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Job Creation and Environment policy

Uk Hwang | Seok-Joon Hwang | Jangyul Cho

Korea Environment Institute

Research Staff

Leading Researcher:
Uk Hwang (Korea Environment Institute)

Participating Researcher:
Seok-Joon Hwang (Keimyung University)
Jangyul Cho (Korea Environment Institute)

Project Advisory Committee:
Taek-Whan Han (Seokyeong University)
Dong-Ki Min (Konkuk University)
Young-Keun Chung (Sunmoon University)
Chang-Hoon Lee (Korea Environment Institute)

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613-2 Bulgwang-Dong, Eunpyeong-Gu,
Seoul, 122-706, Republic of Korea
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FOREWORD

In Korean labor market, it is highly important to estimate the effect of environmental policies on employment levels from both a real and potential viewpoint. It is also meaningful to analyze how to integrate economic and environmental policies together based on estimation. These works were carried out in this research.

In this study, the researchers have focused on the calculation of employment changes according to the three environmental policies using econometrics and survey investigation. As the overall literature suggests, we can support that environment-related activities can be a significant source of employment.

However, there are lots of difficulties to assess the effect of environmental policy on employment. The most difficult problem is the lack of data. Data can be accumulated with time and this problem will be solved.

I hope that this study will facilitate related researches. I would like to thank the research staffs, Uk Hwang, Seok-Joon Hwang, and Jangyul Cho for their contribution. In addition, I wish to express my sincere gratitude to the reviewers for their helpful comments and suggestions on this study.

Suh Sung Yoon
President
Korea Environment Institute

ABSTRACT

Chapter 1. Introduction

1. Introduction

Because the Korean economy is in recession, the Korean government is in a dilemma between improving the environmental quality and developing the economy. But, in 2004, Hwang and Kang investigated the relationship between labor demand and environmental policy and showed that there is at least no trade-off between economic development and environmental protection. Two years later, we had the opportunity to collect more data, and we study the relationship between environmental policy and job creation in more depth.

In this study, we classify environmental policies into three big categories: first, a policy that can affect the environmental industry; second, public expenditure for natural environmental protection and third, the effect of renewable energy industry on job creation. And we try to analyse the effect of these policies on job creation.

2. Literature Review

Even though a regulation raises the production cost, it provides strong incentives for environmental protection, and sometimes it enhances labor demand in that sector. Two OECD reports suggest that the effect of policies on employment will be small but having potential for greater effects. Some papers also support that at least environmental policies do not have serious negative effects on the labor market.

Chapter 2. Jobs in the Environmental Sector in Korea

1. Environment-related Jobs in the Overall Industry

The Korea Employment Information Service(KEIS) has annually published the Occupational Employment Statistics(OES) since 2001. The occupations which are related to the environment in the OES are categorized as environmental engineers, environment/health hygiene workers, operator of environmental facilities, managers, and cleaners. 2.4 percent of total workers in OES had environment-related jobs in 2003. Among them, high-skilled workers are about 10 percent and the remaining 90 percent are low-skilled labor. This indicates that the majority of workers in the environment-related labor market are low-skilled labor. Using this categorization, the distribution of low-skilled and high-skilled workers in each sector is shown below Table 1.

Table 1. Distribution of Worker Skill by Category (2003)

Category	Low-skilled(%)	High-skilled(%)
Direct Environmental Services	42.8	57.2
Public Services	89.7	10.3
Private Technology Services	16.3	83.7
Private Business Services	99.2	0.8
Social Overhead Capital Related	41.7	58.3
4 Manufactures	39.8	60.2

Sources : Korea Employment Information Services. 2004. *Occupational Employment Statistics*.
Note : Low-skilled is the share of low-skilled workers among total environment- related workers in the category. High-skilled is the share of high-skilled workers among total environment-related workers in the category.

This suggests that if the government focuses on the improvement in environment-related labor structure, then it had better spend its money on environmental technology development or industrial restructuring for an environment-friendly industry structure.

2. Jobs in the Environmental Industry

The statistics about environmental industry is collected by the Ministry of Environment in Korea. In 2004, 15 percent of the environmental industry is engaged in the manufacturing sector, 5 percent in construction, and the remaining 80 percent of the companies are in the service sector. Total sales of the environmental industry in 2004 was 21,428 billion won. Forty percent of total sales came from the manufacturing sector, 17 percent from construction, and 43 percent from the service sector. The distribution of workers is provided in Table 2;

Table 2. Worker Distribution in the Environmental Industry

	Manufacture	Construction	Service	Total
Total Employee (A)	97,380	135,384	139,378	372,142
Employee in Environmental Sector (B)	57,103	22,544	88,314	167,931
B/A	58.6	16.7	63.4	45.1

Sources : Ministry of Environment. 2006. *Report on Environmental Industry Statistics*. Korea.

Chapter 3. Job Creation by the Environmental Industry and Public Investment

1. Some Background of the Estimated Model

Ordinary labor demand function (here, labor demand means the labor demand in the environmental sector of each environmental industry) is derived from the profit maximization condition of firms. We adopt the panel data technique. Generally, we follow the widely accepted estimation methods; panel generalized least square, panel generalized least square with heteroskedasticity, panel generalized least square with autocorrelation, random effect model, and random effect model with autocorrelation.

2. Job Creation in the Environmental Industry

On the average, each industry is estimated at the elasticity of sales on labor demand as from 0.193 to 0.259. So, when we define 0.193 as minimum elasticity estimator and 0.259 as maximum value for that, it means that at one percent change of sales on the average level, it gives 0.193 percent to 0.259 percent increase of labor demand in each environmental industry. The following Table 3 shows the labor demand increase in the environmental industry with regard to the sales increase in the environmental sector.

Table 3. Total Labor Demand Increase in the Environmental Industry according to One Billion Won Sales Increase in the Environmental Sector

(Unit : persons)

ε = 0.193			ε = 0.259		
Environment	Non-Environment	Total	Environment	Non-Environment	Total
3.5	4.2	7.7	4.9	5.6	10.3

Note : ε represents the labor demand elasticity of environmental sector sales on labor demand

When we compare the result with the direct induced employment coefficient of the overall manufacturing industry presented in the with Input/ Output tables, we can find that the job creation ability of the environmental industry is not that small.

