與分散程度的指標。冪次法則指數的估計方法有兩種：最小平方法與 Hill 估計式(Gabaix and Ioannides, 2003; Dobkins and Ioannides, 2000; Black and Henderson, 2003)。Henderson(2002)曾估計吉伯特定理，得到顯著的 mean reversion coefficient。Davis and Weinstein(2002)和 Brakman et al.(2002)在相同的迴歸式中得到誤差的正相關。

相關研究證實，都市化的程度與所得水準的關係是正向的(Fay and Opal,2000; Jones and Kone, 1996; Lemelin and Polese, 1995; Tolley and Thomas, 1987) ；也有文獻顯示，生產力與城市中經濟活動的聚集有正向的關係，此結果說明了聚集經濟的外部性(agglomeration economies externalities) (Ciccone and Hall, 1996;Glaeser, 1994, 1998; Henderson, 1988, 2003; Krugman, 1991; Rauch, 1993; Quigley, 1998)。實證資料發現，愈大的城市，生產力愈強，所得水準也愈高，但是城市的大小與所得成長的關係還尚未確定。Jane Jacobs(1969)最早提出城市是經濟成長的來源這樣的概念。Fay and Opal(2000)研究發現都市化程度無法預測經濟成長，都市化與經濟成長的相關性與因果關係未定論。Black and Henderson(1999)以內生經濟成長模型，探討都市化程度如何影響經濟成長的效率，以及經濟成長如何影響都市化的模式。研究發現，經濟成長會使都市擴大，城市的數目增加。Mario Polese(2005)嘗試探討都市與經濟成長的關係，研究結果無法證實城市會促進經濟成長，尚無文獻發現都市化程

度與所得的成長有顯著的相關性。

Simon Kuznets 提出 Kuznets 假設，隨著所得水準的增加，所得不均度(inequality)先遞增再遞減，呈現出倒 U 型的關係。Deininger and Squire(1996)發現，所得分配的不均程度，與其後續的所得水準呈負向的關係。Perotti(1996)的研究，以橫斷面資料（cross sectional）分析，結果發現所得分配的不平均會阻礙經濟的成長。然而最近其他以 panel 資料分析的研究，結果卻是相反的，發現所得不均程度與經濟成長呈正相關。Panizza (2002)用美國的 panel data 分析，研究結果為所得分配的不均程度與經濟成長的關係是不確定的，所得分配不均度的衡量方式對結果的影響很大。

本研究擬分析台灣的都市分佈特徵、都市化對經濟成長與所得分配的影響。研究結果顯示台灣所得分配的不均程度與經濟成長的關係與文獻結果一致是不確定的；都市化與經濟成長的關係與相關研究結果一致呈顯著的正相關，即都市化的程度與所得水準的關係是正向的；所得分配的不均程度與經濟成長的關係與相關研究結果一致是不確定的。台灣都市的分佈特性符合吉伯特定理。

Abstract

Keywords: Urbanization, Gibrat’s law, The rank size model, Income inequality

The underlying forces why economic activity agglomerates into cities makes cities the engines of economic growth in an economy (Lucas 1988). Black and Henderson (1999) find that urban institutions could lead to efficient growth with the internalization of local knowledge spillovers theoretically. Thus, urbanization strongly influences the growth process as well as income inequality. The rank size model (Zipf 1949), which has been widely applied in urban hierarchy analysis (Krakover, 1998; Guerin-Pace, 1995), provides a benchmark for the measurement of primacy; the estimated parameter indicates the concentration level. This paper empirically studies the relation of urbanization and economic growth, and investigates the properties of cities distribution and urban evolution in Taiwan to analyze the links among urbanization, economic growth, and regional inequality.

The estimated result shows that the level of urbanization is increased in Taiwan. Increased urbanization is significantly correlated to economic growth. Mean and variance of population growth rate have no significant relation with corresponding population share. These results are consistent with Gibrat’s law. There is no significant correlation between per capita income and income inequality. Population distribution and income distribution do not have significant relation. The link between urbanization with incomes is less clear. The positive relationship between urbanization level (cities) and per capita incomes (economic development) is consistent with other studies.

1. Introduction

Recent observation indicates that three sorts of places make up the modern economic landscape. First are the a few cities in a few countries that generate innovations. These are the tallest peaks. Second are the economic “hills”; places that manufacture the world’s established goods and support its innovation engines. Finally there are the vast valleys, places with little connection to the global economy (Florida, 2005). Globalization has reinforced the gain from innovation which exacerbates disparities of wealth and economic production worldwide. Is regional inequality a necessary price for economic growth? What is the relation between urbanization and regional inequality?

