# MUNICIPAL SOLID WASTE MANAGEMENT OF TOYOHASHI CITY: AN ANALYSIS BY ENVIRONMENTAL KUZNETS CURVE

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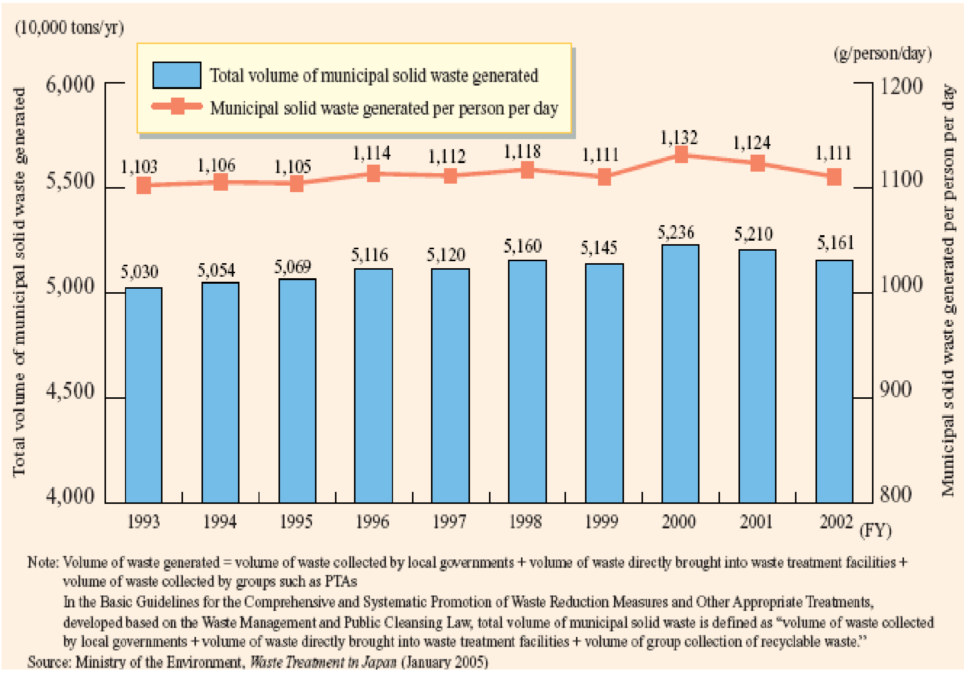
**Abstract:**
*Agglomeration of economic activities and decline in rural population are expanding city size in Japan. Chubu region is developing as a center for manufacturing and seaport related economic activities and Toyohashi, a mid-sized city in the region, is becoming a successful area for manufacturing and trading. As a result, alike other cities of Japan, the city is growing vertically and substantial daily output of waste by city dwellers is creating difficult situation to endorse proper processing technology and space for landfill. Mid-sized cities are facing difficult situation to combat such waste as the trend of generation, composition, and relevant management remain complicated. This paper provides an overview of municipal solid waste situation in Toyohashi city and estimates effectiveness of central and local level initiatives to manage the dilemma. The results of the study show that from 1980 to 2005, increase in municipal solid wastes generation can be explained by the growth in per capita EL. Evidences from Environmental Kuznets Curve (EKC) analysis reflect the effectiveness of governmental initiatives. The study also finds that technology of waste to power is effective even in a mid-sized city. The shortcoming of the study can be described as the limitation in research sample and data influence on the results coming out from market orientation. Technology mix and variety in direction toward the waste generation, disposal and economic benefit analysis was not taken care of by the study.*
**Keywords:** *Municipal Solid Waste, City Economic Level, City Expenditure for Waste Management, Environmental Kuznets Curve, Toyohashi city.*
**JEL, classification** R10, R40, R30

## 1. Introduction

Rapid urbanization together with its increasing economic activities in city areas are causing greater challenges to urban environmental management. The typical structure, scale and scope of city economic development are creating uninvited impacts on the safety of the natural environment. Cities are emerging as the driving force of the economic activities and are supplying essential knowledge of production and innovation. The future cities are therefore a vital element of the global future. Understanding the relationship between city development and environmental collision is therefore critical. An important aspect of city activities is the generation of various forms of waste. Industrial, commercial, municipal activities within the city generates large scale of wastes than rural settings and are becoming the most important environmental problems for city (Buenrostro and Bocco 2003 [5]; Pokhrel and Viraraghavan 2005 [23]). Global generation of municipal solid waste in 1997 was 0.49 billion tones (Suocheng et al. 2001 [31]) and it stood at 2.02 billion tons in 2006 (Global Waste Management Market Assessment Report 2007 [9]). The link between growth in wealth and increase in