3. Job Creation by the Public Environmental Expenditure and the Renewable Energy

3.1. Job Creation by Public Expenditure in Natural Resource Preservation Area

We investigate the job creation in the natural resource sector first. Kim(2006) suggests the detailed job availability in the natural resource sector as follows;

Table 4. Job Creation in the Natural Resource Sector

(Unit: person)

Job Classification	Ⅰ	Ⅱ		Ⅲ
	2007	2008~2011		2012
Eco-guide Jobs are related to eco-tourism, eco-marketing and eco-education, etc.	586	1,162	1,785	2,423
Monitoring/Recovering Jobs are related to monitoring and investigating the natural environment state/recovery of damaged natural resources	625	1,815	2,845	5,215
Natural Resource Use Jobs are related to the coordination and improvement of the use of environment friendly natural resource products and forest bio-mass	100	150	250	500
Total	1,311	3,127	4,880	8,138

Source : Reorganize the table from Kim. 2006. *Report of Social Job Creation in Environmental Sector*. PCSD. pp. 90-91.

Based on this scenario we can guess the size of expenditure for the job creation in Table 5 by simple multiplication.

Table 5. Expected Annual Government Expenditure for Job Creation in the Natural Resource Sector

(Unit: million won)

	Ⅰ	Ⅱ		Ⅲ
	2007	2008~2011		2012
Total Expenditure	11,012	26,267	40,992	68,359

Note : Total Expenditure = expected job creation in Table 12 × ₩)0,000 × 12

So when we compare the job creation ability between public expenditure in the natural environmental sector with that of the environmental industry sector, the effect of job creation in the natural resource sector is very large in view of job creation size.

3.2. Job Creation by Public Expenditure in the Renewable Energy Industry

In 2004, Soo-Jin Kim studied the employment effect of solar and wind energy industry in Korea with 1998 Input/Output table. Based on her scenario and calculation we can get the following Table 6.

Table 6. Job Creation in Wind and Solar Power Plant (2015)

(Unit: million won, person)

		Installation	Power Generation	Total
Wind	Cost	923,697	455	924,152
	Job	15,084	2,303	17,387
Solar	Cost	1,807,500	244	1,807,744
	Job	17,509	1,036	18,454

Chapter 4. Policy Implications

Environmental policy will be heading toward an integrated approach to pollution management instead of managing each pollutant separately. This change requires the development of environmental technology to control the pollution. Given this point of view, it is desirable for government policies to focus on job creation in the environmental sector. Furthermore, the government needs to upgrade the labor quality in the environment-related sectors, and it is timely for the government to consider the ways to enhance the high-skilled labor force.

The following Table 7 shows the job creation possibility by spending 1 billion won for the environmental industry, public expenditure for natural

resource protection, and power generation of renewable energy (wind and solar).

Table 7. Job Creation per One Billion Won Spending

(Unit: person)

	Calculation Method and Assumption	Job Creation	
Environmental Industry	We assume that ε = 0.256.	10.3	
Public Expenditure	Total Job Creation/Total Expenditure (in 2012 and in the case of natural resource protection)	119.0	
Renewable Energy	Total Job Creation/Total Cost for Installation and Power Generation(in 2015)	wind	18.8
		solar	102.0

Note : In the case of the job creation number in the environmental industry and renewable energy, the table only contains direct effect on job creation.

This suggests that, in the short run, the best policy to create jobs is related to the policy that enhances private business services and public services industry. But when we consider that a large portion of created jobs from expenditure in the natural resource sector is low-skilled workers. In the long run and in view of the size of the market for the industry, the desirable policy is to promote the environmental industry.

For example, if the government wants to create jobs by developing the environmental industry, it is appropriate for the policy to focus on the construction and other machinery industry sector. However, if the government wants to directly increase environment-related jobs, then it is effective for the policy to support other sectors.

In the case of the renewable energy sector, it has a reasonable job creation ability if the conditions for development of renewable energy are satisfied. But, the development of renewable energy is very restricted in Korea.

The last thing that we consider is the change of location of manufacturers or production site of industries according to the stringency of an

environmental policy. But it is not easy to indicate the stringency of the environmental policy because of employment loss according to production site change.

Chapter 5. Conclusion

When we consider that the policy direction has changed to an integrated approach from treating each pollutant separately, so it is time to consider that labor policy in the environmental sector pursues the way to enhance labor quality in the environmental service section.

One of best ways to achieve job creation is to support the environmental industry. The environmental industry has a high potential to be a major industry in the future. Because the environmental industry itself is relatively technology or research oriented, it is quite an appropriate place to improve the labor quality.

Job creation through public expenditure spending looks more effective than that in the environmental industry support. But when we consider labor quality and job duration, it is useful for the government to solve only the temporary unemployment problem.

When we look at the renewable energy industry, it is also effective to invest in this sector in the view of job creation and labor quality improvement. But when we consider the climate condition and demand for energy in Korea, the job creation effect in this sector is limited.

So the government chooses the policy effectively according to the situation which the government is confronted with. Sometimes, some can argue that if money is spent on other sections that can create more jobs, then it is not an efficient way to invest or spend money for the development of the environmental sector in the view of job creation. But when we consider the characteristics of environment, unpredictable, asymmetry of recover and destruction, the value of environmental protection can be larger than some job creation.

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Chapter 1. Introduction

1. Introduction

Recently in Korea, the 2005 Environmental Sustainability Indicator was announced. And Korea was ranked 122nd among 146 countries. Furthermore ecological damage in this country is 3.8ha, next to the U.S., which is 4.9ha. Ecosystem wellbeing index is also ranked low as 161st among 180 countries[1]. Since these results indicate the environmental quality getting worse, people have started to be keenly aware of the importance of the environment.

People might think that the economic improvements can compensate them for this loss of environmental quality. The current state of the Korean economy, however, does not show any sign of business booming up. Especially, the unemployment problem has not been solved yet. In the case of unemployment of workers who are from 15 years old to 24 years old, the unemployment rate was around 9 percent in the 2000s, which is higher than the total unemployment rate of 3 percent in Korea.