The underlying forces why economic activity agglomerates into cities makes cities the engines of economic growth in an economy (Lucas 1988). Blace and Henderson (2002) estimate an equation for Gibrat’s law, that is for the city growth rate as a function of lagged size, which yields a statitstically significant estimate for the mean reversion coefficients. The studies of Davis and Weinstein (2002), Brakman *et al.* (2002) estimate generally positive autocorrelation for the error in such a regression. Blace and Henderson find that cities in warmer, drier and coastal locations do grow faster, and that regional dummies have little additional impacts. Empirical studies on the determinants of urban growth in a non-U.S. contexts deserve serious attention.

Stripped of the constraints of geography itself, New Economic Geography implies that de-agglomeration (or de-urbanization) is efficient. Anas (2004) finds that falling interurban trading costs favor this de-urbanization process; and only if intraurban commuting costs fall sufficiently, can a pattern of growing city sizes be efficient with growing population. Henderson (2003) investigates the impact of the degree of urban concentration on economic growth, with too much or too little urban concentration having a relatively negative impact on growth. This relationship changes with levels of concentration: first rising and then falling with the level of development.

Bertinelli and Black (2004) explore how the trade-off between optimal and equilibrium cith size behaves when introducing dynamic human capital externalities in addition to the classical

congestion externalities. They show that there are dynamic gains from statically oversized cities; myopic policies designed to reduce the degree of over-urbanization by limiting urbanization will tend to have an adverse impact on economic growth. They assume that productivity depends on human capital, which is solely accumulated in cities, such that urbanization is the engine of growth.

Gibrat's law is the theory that has been advanced to explain the constancy of the city size distribution across various economic and social systems. The idea is that if different cities grow randomly with the same expected growth rate and the same variance, them the limit distribution of city sizes converges to Zipf's law. There are two statistical methods introduced to measure power law exponents: the OLS estimates and Hill (Maximum Likelihood) estimator (Gabaix and Ioannides, 2003; Dobkins and Ioannides, 2000; Black and Henderson, 2003).

The positive relationship between urbanization level (cities) and per capita incomes (economic development) is overwhelming. (Fay and Opal,2000; Jones and Kone, 1996; Lemelin and Polese, 1995; Tolley and Thomas, 1987) Others have demonstrated the positive link between productivity and the agglomeration of economic activity in cities (Ciccone and Hall, 1996;Glaeser, 1994, 1998; Henderson, 1988, 2003; Krugman, 1991; Rauch, 1993; Quigley, 1998). In sum, bigger cities mean higher productivity and higher per capita income. However, the link between urbanization with growth in incomes is less clear.

Mario Polese (2005) proposes a review of the link between cities and economic growth, and attempt to show that cities cause economic growth is inclusive. No significant relationship is observable between urbanization levels and subsequent growth in GDP per capita. He finds that it is difficult to imagine sustained economic growth without cities, but cities are not a sufficient condition to generate long-term economic growth. Fay and Opal (2000) find that urbanization levels are poor predictors of growth. The direction of causation lies at the heart of the debate. The idea that cities are sources of economic growth has gained ground in recent years. The pioneer view point of this idea is from Jane Jacobs (1969, 1984). It is difficult to test the relationship between agglomeration and economic growth, part of the problem stems from the difficulty of distinguishing factors that allow cities to capture a greater share of national economic growth

from those that allow cities to add to national economic growth.

Black and Henderson (1999) explore how urbanization affects efficiency of the growth process and how growth affects patterns of urbanization in an economy experiencing endogenous economic growth and exogenous population growth. They find individual city sizes grow with local human capital accumulation and knowledge spillovers; and city numbers generally increase, which is consistent with empirical evidence. They explore how growth involves real income differences across city types and comment on the effect of urbanization on income inequality.

The Kuznets hypothesis, first formulated by Simon Kuznets, suggests that, at low levels of per capita income, inequality increases with rising per capita income and decreases only in the later stages of development--resulting in an inverted U-shaped relationship between per capita income and income inequality. Recent research has also identified a negative relationship between initial inequality and subsequent growth (Deininger and Squire, 1996). This would suggest that even when inequality has worsened; its negative effect on the poor has been more than outweighed by the positive effect of growth.

Recent research suggests that an unequal distribution of income can hamper growth. Cross-country studies found a negative relationship between inequality and growth (Perotti, 1996); however, recent work showed that panel estimations yield a positive relationship between inequality and growth (Li and Zou, 1998; Forbes, 2000) Panizza (2002) denotes that the relationship between inequality and economic growth is not robust and small differences in the method used to measure inequality can result in large differences in the estimated relationship between inequality and growth by panel estimations based on US data.