waste is narrated as the more affluent a society becomes the more waste it generates (Takanori, 2008 [34]). In order to achieve sustainable growth, therefore, elimination or minimization of any negative environmental impacts resulting from economic activities is a necessary criterion.
Study of the Environmental Kuznets Curve, EKC hypothesis provides empirical evidences that some pollutants follow an inverse-U-shaped pattern relative to income. The EKC hypothesis states that for many types of pollution, environmental damage increases up to a certain level of GDP per capita, and then begins to decrease as income increases further. Environmental pollutants for which this relationship holds include particulate matter, sulfur oxides, fossil fuel forms, ambient air impurities, and the rate of tropical deforestation (Mazzanti, et al., 2009 [16]). Different studies have found a range of shapes of the EKC as the shape depends on the pollutant and income growth stage (see Grossman and Krueger, 1991 [10]; Shukla and Parikh, 1992 [28], Shafik and Bandyopadhyay, 1992 [26]; Beckerman, 1992 [3]; Stern, et al 1996 [29]; Stern and Common, 2001 [29]; and Dinda, 2004 [7]). The stake of the argument is vital and arises from the estimation intensity of the environmental pollution imposed by economic system. The major argument arises from the view point that, if the EKC hypothesis appears to be robust, then the perspective of an infinite accumulation of wealth is possible. Theoretically, the EKC relationship can be divided into three parts: scale, composition, and technology (Brock and Taylor, 2005 [4]). If an economy grows in *scale*, all activities increase proportionally including pollution. If growth is not proportional but is accompanied by a change in the *composition* of goods and services produced, then pollution may decline or increase with income. Finally, if richer countries introduce less pollution-intensive production *technologies*, taking environmental quality as a normal good, growth can lead to reduction in pollution (Andreoni and Levinson, 1998 [1]). Panayotou (2001) [21] study provides a brief sketch of the shapes of the EKC. Among the empirical findings, inverse U-shaped by Shafik and Bandyopadhyay (1992) [26], Panayotou (2003) [22], Grossman and Krueger (1995) [11] provide evidences in the line of EKC hypothesis. On the other hand, findings of Vincent (1997) [38], Grossman and Krueger (1993), Grossman and Krueger (1995) [41] show an N-shaped EKC.
Waste Management and Public Cleaning Law of 1970 of Japan define municipal waste as the waste other than industrial waste. Therefore, waste discharged from a household is definitely municipal waste. But some kinds of waste discharged from industrial activities are categorized into municipal waste as they do not fall in the definition of law as industrial waste. Waste generated by activities offices and garbage from restaurants or retail stores, for example, are considered municipal waste. The amount of municipal waste generated in Japan was increased at a higher rate till 1990 and later on the trend is remaining stable (figure 1). Economic, social and regulatory factors worked to curve down the increasing trend (Nakamura, 2007) [19]. The responsibility of managing municipal waste lies on the local authorities. Household activities are the prime generator of municipal solid waste that accounts 68 percent of total municipal waste while the remaining 32 percent come from business activities. Difference in household activities also provides different size and amount of municipal waste. As a result, cities and municipalities are confronting different kinds of challenge to manage municipal waste.

**Figure 1: Changes in the total volume of municipal solid waste generated in Japan from 1993 to 2002.**




Source: Ministry of Environment, Government of Japan, 2011.

Most of the municipalities in Japan treat municipal waste by incineration and dehydration. Because of its limited land area size, the amount of waste treatment by landfills is limited and has been decreasing. In FY2003, of the final disposal volume of municipal waste was about some 8.5 million tons or 16 percent, and the figure was about half the volume of 15 years earlier. In contrast, larger amounts of waste are recycled, and the recycling rate has increased gradually for both municipal and industrial waste. In FY2003, the recycling rate for municipal waste was around 17 percent compared to 5 percent in FY1990, and the recycling rate for industrial waste was about 49 percent versus 38 percent in 1990 (Nakamura, 2007) [19]. The trend of recycling of waste is increasing amid legal pressure like Containers and Packaging Recycling Law, Home Appliances Recycling Law, Food Recycling Law, Construction Material Recycling Law, and so on. A noteworthy feature of waste management in Japan is that the final disposal rate is very low and the waste reduction rate is extremely high. Waste for landfills like woods, waste-oil sludge, and so on are usually burned by incineration as the scope of landfills is very limited. Cost of incineration is high (typically 25,000-40,000 Japanese Yen/ton) and another aspect of incineration is the cost associated to transportation of waste (Ministry of Environment, Japan, 2011 [18]). At present, many of incineration facilities are adopting technology of generating heat and electric power. As a result, the incineration facilities would be able to provide scope for reducing Japan's high dependency of fossil fuels to produce power. Data of Ministry of Environment, Japan, 2011 show that in 2008, 19 percent of the total municipal waste was recycled, 1.8 percent was directly sent for final disposal and 79.1 percent was directly incinerated. In the same year, total cost of municipal waste treatment stood at 1823.5 billion Japanese Yen or 14, 200 Yen per person. At the end of 2008, 300 incinerators were producing electricity. The number is about 23 percent of all incinerators in Japan (MOE, Japan, 2011 [18]). Possibility of generating more electricity by using incinerators, therefore, becoming a growing issue.