Because of this situation, it looks like the Korean government is in a dilemma between improving the quality of the environment and economic development. However, before we think this as a dilemmatic situation, first we must check whether there is a trade-off between improving the environment and the economy. As we can sometimes improve both the economy (or industry competition) and the environment, we need to find out ways to improve both successfully.

In 2002, Hwang and Kang investigated the relationship between labor demand and environmental policy. They estimated that the labor demand function from 1992 to 2002 with environmental policy changes as they relate to the number of monitoring ambient environmental quality and the change of budget for environmental protection. In their study, they found a positive relationship between the overall labor demand and the increase in pollution

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1) This information is based on Jeong(2006b).

abatement cost of manufacturers. They thus concluded that environmental protection activities in Korean manufacturing industry from 1992 to 2002 created jobs. This job creation was not any big burden to business activities during this period, because the share of pollution abatement cost among total production costs is just around 1 percent. However, the research could not provide more information in detail. It means that because of data restriction, they just focused only on overall labor demand of the manufacturing industry.

After two years, we fortunately have had the opportunity to collect more data. The new data sets are environmental industry statistics and occupational employment statistics. These data contain more specific information about the status of the environmental industry and the description of current environment-related jobs. These added information motivates the study of job creation and environmental policy again. Therefore, we restudy the relationship between economic improvement and environmental protection in more detail in this new project.

In this study, we still cannot define clearly what the environmental policy is. In reality, there are lots of environmental policies and it is impossible for us to investigate the effect of each environmental policy one by one. If people want to know the specific effect of each environmental policy on employment, then it would rather be researched as one independent project per case. Therefore, in this research, we still take an overall point of view about the effect of environmental policy on employment but the focus is more narrowed compared to the previous research in 2004.

We classify the environmental policy into three big categories. First, it is the policy which can affect the environmental industry, second, public expenditure for natural environmental protection and last, the effect of renewable energy industry on job creation. These three categories represent each different section of the economy. That is, as a private sector, we focus on the environmental industry. When we look at the budget of the Ministry of Environment, we can observe the R&D investments and the subsidies for environmental industry[2]. This government spending increase can spur

[2] The contents of investments are natural gas auto supply, next generation environmental

directly the environmental industry to grow. And it will create jobs in that sector.

Second, we want to suggest some ways for environmental protection and the promotion of employment. While the more stringent regulation cannot only protect the environment but also create jobs, it can also dampen business incentives in the private sector. To overcome shrinking incentives of the business sector, it is reasonable for the government to increase public expenditure more instead of strengthening the regulation. So we change our focus from the private industry to the effect of public expenditure on job creation, especially, public expenditure for natural resource protection.

Last, we focus on the renewable energy sector. Even though in Korea, energy policy is not a main area of the Ministry of Environment, when we consider that energy is the main source of pollution, it is worth to look at the relationship between energy supply system change and employment. Furthermore, in some countries like Germany, the increase of renewable energy supply shows the employment growing at the same time as environmental protection. Therefore, in this study, we introduce a study of job creation in the renewable energy industry in Korea and look at the job creation ability in this sector.

Even though this study is a consecutive study of the former report of 2002, still, we have many limitations. As we mentioned earlier, still we cannot define clearly environmental policies. And the number of data set itself is so small and inconsistent with previously widely used economic data in some points. For example, we cannot but use some proxies to estimate wages and production in the environmental industry sectors. Because the data collection in the environment is in early stages, it is difficult to overcome these problems in this research. And we cannot consider the whole effect of policies on employment, especially indirect job creation in other sectors and the job loss from environmental policy. But those problems are expected to be solved when more data are collected and the model for this analysis is developed.

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technology development and environmental quality improvement funds, etc. From 2004 to 2005, these investments are growing by 11.7%(Ministry of Environment. 2006. *2005 Annual Report on Environment*, Korea).

Even though we have some limitations in this report, we did our best to investigate the relationship between environmental policy and job creation, and suggest some desirable government policies which can improve environmental quality and decrease the unemployment level in Korea.

2. Literature Review

Even though a regulation raises the production cost, it provides strong incentives for environmental protection, and sometimes it enhances industrial competitiveness under some conditions. Porter et al.(1995) suggests the positive role of regulation for industrial competitiveness. He argues that since the entrepreneurs do not have an interest with environmental quality control in their production process, there is too much ignorance in searching for innovation and this leads them to have incomplete information for innovation. But some regulations under some conditions can make them find innovations. As a result, sometimes the harmony between environmental quality improvement and industrial competitiveness can be found. The conditions under which economic regulation makes industrial competitiveness stringent are a clear policy target suggestion, a flexible policy including voluntary participation, and the usage of economic instruments.

While those policies are desirable to protect environmental quality and improve an economy, some economists have suspicions about Porter's argument. The baseline of their critics is the ignorance of opportunity cost which is generated by changing old production line with new one. That is, except the direct cost of changing the production line, we must consider the foregone future cash flow from the old production line. They argue that if we do not add the direct cost to this opportunity cost, then the benefits of regulation and innovation may be overestimated. But they agree with the idea that the difficulties in evaluating environmental benefits also make the benefits of regulation underestimated.

These two arguments provide reasonable explanations for the effect of environmental policy in a broad sense. But they agree with the difficulties

in estimating the benefits of environmental quality improvement in common. This means that since the calculation of cost is an easier approach to evaluate environmental policies, it is highly probable that many researches focus on only cost side and underestimate the benefits of environmental policy. Somehow this restraint can provide, at best, the potentialities of benefits of environmental policy. In the case of Korean literature, they provide also only the potential relationship between environmental improvement and industrial competitiveness.

Let us focus on the relationship between job creation and environmental policy. OECD published its first report about environmental policies and employment in 1997. The report suggests the effects of environmental policies on job creation in two ways with various dimensions (short and long term, direct and indirect, micro and macro etc.). One way, as positive views, it focuses on the increases of labor demand due to the expansion of environment-related activities and investment. The other way, it focuses on the lost of effective investments and competitiveness which can bring onto job creation.