The purpose of this study is to empirically investigate the properties of the cities distribution and urban evolution in Taiwan, to test Gibrat's law and estimate the power law exponent; examine the evolution of urban distributions and to analyze the relationship of urbanization, income distribution and economic growth in Taiwan.

2. Data and Methods

The data used in this study is the county data in Taiwan from 1998 to 2005. There are 23

counties in Taiwan. Population is from The Ministry of Interior, Executive Yuan, Taiwan; and Per Capita Disposable Income is from Directorate General of Budget, Accounting and Statistics, Executive Yuan, Taiwan.

The form of the size distribution of cities takes the following Pareto distribution:

$$\log y = \log A - \alpha \log x$$

where x is population(or income), y is rank of population(or income).

The Expanded Zipf's Law:

$$\log y = (\log A)' + \alpha' \log x + \beta' (\log x)^2$$

Two estimation methods are used in this paper to estimate Pareto exponent: OLS and the Hill (1975) method.

Hill(1975) estimator:

$$\hat{\alpha} = \frac{n-1}{\sum_{i=1}^{n-1} (\ln x_i - \ln x_n)}$$

where for a sample of n cities with sizes $x_1 \geq \cdots \geq x_n$.

There are other two index used to measure the level of inequality: covariance (CV) and Theil entropy measure.

$$CV = \frac{\mathrm{cov}(x, y)}{\sigma_x \sigma_y}$$

Theil entropy measure

$$T = \sum_{i=1}^{n} w_i \log n w_i \quad , \quad w_i = \frac{x_i}{\sum_{i=1}^{n} x_i}$$

where n is total number of regions.

3. Results

Table 1 presents measures of the level of inequality of county population in Taiwan. There

are Pareto exponent (α), Pareto exponent of the expended Zipf's Law (α'), Covariance (C.V.), Theil entropy measure (T), and Hill estimator ($\hat{\alpha}$). Estimated Pareto exponents are less than one, they are decreasing. Diminishing Pareto exponents indicate population in Taiwan is less evenly distributed, the variation among cities' population is increased. Covariance and Theil entropy measure also shows consistent trend of increasing variation among cities. Estimated result shows level of urbanization is increased in Taiwan.

Table 2 presents measures of the level of inequality of per capita income in Taiwan. The trend of Pareto exponents and Covariance are not consistent.

Figure 1 presents the mean of population growth rate versus corresponding population share. It does not shows significant correlation between mean growth rate and corresponding population. Furthermore, Figure 2 presents the variance of population growth rate versus corresponding population share. Similar to the result of mean growth rate, there is no significant correlation between the variance of growth rate and corresponding population. These results are consistent with Gibrat's law.

Correlation coefficient and regressions result show significantly negative correlation between per capita income and Pareto exponent of population. This result indicates that increased urbanization is significantly correlated to economic growth in Taiwan. There is no significant relation between per capita income and income inequality. Similarly, population distribution and income distribution do not have significant relation. The link between urbanization with incomes is less clear. The positive relationship between urbanization level (cities) and per capita incomes (economic development) is consistent with other studies.

Table 1

Measures of inequality level of population of counties in Taiwan

Year	OLS							Hill
	α	logA	R^2	α'	β'	C.V.	T	$\hat{\alpha}$
1998	0.907**	14.451**	0.837	7.858**	-0.328**	-0.915	0.125	0.466
1999	0.904**	14.410**	0.838	7.802**	-0.326**	-0.916	0.126	0.463
2000	0.902**	14.384**	0.840	7.756**	-0.324**	-0.917	0.127	0.463
2001	0.906**	14.449**	0.844	7.797**	-0.325**	-0.918	0.127	0.469
2002	0.904**	14.432**	0.845	7.759**	-0.324**	-0.919	0.127	0.469
2003	0.904**	14.416**	0.845	7.733**	-0.323**	-0.919	0.128	0.468
2004	0.900**	14.382**	0.845	7.689**	-0.321**	-0.919	0.129	0.466
2005	0.901**	14.387**	0.847	7.674**	-0.320**	-0.920	0.129	0.467

* significant at 5%； ** significant at 1%

α : Pareto exponent

α' : Pareto exponent of the expended Zipf's Law

C.V.: Covariance

T: Theil entropy measure

$\hat{\alpha}$: Hill estimator

Data resource: The Ministry of Interior, Executive Yuan, R.O.C. (Taiwan)