In 2000, Japan introduced the concept of "recycle- based society" by introducing the Basic Act for Establishing a Sound Material –Cycle Society. The two side approach of the concept performs to reduce environmental load in one hand and promote effective use of resources and energy on the other hand. The principal objective the concept was establishing "End of Pipe Technology" that process the environmental load materials exhausted from human activity to reduce environmental load (Fujie, Goto, and Usui, 2001 [8]). As a result, in the line of using fossil fuel and mineral wealth for usage of

economic resources and energy, resource circulation and effective use of waste heat was promoted. The well known concept of 3R has been emphasizing since then. Material and chemical recycle, thermal recycle to collect heat and electricity as well as waste recycle is an established concept in Japan. In support of the efforts, Resource Effective Promotion Law, 2001; Food Recycling Law, 2001; Green Purchase Law, 2001; Revision Law Concerning Rational Use of Energy, 2002; and Law for Recycling of Specified Kinds of Home Appliances, 2001 were adopted by the government (Ministry of Economy, Trade and Industry, Japan, 2007 [17]). In principle, all the laws and regulations obligate local authorities or the cities and towns to implement the national level guidelines.
This paper focuses on environmental aspects of refuse municipal solid waste collection and disposal by drawing on delinking literature between per capita income and pollution of Toyohashi city, Japan. Literatures related to EKC, waste management and income can be found in Ozawa (2005) [20], Mazzanti, et al (2009) [16] and, Calcott and Walls (2005) [7]. The structure of this paper is as follows: in section 2 waste generation scenario in Japan has been described. The section also contains a brief description of study area or Toyohashi city. Objective, hypothesis, and estimation method of empirical testing model are illustrated in section 3. Section 4 describes characteristics of panel data. Econometric results of regression analysis are described in section 5. Finally, concluding remarks and policy implication are drawn in section 6.

## 2. Brief description of waste generation scenario in Japan and in Toyohashi city

Global Warming Law, 1998 and the Kyoto Protocol Target Achievement Plan of Japan ratify 47 prefectural and 1,800 municipalilities to introduce programs to address greenhouse gas emissions. About one third of the local governments adopted the national reduction target while another 40% adopted targets that go beyond the national government's 6% target (Takeuchi and Sugiyama, 2008 [32]). The guidelines of the Fundamental Law for Establishing a Sound Material-Cycle Society sat a numerical target of 'material flow indexes' that identifies the overall flow of materials in the economic sector (MOE, Japan, 2009 [18]). The three aspects of the material flows are:

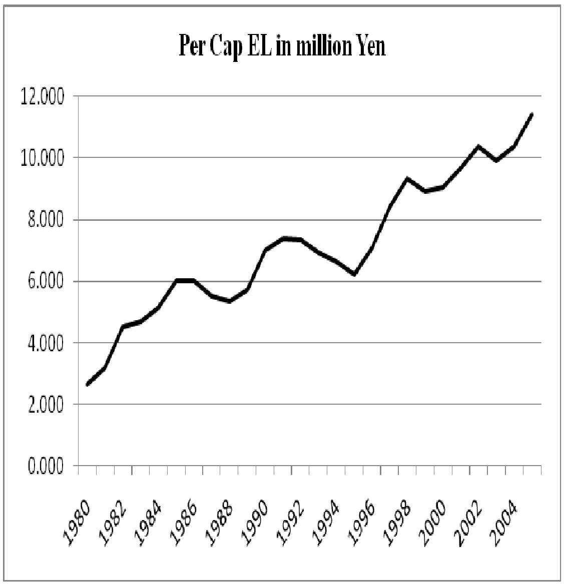
1. Inlet: Connects resource productivity (=GDP/natural resources, etc. Input) and the target value was set at JPY420,000/ton by 2015;
2. Cycle: cyclical use rate (=cyclical use amount/(natrual resources, etc. Input+cyclical use amount)) and the traget value was set at 14-15% by 2015;
3. Outlet: funal disposal amount and the target value was set at 23 millions tons by 2015 against 110 million tons of 1990 benchmark (MOE, Japan, 2006 [18] ).