With these points, the report investigates empirical data. First, it measures the share of environment-related labor force on the total labor force of each OECD member country. The overall share of this is around 1 to 3 percent. The report indicates that the major sources of negative effect on employment are the loss of competitiveness, plant closure, and industrial relocations. After research about these effects, it concludes that there is no massive and systematic job loss because of environmental policies. Macro researches also support this view. Since environmental goods have its own market which is not small, it seems that this macro argument works.

Based on these results, the report suggests that policy directions for both job creation and environmental protection as follows; first, the increase of governments' expenditure to labor-intensive environmental protection activities as anti-recession policy, second, environment friendly restructuring of industry which aims for clean technology development, renewable energy usage and intensive waste recycling etc., third, environment-related employment policy such as specific job related education and training

programmes in the environment-related section. Fourth, though it is controversial, green tax reform.

In 2004, the OECD presented another report about environment and employment. In this report, OECD strengthened empirical part. It suggested that the statistical criteria for environment-related labor statistics are needed and more new, updated statistics of OECD countries are required. The shares of the environmental sector labor to total labor of each OECD country are around 1 to 3 percent between 1997 and 2000. It also tries to assess the effect of local/regional policy and initiatives on employment. Unfortunately, it concluded that, because of lack of available data, it cannot confirm the positive effect but still there is potentiality. They also used various economic models to check the double-dividend hypothesis and technological change due to subsidy. In this part, it concluded that, in the short run, the subsidies work for employment increase but the effect was not sustained in the long run. So it predicts that the effect of policies on employment will be small except environment friendly energy related policy.

Besides these reports, some academic papers show that, at least, there is no serious negative effects on the labor market. Golombek and Raknerud (1997) suggest that the industry sector which is under rigid environmental regulation would increase the employment level as was shown in the Norwegian industry. They use a multi-state Markov model to explain the relationship between the entry and exit of firm and employment. Morgenstern, Pizer and Shih(1998) had similar results with the USA data, but the methodology was different. They used decomposition of labor translog cost function approaches for pulp and paper, plastics, petroleum, and steel industry. They concluded that there exists a net gain of small employment increase which is insignificant. When they focus on plastic and petroleum sectors they found strong significant positive effects between job creation and environmental expenditure increase.

In Korea, Hwang and Kang(2004) estimated labor demand function with environmental policy change from 1992 to 2002 in the manufacturing industry sectors. They used fixed effect instrument variable method. They found the positive relationship between labor demand and environmental expenditure

too. Even though those results could not support the strong positive effects between environmental protection and employment, these results, at least, imply the potentiality of a positive relationship between employment and environmental protection.

Except for a direct positive relationship between environmental expenditure increase and job creation, there exists the opposite effect which may lead to job losses with location change. That is called pollution haven activities. According to Brunnermeier and Levinson(2004), at the early stage of the literature, the empirical results of pollution haven effects do not support the existence of those effects; that is, the strength of environmental regulation does not make the manufacturer change its industry location to a region with less stringent environmental regulation. However, nowadays, the development of estimation technique, which includes the heterogneity treatment and endogeneity problems in panel data, can support the prediction of pollution haven effects. This estimation equation is a closed form of single equation which is based on the Heckscher-Ohlin model.

Therefore, still, it is difficult to find out strong support for the existence of pollution haven effects. In Korea, Lho(2002) estimated the relationship between industrial relocation and environmental policy through foreign direct investment and policy instruments. He concludes that foreign direct investment of heavy pollution industry in Korea statistically does not have any relationship with the stringency of environmental policy. Hwang(2006) suggested the theoretical conditions for observing the industrial relocation which pollution haven effects and hypothesis predicts. He uses the model which shows the home-market effects in trade with environmental policy and pollution treatment costs. He suggests some conditions under which we can observe industrial relocation. Industrial relocation happened when a small country with strong environmental policy trades with a large country with weak environmental policy. Furthermore, the industrial relocation depends on each industry's cost condition between traditional production cost and pollution treatment cost. Therefore, he concluded that it is not easy to identify the pollution haven effects from the home market effects as industrial relocation. That is, since it is highly probable that industries relocate their

production center because of traditional cost savings, it is hard for us to accept environmental policy stringency itself as a main and important relocation factor. When we synthesize the whole results, at least, it cannot be supported that environmental policy stringency can have a big effect of job loss. Ultimately, this means that the policy which protects environmental quality must not be treated unduly as a main cause of economic impediment. When we consider the difficulties in calculating the benefits of environmental protection, even if we admit there exists a negative effect of environmental stringent policy on employment, we do not have to exemplify the job losses which can be covered with alternative investment opportunities.

Let's simply look at some literature about environmental policy. The aim of environmental policy is simply defined as a maximization of social welfare given an appropriate environment level. An appropriate environment level means the polluted level at which marginal cost of pollution is the same as marginal benefits of environmental quality improvement. To achieve this goal, on the one hand, the government regulates directly the production and consumption behavior of economic agents, and on the other hand it spends government expenditure on several environmental activities, including investments which are related to the development of best available technology for environmental protection.

Direct regulation or command and control is regarded as an inefficient instrument. For example, pollution emit permission, one of the typical examples of direct regulation, is known as a rigid policy to manage. The pollution emit permission is as follows; the government gives a pollution permission to economic agents after the government scans the pollution level the results of behaviors produce. But to manage this policy, the government must have entire information about technology and the effects of the behaviors on the environment. So in view of the managing cost of this policy and incentives for technology improvement, it is criticized as an inefficient policy.

Currently, many governments changed their policy target to incentives of voluntary environmental protection from direct regulation. This trend makes the governments use economic instruments like taxes, subsidy etc. However,

the usage of those instruments also requires more information about technology, eco-management skills and life-cycle analysis of the product. Furthermore, integrated pollution control can be possible with this information. What this means is that even though the way of environmental policy or regulation turns to encouragement-oriented from punishment-oriented, those policies must be accompanied with technological and scientific knowledge about the environment and behaviors of economic agents. This policy change makes the government more focused on the creation of an atmosphere for environmental technology development and even on leading environment friendly technology advances and development. Recently, Jeong(2006b) indicated the future direction of the Korean environmental policy must pursue the introduction of an integrated pollution control from the point of view of industrial ecology the access control to environment information as a way of regulation and clean technology development being accompanied with environment- oriented product innovation.