Table 2

Measures of inequality level of per capita disposable income of counties in Taiwan

Year	OLS							Hill
	α	logA	R^2	α'	β'	C.V.	T	$\hat{\alpha}$
1998	4.937**	62.788**	0.956	47.238	-2.116*	-0.978	0.006	3.695
1999	5.122**	65.379**	0.912	112.374**	-4.753**	-0.955	0.005	3.302
2000	5.723**	72.910**	0.965	65.532*	-2.872*	-0.982	0.005	4.661
2001	4.915**	62.782**	0.985	27.549	-1.309	-0.992	0.006	5.190
2002	5.036**	64.163**	0.951	-17.462	0.501	-0.975	0.006	4.033
2003	5.002**	63.936**	0.985	-7.087	0.084	-0.992	0.006	4.187
2004	4.984**	63.865**	0.976	-45.868*	1.638*	-0.988	0.006	5.008
2005	5.109**	65.522**	0.949	-40.062	1.399	-0.974	0.006	5.680

* significant at 5%；** significant at 1%

Data resource: Directorate General of Budget, Accounting and Statistics, Executive Yuan, Taiwan

Figure 1

Mean of population growth rate

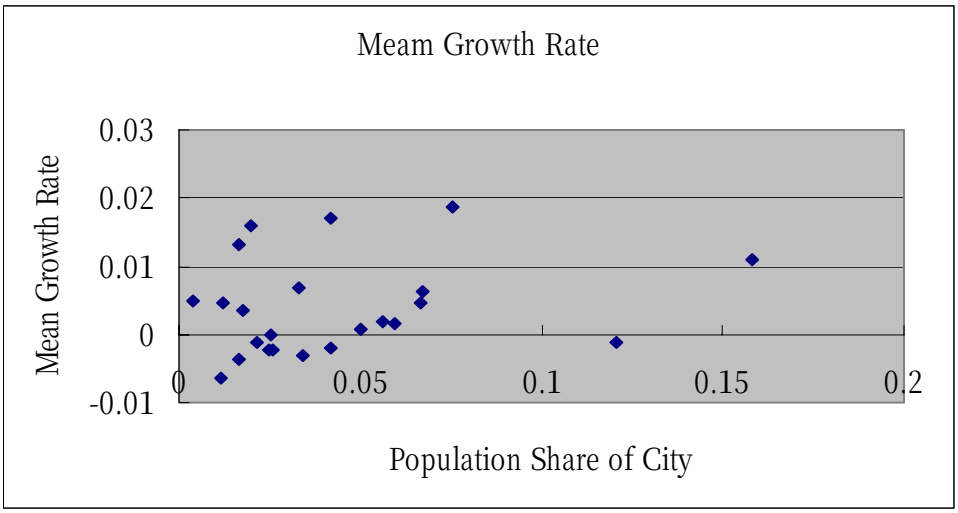
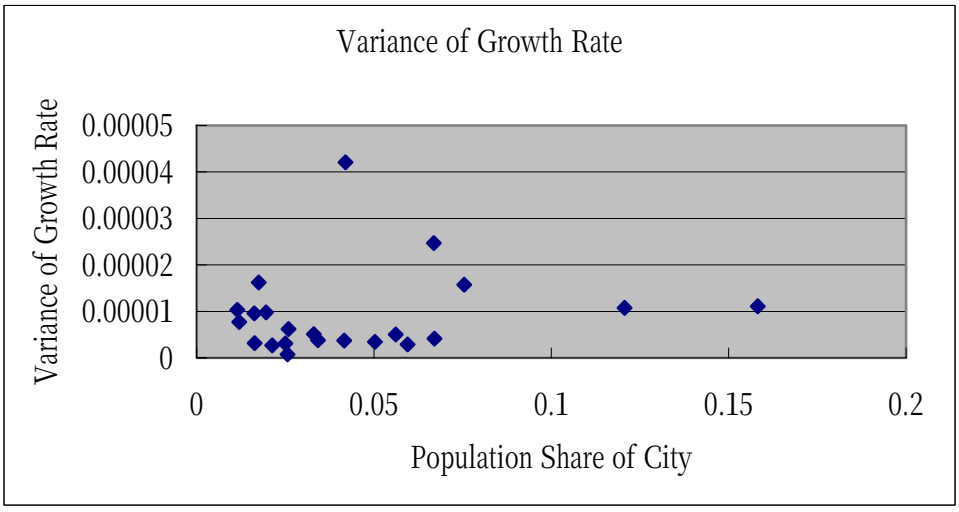


Figure 2

Variance of population growth rate



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