Generation of waste all over Japan remained flat during the years 2000 to 2006. Waste was generated roughly less than 600 million tons every year. The composition of disposal was also remained almost the same during the years. As an example, in 2006, 84.75 million tons were retunred to nature (mostly waste generated in the form of animal manure, rice straw, husks, wheat straw); 29.18 million tons were disposed as final disposal (waste like paper, waste plastic, sludge, rubble, dust, and so on), and 240.7 million tons were reduced by burning (waste generated by sludge, kitchen, paper, human waste, and so on) (MOE, Japan, 2009 [18]). An amount of roughly 200 million tons were disposed off as cyclical use.
Japan has about 1,900 waste incineration facilities and 60% of them are classifed as discontinuous run system incineration facilty (8 hours run per day). 40% of the facilities are continuous running system facilties (16 hour run per day). By volume, only 10% of the waste processing are done by the discontinuous system. The continuous system facility represents only 20% of the total facilities but they dispose off larger amount of the waste (Kusuda, 2002) [12]. Off the 1900 incinerations, about 190 are constructed with a technology to produce electricity and in 2002 the installed power generation capacity was 1000 MW and located in 15 prefectures (NEDO, 2011) [35].

Toyohashi city was formally founded on August 1, 1906 with area size of 19.69 square kilometer and population of 9,900 (Toyohashi City Statistics, 2011). At present the city size is 261.35 square kilometers and population stands at 381,977 (Toyohashi city web page, 2011) [36]. The present population density stands at 1462 per square kilometer. Attractive economic activity like concentration of heavy industries and a large scale sea-port is attracting in-migration to the city and data of Statistics Bureau, Japan provide 10,749 persons migrated to Toyohashi in 2008, 9,779 persons in 2009, and

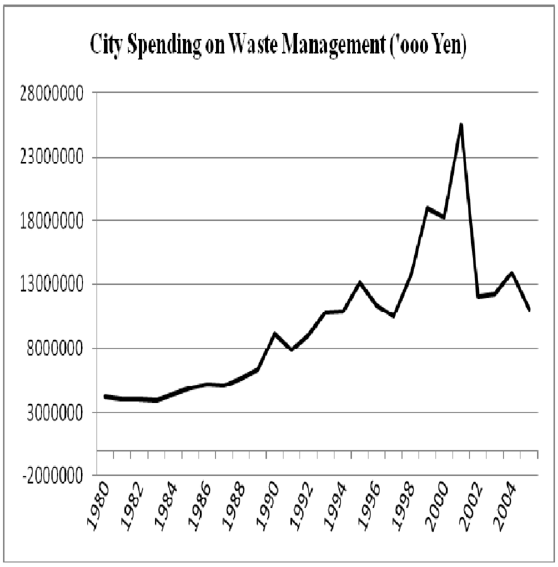
8,577 persons in 2010. As a result, the city is experiencing vertical expansion as the land area is remaining unchanged since 1960 (Toyohashi city web page, 2011) [36]. Mikawa port which is the biggest export and import hub for automobiles has made Toyohashi city an economically important city. The city is faced to the Pacific and regarded as fertile land for natural resources (SENA, 2010) [25]. Figure 2 and figure 3 shows that during the period of 1980 to 2005, per capita EL (defined later) of the city grew rapidly. In 1980, per capita economic level, EL of the city was 2.647 million yen and the figure stood at 11.409 million yen in 2005. On contrary, the city spending on waste management grew steadily during the same period till 2001 and started falling from 2002. A shift in policy guidelines and technological initiatives can be regarded as the reasoning for such phenomenon.

**Figure 2: Growth in per-capita EL of Toyohashi city over the time periods 1980-2005.**




Source: Toyohashi city data, 2011.

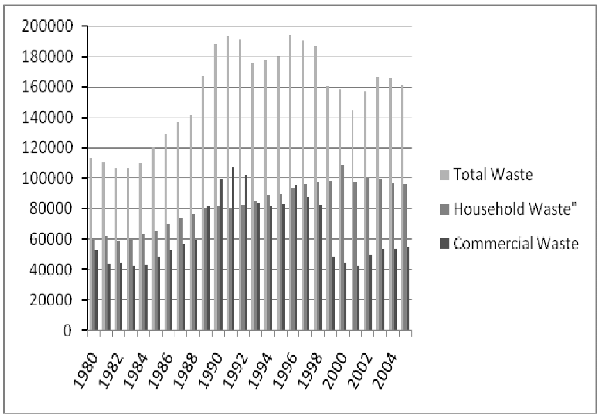
**Figure 3: Growth in per-capita city spending on waste management of Toyohashi city over the time periods 1980-2005.**




Source: Toyohashi city data, 2011.