There is another role of environmental policy except environmental protection. That is, the environmental policy can be used as anti-recession instruments as the OECD(1997) suggested. When the economy is in recession, the government can spend its expenditure on environmental protection for booming up the economy in the short run. This fiscal policy is the typical way of the government to release the economy from recession, which Keynes suggested. The only difference from the traditional fiscal policy and this, is that the government spends money for environmental protection. By using government expenditure this way, the government can improve the economy and protect the environment at the same time.

Chapter 2. Jobs in the Environmental Sector in Korea

1. Environment-related Jobs in the Overall Industry

The Korea Employment Information Service(KEIS) has annually published the Occupational Employment Statistics(OES) since 2001. This OES statistics provides information on occupational employment data classified into 194 industrial sector with 392 occupational categories. In 2004, the KEIS gathered surveys of 70,016 people. First, we analyse the distribution of workers who have environment related jobs with these statistics.

The occupations which are related to the environment in the OES are categorized as environmental engineers, environment/health hygiene workers, operator of environmental facilities, managers, and cleaners. Among them, the first three occupations can be high-skilled labor jobs and the last two occupations are low- skill labor. When we sort the environment-related occupation in the OES, we regard only the occupations which indicate the explicit relationship with the environment as environment-related job. This is a strict criterion. Because we can not clearly discern the jobs' characteristics from the data description in the OES, the only way to identify whether the job is related to the environment or not is to pick the occupation whose title shows the explicit relationship with the environment.

environmental engineers are the engineers whose job is related to sewage system, waste or waste water treatment, clean technology development, noise protection technology, pollution air prevention technology, and so on. The environment/health hygiene workers engage in inspections of water, air, noise, waste treatment and other environment-related matters. The operators of environmental facilities are the people whose job is related to sewage or water supply facility operation and incinerator facility operation. The managers and cleaners are the people who engage in environmental service businesses.

When we analyse the distribution of environmental jobs, we use weight

which is provided in these statistics. With these weights, we can estimate the whole labor market size and the whole environment labor size together. The table 1 shows the overall description of the environment-related employment distribution. When we use the weight, the total estimated number of workers in 2004 is 22,902,000.

Table 1. Distribution of Environment-related Workers (2004)

Job Title	Employment
High-skilled Labor	
Environmental Engineers	16,329
Environment/Health Hygiene Workers	21,472
Environmental Facilities Operators	18,707
Low-skilled Labor	
Managers in Environmental Service Business	11,266
Cleaners	490,047
Total Number of Workers in Environment-related Jobs	557,821
Total Number of Workers in OES	22,902,000

Sources : Korea Employment Information Services. 2005. *Occupational Employment Statistics.*
Note : High-skill and low-skill are classified by the technology related certification holding requirement

In total, 2.4 percent of workers in OES had environment-related jobs in 2003. Among them, high-skilled workers are about 10 percent of those jobs and the remaining 90 percent are low-skilled labor. This indicates that the majority of workers in the environment-related labor market are low-skilled labor. On the one hand, this job structure implies that the government can use environment-related job labor policy as a temporary policy which is against unemployment and income inequality during recession periods. Also, this structure indicates that the environmental industry in Korea needs to find out or develop the market which can enlarge the high-technology demand. By doing that, the high-skilled labor in the environmental industry can be a major labor force in the environment-related labor market. And the low-skill dominant structure of environment job can be improved.

Table 2 shows the share of environment-related workers among the total workers by industry. Table 2 lists the first fifteen industries that have high value in environment-related worker share. The share of environment-related workers in the public and private service sector is higher than that in manufacture. Among service sectors, the share of environment-related workers is the highest in the waste-related service sector.

Table 2. The Share of Environment-related Workers by Industry (2003)

Industry	Share(%)
Sewage, Human & Animal Waste Treatment Services	57.5
Waste Collection and Treatment	31.3
Facilities Support & Employment Services	25.4
Executive, Legislative and General Gov't Support	18.9
Collection, Purification & Distribution of Water	6.8
Scientific and Technical Services	4.8
Administration of Industrial & Social Policy of Community	4.0
Research and Experimental Development on Natural Science	3.1
Production, Collection and Distribution of Electricity	2.4
Articles of Paper & Paperboard	2.1
Basic Chemical	1.8
Higher Education	1.7
General Purpose Machinery	1.2
Heavy Construction	1.1
Architectural Engineering Services	0.8
Basic Iron and Steel	0.6

Sources : Korea Employment Information Services. 2004. *Occupational Employment Statistics*.
Note : The share of environment-related workers is calculated by the number of environment-related worker in a specific industry divided by the total number of workers in that industry.

To see the distribution of environment-related workers by industry in detail, let's categorize the industry in Table 2 as follows;

① "Direct environmental services" includes

Sewage, human & animal waste treatment services
Waste collection & disposal.

② "Public services" includes
Executive, legislative & general government services
Administration of industrial & social policy of community
Higher education

③ "Private technology services" includes
Research & experimental development on natural science & engineering
Scientific & technical services
Architectural engineering services

④ "Private business services" includes
Facilities support & employment services

⑤ "Social overhead capital related" includes
Collection, purification & distribution of water
Production, collection & distribution of electricity
Heavy construction

⑥ "4 manufactures" includes
Manufacture of articles of paper & paperboard
Manufacture of basic iron & steel
Manufacture of general purpose machinery
Manufacture of basic chemical

With this categorization, the distribution of low-skilled and high-skilled workers in each sector is shown as following Table 3.

Table 3. Distribution of Worker Skill by Category (2003)

Category	Low-skilled(%)	High-skilled(%)
Direct Environmental Services	42.8	57.2
Public Services	89.7	10.3
Private Technology Services	16.3	83.7
Private Business Services	99.2	0.8
Social Overhead Capital Related	41.7	58.3
4 Manufactures	39.8	60.2

Sources : Korea Employment Information Services. 2004. *Occupational Employment Statistics*.
Note : Low-skilled is the share of low skilled workers among total environment- related workers in the category. High-skilled is the share of high-skilled workers among total environment-related workers in the category.