Growth in economic level as well as in population and economic concentration triggered municipal solid waste generation in the city. Data obtained from Toyohashi city statistics show that during the periods of 1980 to 2005, municipal solid waste was generated at a higher volume till 1998. Later on a slight reduction in the waste has been observed but the figure remained higher than 1980-1989 periods (figure 4).

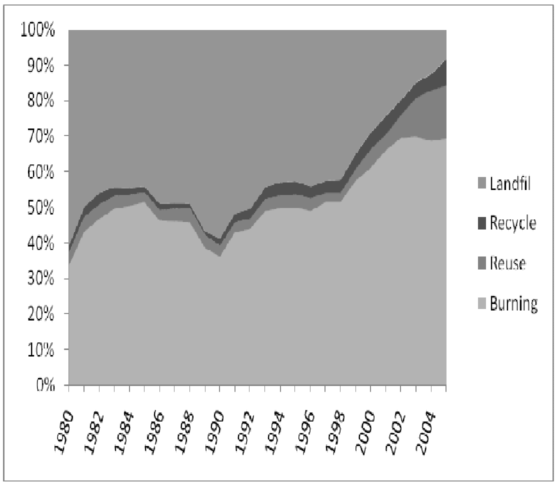
**Figure 4: Growth of municipal waste in Toyohashi city over the time periods 1980-2005.**




Source: Toyohashi city data, 2011.

Toyohashi city integrated waste treatment facility was commissioned in April, 1980 and the two incinerators plant can burn 250 tonnes of waste per day. The steam-turbine generator has an output capacity of 1,500 KW (CADDET, 1995 [6], Shimuzu, 1984 [27]). Figure 5 gives an idea of waste disposal scenerio over the periods of 1980-2005. The city statistics show that during the periods, minucipal waste diposing using reduction method was increased and landfilling was decreased. Reusing of the waste has shown an increasing trend in recent years.

**Figure 5: Clearance of municipal waste of Toyohashi city over the time periods 1980-2005.**




Source: Toyohashi city data, 2011.

Clearance of municipal solid waste remains a significant challenge to the cities in Japan as situation leads to a two tier problems: environmental hazards in one hand, and locating reasonable land area for waste disposal on the other hand (Sakai, et al. 2008 [24]). However, possiblities of renewable energy production could generate a better technological advantage under the changed power generation approach for Japan (Industrial Fuels and Power, 2011 [13]).

## 3. Objective, hypothesis, and estimation method:

This paper focuses present situations and proponents have urged the use of descriptive research method for such state. The method involves cording, description, analysis and the presentation of the present scenarios, compositions or processes of the phenomena. Under the method, the entire research methodology of the paper has considered panel regression analysis to achieve the objectives of the research. The paper considers municipal solid waste generation as the dependent (response) variable of the regression analyses.

The broad objective of this paper is to find the dynamic delinking relationship between pollution or environmental damage and economic growth what is often regarded as Environmental Kuznets Curve (EKC) study. The study attempts to find the relationship between economic growth and municipal solid waste of Toyohashi city, Japan. The broad-spectrum of this paper thereby is to:

1. Outline economy- municipal solid waste generation and disposal pattern following growth of a city;
2. Investigate scope for city government in municipal solid waste management; and
3. Outline potential plan for city to generate energy from municipal solid waste.

The present study aims to focus on following research questions:

1. Does the growth of an economy provide possibility to improve environmental hazards?
2. What is the implication of national level benchmark on a city waste disposal in Japan?
3. Does Toyohashi city following the government target to secure municipal waste management?

It is important to know that local or city governments in Japan have implemented their own anti-environmental pollution measures based on the national guidelines. Since the nation has already achieved high level of income, its economic growth targets need not rest in higher income growth strategies, rather focuses to improve quality of life. Based on this assumption, our study aims to measure city government's initiatives to pursue better quality of life for citizens. Based on the argument above, our study takes following hypothesis:

Hypothesis 1: *The treatment of municipal waste is well-organized in the city that experience growth in income and municipal waste; and therefore develops effective municipal solid waste disposal process.*

Since, better technological administration of municipal waste can open opportunities to produce energy, our study accounts following hypothesis:

Hypothesis 2: *The technology of waste to power energy can be introduced to economically growing city as growth of municipal waste remains expected.*

Multiple regression models have been considered for the purpose of research. The relationship among the variables has been considered as linear. We consider following relationship between economic level and municipal waste:

$$MunicipalSolidWaste \equiv f(EconomicLevel, CityExpenditure)$$

Using city level panel data, ordinary least square method is applied to estimate the implication of EKC for the city. The reduced form of OLS regression equation takes the form:

$$W_i = \alpha_i + \beta_1(EL_i / P_i) + \beta_2(EL_i / P_i)^2 + \beta_3(CE_i / P_i) + \beta_4(CE_i / P_i)^2 + \varepsilon_i \qquad (1)$$

where W: municipal solid waste generated, EL: economic level of the city, CE: city expenditure for waste treatment, P: population, *i* represents *i*-th period and ε is the error term

## 4. Data description:

Data used in this study analyzes empirical evidence of EKC considering per capita economic level, EL, per capita city expenditure on municipal waste management, and volume of municipal solid waste generated of Toyohashi city. Data for the variables were taken from Toyohashi city statistics for 100 year (2011). The data consist of periodical surveys in the municipality which have been quantifying their own data on yearly basis since 1907. The explanatory variables applied for the analysis are: municipal solid waste generated from households, commercial and other municipal solid waste in tons;

per capita EL obtained from on manufacturing, agriculture and trading output of the city and, per capita city expenditure on waste management obtained from the city accounts. The data set covers the periods from 1980 to 2005. The panel data of the study collects all the relevant data from Toyohashi city annual statistics. So in this study we have 26 year time period and we have 78 observations. The variable is the stated amount in thousand Japanese yen that has been spent for the specific purpose. The descriptive statistics of the data is shown in table1.

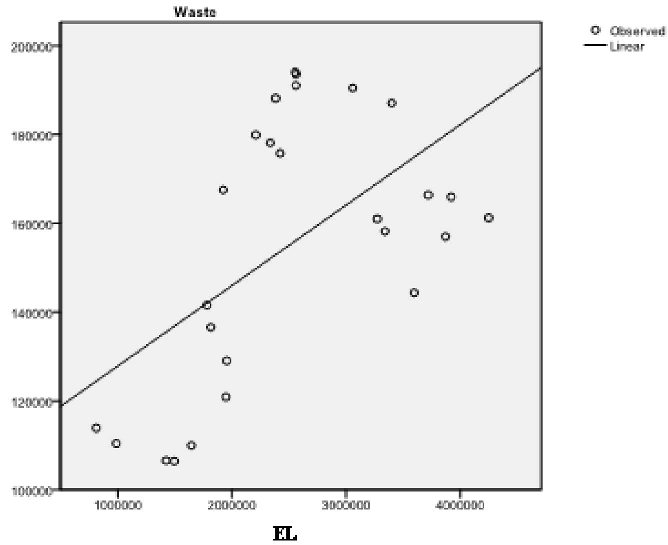
**Table 1: Descriptive statistics and definitions of variables**

| Variable | Definitions | Mean (SD) |
|---|---|---|
| W | Annual municipal solid waste generated by households and commercial enterprises in ton | 155196.42 (30111.34) |
| EL | Annual per capita economic output calculated from manufacturing, agriculture, trade in million yen | 7.1031 (2.284) |
| CE | Annual per capita city expenditure on waste collection and treatment in thousand yen | 27.7085 (13.842) |

N=26

The relationship between per capita EL and municipal solid waste was found significant ($R^2$=0.94) and has been shown in figure 6. The evidence suggests that EL of the city can be explained for higher generation of municipal waste over the time periods.

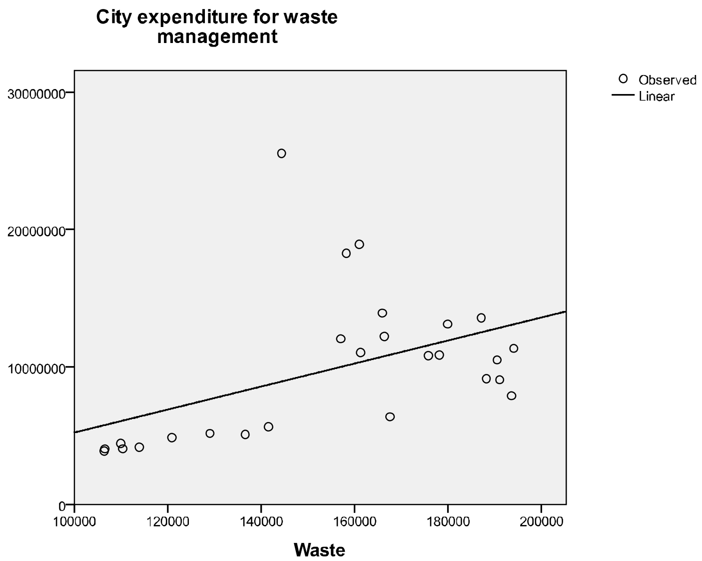
**Figure 6: Relationship between municipal solid waste and per capita EL of Toyohashi city over the time periods 1980-2005**




Source: Compiled by the authors.