In Table 3, low-skilled workers are dominant in public and private business service sector. On the contrary, in private technology service category, the skilled workers are dominant. In other categories, the distribution is similar to each others; unskilled : skilled is 4 : 6. This distribution implies that the effects of government labor policy are different across the industry sectors. For example, if the government wants to improve unemployment in the short period and the policy is in favor of environmental protection, then it is helpful for the government to make the policy which targets public services and private business services sectors. But if the government focuses on the improvement in environment-related labor structure, then it had better spend its money on environmental technology development or industrial restructuring for an environment-friendly industry structure.

2. Jobs in the Environmental Industry

The statistics about the environmental industry is collected by the Ministry of Environment in Korea. These statistics cover the data of 2000, 2002 and 2004. First of all, to collect the data, the ministry follows the definition of environmental industry as the OECD(1999) defines;

The environmental goods and services industry consists of activities which produce goods and services to measure, prevent, limit, minimise or correct environmental damage to water, air and soil, as well as problems related to waste, noise and eco-systems. This includes cleaner technologies, products and services that reduce environmental risk and minimise pollution and resource use.

Based on the definition of the above, the Ministry gathered data from around 23,000 companies categorized into 101 industries in 2004. In 2004, 15 percent of the environmental industry is engaged in the manufacturing sector, 5 percent in construction, and the remaining 80 percent of the companies are in the service sectors. The sales amount of the environmental industry in 2004 was 21,428 billion won. Forty percent of total sales came from the manufacturing sector, 17 percent from construction, and 43 percent from the service sector. The distribution of workers is provided in Table 4;

Table 4. Worker Distribution in the Environmental Industry

	Manufacture	Construction	Service	Total
Total Employee (A)	97,380	135,384	139,378	372,142
Employee in Environmental Sector (B)	57,103	22,544	88,314	167,931
B/A	58.6	16.7	63.4	45.1

Sources : Ministry of Environment. 2006. *Report on Environmental Industry Statistics*. Korea.

The total number of workers in the environmental industry is 372 thousand. Among them, 168 thousand workers work directly for the environmental sector. So, when we look at worker distribution, workers in the service industry are engaged in relatively more jobs directly related to the environment.

In this data set, the number of sampling companies in the environmental sector has increased from 15,801 companies in 2000 to 17,520 in 2002.

Therefore, it is hard to estimate the growth pattern of the environmental industry. But, fortunately, we can get information on average sales and employment.

Table 5. Average Sales and Employee in the Environmental Sector

	Company (A)	Sales in Environment (million won) (B)	Workers in Environment (persons) (C)	Average Sales (B/A)	Average Employee (C/A)
2000	15,801	11,536,227	111,468	730	7.1
2002	17,520	18,006,750	129,978	1,028	7.4
2004	23,035	21,427,465	167,961	930	7.3

Sources : Ministry of Environment. 2006. *Report on Environmental Industry Statistics*. Korea.

The number of companies in the sample has increased by 5.3 percent annually from 2000 to 2002 and 14.7 percent annually from 2002 to 2004. Even if the number of companies in the sample has increased from 2002 to 2004, the average sales per company and average employee per company have decreased. This is opposite to what the environmental industry experienced from 2000 to 2002. For this period, the average sales of company in the industry grew annually by 18.6 percent. The average number of workers grew annually by 2.5 percent from 2000 to 2002, and the average number of workers decreases by 0.9 percent annually from 2002 to 2004. Maybe this pattern is related to a particular reason such as hosting the World Cup in Korea in 2002. To manage the ambient air or water quality appropriately, the government could take more care of pollution than at any other time. This could boost the environmental industry growth during this period.

The change of average sales in the environmental sector and the average workers in environmental sector per company by industry are shown in following Table 6.

Table 6. Average Sales in the Environmental Sector per Company and Workers in the Environmental Sector per Company by Industry

(Unit: persons, million won)

	2000		2002		2004	
	Workers	Sales	Workers	Sales	Workers	Sales
Food, Beverage	18.4	3,916	24.2	5,849	7.4	636
Textiles	43.3	5,131	31.7	1,271	12.5	3,326
Pulp, Papers	65.0	50,850	126.0	50,061	7.2	1,549
Cokes, Oil Products	4.9	1,372	13.6	3,672	14.3	943
Chemical Products	10.3	2,248	11.8	4,021	13.8	865
Rubber, Plastic	12.0	1,012	14.5	2,429	18.3	1,230
Non Metal	31.7	9,014	39.0	9,292	36.6	2,479
Fabricated Metal	15.1	1,934	14.9	2,524	10.4	1,909
Others Machinery Equipment	15.7	2,030	14.7	2,258	13.3	2,833
Others Electronics	21.1	4,563	17.7	3,553	12.4	1,559
Precision Machinery	11.7	2,618	10.4	1,183	10.6	1,441
Autos, Trailer	15.5	4,976	32.3	4,242	39.4	38,688
Furniture and Others	9.0	1	1.0	-	10.3	1,402
Recycled Materials	8.3	2,216	17.7	6,641	10.3	1,973
Water	25.0	4,870	25.3	6,261	38.6	7,937
Construction(General)	16.3	2,593	15.0	2,748	20.4	3,529
Construction(Special Trade)	8.6	871	13.4	3,383	5.3	690
Wholesale	3.2	255	3.3	356	3.3	434
Retail	1.9	44	1.8	55	1.7	54
Research & Development	14.0	213	22.3	980	23.0	2,179
Scientific Tech. Service	20.5	1,509	24.1	1,740	14.9	1,184
Business Service	44.2	772	34.0	638	15.9	1,723
Sewage Treatment etc	16.4	1,404	18.3	1,483	12.3	1,277
Clubs	32.8	40	72.0	39,600	6.1	125

Sources : Ministry of Environment. 2006. *Report on Environmental Industry Statistics*. Korea.

When we look at this table, we can also find the same patterns as following. In sales, the sales growth of industries which showed higher growth from

2000 to 2002 diminished rapidly or slowed from 2002 to 2004. In employee state, the employment growth shows similar pattern to that of sales, except some industries such as auto, textile, precision machinery and business services between 2002 and 2004. It looks like the environmental industry development has lost its momentum after 2002 except for some industries.

Chapter 3. Job Creation by the Environmental Industry and Public Investment

1. Some Background of the Estimated Model

Ordinary labor demand function is derived from the profit maximization condition of firms. Short run labor demand is the function of real wage and production quantities. We estimate the traditional labor demand function (here, labor demand means the labor demand in the environmental sector of each environmental industry). So this is a partial equilibrium approach. Even though there are many constraints for us to interpret the estimation results, if we interpret the results carefully, that is, we keep in mind that the estimation is based on the partial analysis, we can extract meaningful information from the estimation.

Before we explain the estimation methods and results, we want to notify people of data shortages; not only the number of data points but also data reliability. Currently, the Korean Ministry of Environment produces environmental industry statistics biannually. As we mentioned before, since the data collection is in the early stage, there are not enough data points, and it takes some time for these data to be reliable. But this data set is a unique official data of the environmental industry in Korea. So we want to let the readers know that the data set which we use here is officially the best data set about environment occupation distribution and environmental industry.

Furthermore, there is no exact information of wages and price levels in each environmental industry sector in the data. To overcome the lack of information in the data, we use some proxy variables for wage and price levels for each environmental industry. Since the environmental industry statistics is based on standard industry classification and many of meta data in environmental industry statistics share with the sample of industry statistics which is announced in the Korea National Statistics Office, wages

and price levels of the same industry sector to the environmental industry sector can be useful proxies for wages and price levels.

We include environment sales information instead of production quantity of environmental goods in the estimation. It is very difficult to define the production quantity in service sector of the environmental industry. To keep the consistency, we decide to use proxy variables which can be commonly used over environmental industry to indicate the production level for controlling the marginal labor productivity. So the real sales value is used in the estimation.

We adopt panel data technique as an estimation technique. Because there is not enough time series of data for using time series analysis and we do not have enough data points for cross section analysis (in the data, the environmental industry is classified with only 24 industry categories), there are no appropriate approaches to analyze by using estimation. Fortunately, however, the Ministry of Environment started to collect the data for 2000, 2002 and 2004. With these three years of data, we can estimate the labor demand function with panel data analysis. So each industry category is regarded as one subject and each has three time series data point. Sometimes, there are missing variables. In this case, we do not include that industry in the estimation sample.

Since we do not have enough data set in time series and cross section points of view, it is difficult to use instrumental variable methods either. Therefore, in the estimation of labor demand, we estimate the model in several ways. Generally, we follow the widely accepted estimation methods with established statistical package, STATA. These are panel generalized least square, panel generalized least square with heteroskedasticity, panel generalized least square with autocorrelation, fixed effect model, random effect model to check Hausman test, and random effect model with autocorrelation. Each model is tested with a misspecification test. Based on several estimation results, we decide the range of the labor demand elasticity with regard to environmental industry sales. Especially we use log form labor demand function, since it is easy to calculate the elasticity. So the basic structure of estimation equation is

$$\ln(L_{st}) = \beta_0 + \beta_1 \ln(w_{st}) + \beta_2 \ln(S_{st}) + \beta_3 \ln(EINV_{st}) + u_{st}, \qquad (1)$$

where L: environment-related labor demand, s: industry, t: time, w: real wage, S: real sales amount in the environmental sector, $EINV$: real environment investment

With this equation, first, we estimate the model with different assumptions of each error structures. Since we do not have enough information in the view of time series and the number of variables itself, when we estimate the model, by changing the assumption of error structure, we hope that we can get more reliable estimation result. So the error structure assumptions in panel GLS estimation are as follows;

1) $\Omega = \begin{bmatrix} \sigma^2 I & 0 & \cdots & 0 \\ 0 & \sigma^2 I & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \sigma^2 I \end{bmatrix}$

in the case of homoskedasticity and no correlation between cross sectional part

2) $\Omega = \begin{bmatrix} \sigma_1^2 I & 0 & \cdots & 0 \\ 0 & \sigma_2^2 I & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \sigma_m^2 I \end{bmatrix}$

in the case of heteroskedasticity and no correlation between cross sectional part

3) $\Omega = \begin{bmatrix} \sigma_1^2 I & \sigma_{1,2} I & \cdots & \sigma_{1,m} I \\ \sigma_{2,1} I & \sigma_2^2 I & \cdots & \sigma_{2,m} I \\ \vdots & \vdots & \ddots & \vdots \\ \sigma_{m,1} I & \sigma_{m,2} I & \cdots & \sigma_m^2 I \end{bmatrix}$

in the case of heteroskedasticity and cross sectional correlation

Lastly, we consider autocorrelation in panel error terms. But if the time series are short, normally we assume the common autocorrelation parameters. So we estimate the model with this common autocorrelation assumption. In this case, we can also estimate with the assumption of homoskedasticity case and the assumption of heteroskedasticity case apart.

And we will estimate the labor demand with fixed and random effect model. The basic model for this is the following;

$$\ln(L_{st}) = \beta_0 + \beta_1 \ln(w_{st}) + \beta_2 \ln(S_{st}) + \beta_3 \ln(EINV_{st}) + v_s + u_{st}, \quad (2)$$

where L: environment-related labor demand, s: industry, t: time, w: real wage, S: real sales amount in the environmental sector, $EINV$: real environment investment, v: industry specific errors

After we estimate the model with random effect we will test the Hausman test to decide whether we use the random effect model or not.

Finally, each data is the average data as we mentioned above. Since the number of companies in the sample has changed a lot during those periods, there is inconsistency when we use aggregate data in this case. Therefore, we calculate the sales in environmental sector per company, workers hired in the environmental sector per company, and wages per company. After we estimate the elasticity at the average level, we calculate the direct employment demanded for the environmental sector. By using the worker distribution structure between the environmental sector and non-environmental sector in the environmental industry statistics in 2004, we estimate the total number of labor demand in the environmental industry.