The relationship between per capita CE and municipal solid waste was not found significant ($R^2$=0.22) and has been shown in figure 7. However, the t-statistics 2.58 implies the relationship between the two variables. The evidence suggests that municipal waste generation can be explained by the city expenditure for waste management over the time periods.

**Figure 7: Relationship between municipal solid waste and per capita city expenditure for waste management of Toyohashi city over the time periods 1980-2005**




Source: Compiled by the author.

Highlighting the growth of Toyohashi city over time, the study expects higher generation of wastes. In contrary, the study also expects that with the advancement of tec9hnology and existence of national target, the EKC for Toyohashi city would be an N-shaped one.

## 5. Empirical results:

The model OLS regression analysis results are provided in table 2. The regression coefficients estimated from the panel data are statistically significant, as indicated by the *t*-statistics.

**Table 2: Regression results of the study**

| | Municipal Waste |
|---|---|
| Constant | -14353.743 |
| VAR1 | 21360.370*** (2.41) |
| VAR2 | -1496.873** (2.69) |
| VAR3 | 6198.61 (5.04) |
| VAR4 | -74.47 (5.17) |
| $R^2$ | 0.793 |

***. Correlation is significant at the 1% (2-tailed)
**. Correlation is significant at the 5% (2-tailed)
*. Correlation is significant at the 10% (2-tailed)
Numbers in the bracket denotes t-statistics
VAR1: Per capita EL, VAR2: Per capita $EL^2$, VAR3: CE, VAR4:$CE^2$

The results in table 2 revealed that per capita EL and per capita city expenditure for municipal solid waste management can be explained by the trend of higher municipal solid waste generation in the city. On the closer look, the effect of EKC hypothesis has been confirmed by the regression, as per capita $EL^2$ and $CE^2$ were significant. The results above are contrary to our priori expectations, and formed an inverse U-shaped EKC curve. The simulation result of the outcome is explained in figure 8 and figure 9. The figures show the EKC for the periods of 1980 -2005 for Toyohashi city.

**Figure 8: The effect of growth in per capita EL based on EKC for Toyohashi city for the time periods of 1980 to 2005**.

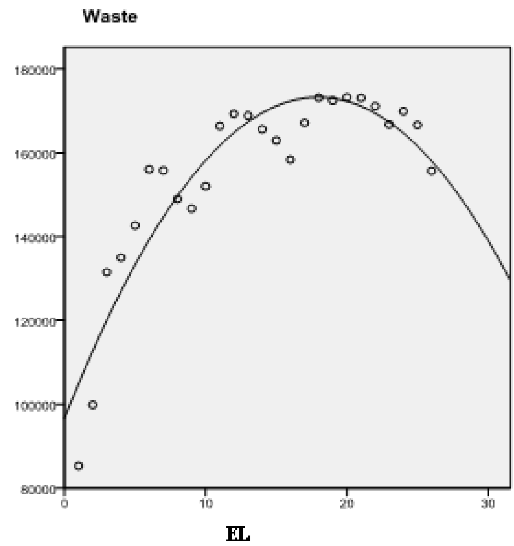
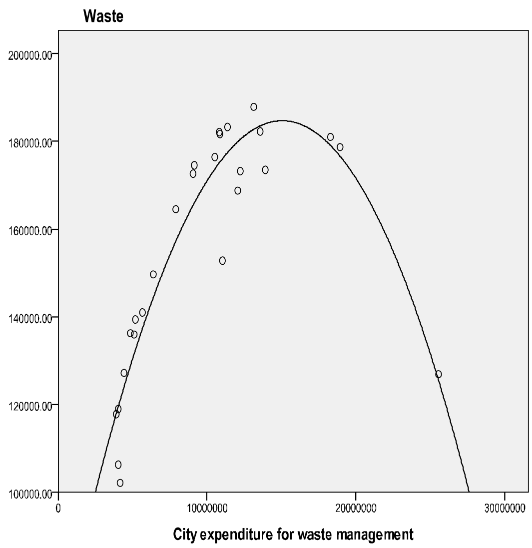



**Figure 9: The result of growth in per capita city expenditure and municipal waste generation based on EKC for Toyohashi city for the time periods of 1980 to 2005.**




Following the results of regression analysis in estimating relationship between municipal solid waste and per capita EL, city expenditure for waste management; the outcome satisfies our priori expectation. All the coefficients are statistically significant, the slope of the coefficients have expected signs. The $R^2$ value is 79.3%. The result implies that larger amount of the variation in waste generation can be explained by the explanatory variable.

## 6. Discussion

This study empirically examined the relation between city economic growth and municipal solid waste. Growth in economic, EL and population has increased discharge of municipal solid waste in Toyohashi city. EL is identified as a strong explanatory variable. As city grows, diversified household activities contribute in generation of various kinds of municipal wastes. Our study found that during the period of 1980 to 2005, EL as well as per capita EL of the city grew fast. Municipal solid waste of the city experienced increase in volume as a by-product of economic activities. Expansion in solid waste disposal contributed more on demand for policy and technological interventions. As a result, city expenditure on waste management increased during the same period. The city opened its high-tech waste treatment facility in 1984. The facility provides waste to heat and power generation technology (Toyohashi city, 2011) [36]. Later on, national concept of sound-material based society supports the city to initiate efficient and effective municipal waste management strategy from 2001 onward (Tachibana, et al., 2008) [33] and city expenditure for waste management started to decline. The positive coefficient of per capita EL for generation of municipal solid waste was positive. The result denotes that economic growth put upward pressure toward the municipal solid waste generation. The negative coefficient of per capita $EL^2$ indicates governmental initiative to manage the municipal solid waste generation in terms of regulations and/or technology. The positive coefficient of per capita city expenditure for generation of municipal solid waste was positive. The result implies that the higher the waste generated, the more the city needs to spend more for waste management. The negative coefficient of per capita $CE^2$ indicates the raised city expenditure to manage municipal solid waste can be overcome by introducing regulations and/or technology. The results provide theoretical and practical significance and proposition. As city grows, various sectors of the city contribute in different ways to produce municipal waste and growth in income provides space for the government to improve quality of life.

The inverse U-shape EKC for Toyohashi city proves that the relation between per capita EL, per capita city expenditure for municipal waste management, and municipal solid waste can be explained by changes in national and local level initiatives accompanied by economic development and quality of life. The results follow the EKC hypothesis (Grossman and Krueger, 1995) [10]. Interpretation of such outcome is that in Japan national level policy and legal agenda reflects in local governmental level as Toyohashi city was able to improve its citizen's quality of life by addressing environmental pollutions problems by the support of higher income and better technology. The EKC of the city demonstrate that idea of sound-material based society could play a vital role in the management of the waste. On the contrary, reduction of volume of municipal solid waste would jeopardize waste to energy technology. A better solution of the outcome could be higher usage of the facility by extending the service to the neighboring localities.

## 7. Conclusion

Outcome of our study suggests that in Japan national level policy and legal agenda reflects in local governmental level as Toyohashi city was able to improve its citizen's quality of life by addressing environmental pollutions problems by the support of higher income and better technology. The EKC of the city demonstrate that idea of sound-material based society could play a vital role in the management of the waste. On the contrary, reduction of volume of municipal solid waste would jeopardize waste to energy technology. A better solution of the outcome could be higher usage of the facility by extending the service to the neighboring localities. The present EKC can be viewed as the hypothesis on the interaction between economic growth, relevant spending and environmental quality. However, the shape of the relationship is not uniform across pollutant and turning points, when they exist, differ across the pollutant. In an optimistic view, the process of globalization and global economy may provide the world's development more sustainable simply by pushing the economy towards the decreasing part of the bell-shaped EKC, but the progress of research needs to learn which variable(s) have a turning point in their relation with output to draw policies to follow. Our study suggests that even a mid-sized city in Japan could play significant role in manage environmental pollutants. In achieving targets of the Kyoto Protocol, national and local governments require to play significant role (Takeuchi and Sugiyama, 2008 [32]). When a city or region grows economically;

better innovation and legal framework to secure natural environmental quality is able to improved quality of life and sustainable society. Despite of these implications, our study is not out of limitations. First, the study sample or data influence the results because of market direction. The degree of correlation differs according to the type of influencing factors of the city. Second, previous researches showed that increase in income results in inverse U-shaped EKC (Panayotou, 2001 [21]), our study followed the same path of the hypotheses. Third, factors influencing municipal solid waste generation might have different technology and direction toward the state. This study did not count the different state of affairs. Lastly, this research did not cover the impact of technological improvement and legal framework competitiveness performance. Therefore, the effect of legal intervention, technology innovation and their competitiveness is left for future task. Comprehensive research outline considering wider factors and technological cost benefit analysis toward the research problems has been kept for future scope.

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