2. Job Creation in the Environmental Industry

The number of industries that are used in the estimation is 16. They are (1) manufacture of food products and beverage (2) manufacture of textiles except sewn wearing apparel (3) manufacture of chemicals and chemical products (4) manufacture of rubber and plastic products (5) manufacture of non-metallic mineral products (6) manufacture of fabricated metal products except machinery and furniture (7) manufacture of other machinery and equipment (8) manufacture of other electrical machinery and apparatus (9) manufacture of medical precision and optical instruments (10) manufacture

of motor vehicles and trailers (11) general construction (12) special trade construction (13) research and development (14) professional, scientific and technical services (15) business support services (16) sewage and defuse disposal, sanitation and similar activities.

The total sales in the environmental sector of these 16 industries make up 55 percent of total sales in the environmental sector in environmental industry statistics. To estimate the panel data, the industry which has missing values within sample periods are excluded from the estimation sample to maintain the balance of panel data set. The following table shows the estimation results.

Table 7. Estimation Results of Environment-related Labor Demand in Environmental Industry with Panel Generalized Least Square Method

Error Type	Homo	Hetero	Hetero	Homo	Hetero
Relation Type	**-**	**-**	**Correlated**	**Autocorrelated**	**Autocorrelated**
Sales in Environment	0.279	0.193	0.019	0.242	0.212
	(3.58)	(3.75)	(0.11)	(3.67)	(4.09)
Wage	-0.787	-0.676	-0.545	-0.669	-0.637
	(2.50)	(4.67)	(0.98)	(1.88)	(4.36)
Environment Investment	0.053	0.133	0.156	0.023	0.077
	(0.95)	(2.74)	(0.77)	(0.43)	(1.64)
Constant	0.729	0.933	2.685	1.132	1.034
	(1.45)	(2.30)	(2.68)	(2.39)	(2.96)
Test Statistics					
Log-likelihood	-23.650	-5.186	717.274	-15.535	1.239
Wald-Statistics	18.81	43.16	8.01	16.74	46.79
	(0.0003)	(0.0000)	(0.0458)	(0.0008)	(0.0000)

Note : 1) Relation type means the relationship in panel
2) The numbers in parenthesis are z-value. Only, the numbers in parenthesis of Wald-statistics show p-value.
3) Every independent variables is real values.

When you look at Table 7, the mis-specification test statistics improve with heteroskedasticity assumption (in view of log-likelihood and Wald test

statistics). Therefore, to estimate the labor demand model in the environmental industry, it is reasonable to assume heteroskedasticity[3]. But when we assume heteroskedasticity and correlation among industries together, we can observe mis-specified form of model. The main reason for this is that we have un-balanced panel data in view of time span and the number of industries. In that case, normally, the assumption of heteroskedasticity and correlation among groups is not appropriate for the estimation. So we rule out this assumption from estimation results.

So when we consider heteroskedasticity and heteroskedasticity with AR(1) assumption, first, we can estimate each sign of coefficient as we expect. In the case of sales, when the sales increase, it affects the labor demand positively and it is significant. Wage affects the labor demand significantly and negatively as the classic labor economic theory predicts. The increase of environment investment also raises the labor demand but the significance of this coefficient is not decisive.

Another estimating method is random/fixed effect estimation. Since we can observe heteroskedasticity among industries, it is good for us to use these methods for the labor demand estimation again. First, as we mentioned, the model with random effect method was estimated. After that, we do Hausman test. Test results show that we accept the null hypothesis, "difference in coefficients of random and fixed effect models is not systematic". That is, since the test statistic $\chi^2(3) = 3.05$ and p-value is 0.3832, we accept null. Therefore, random effect model estimation is reliable. Furthermore, we estimate the random effect model with AR(1) process, too. The results of estimation are as follows;

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3) The estimated variance of each model except assumption of heteroskedasticity and correlations among groups are reported in the appendix. Since we use industry-based data, it is highly probable that we can observe heteroskedasticity.

Table 8. Estimation Results of Environment-elated Labor Demand in Environmental Industry with Random Effect Model

	Random Effect	Random Effect with AR(1)
Sales in Environment	0.259	0.255
	(3.42)	(3.45)
Wage	-0.660	-0.676
	(1.86)	(1.91)
Environment Investment	-0.004	0.018
	(0.07)	(0.32)
Constant	1.111	1.075
	(2.13)	(2.10)
Test Statistics		
Overall R^2	0.27	0.27
Wald-Statistics	$\chi^2(3) = 14.91$	$\chi^2(4) = 15.29$
	(0.0019)	(0.0041)

Note : 1) The numbers in parenthesis are t-value. Only, numbers in parenthesis of F-statistics show p-value.
2) Every independent variables is real values.

Generally, random effect estimation is reasonable in the estimation of labor demand in the environmental industry. When we look at χ^2-statistics, we can accept the argument that the model is well-specified. And the sign of variables which are significant is what the theory predicts. When we compare these estimation results with those of panel generalized least squares, we realize that the estimated coefficient in random effect model relatively overestimates the effect of independent variables on labor demand. So we regard the estimation results in the random effect model as maximum points and the results of the panel generalized least square model with the assumption of heteroskedasticity as minimum estimation value.

Based on former estimation results, we can infer the elasticity of sales on labor demand in the environmental industry easily, because we estimate the model of log linear function. On the average, each industry is estimated at the elasticity of sales on labor demand as from 0.193 to 0.259. So, when we

define 0.193 as minimum elasticity estimator and 0.259 as maximum value for that, it means that at 1 percent change of sales on the average, it gives 0.193 percent to 0.259 percent increase of labor demand in each environmental industry. With the sample data for estimation, we can calculate the amount of 1 percent change in sales at each industry level from average sales and the following labor demand increase range at each industry level from average workers by industry in 2004. And then we adjust the number with basic monetary unit, 1 billion won, to compare the results with each other[4]. Finally when we calculate the increase of labor demand in the non-environmental sector, we assume that the structure of workers between the environment and non- environmental sector is that same to that of 2004.

[4] Actually, this calculation method can make bias in estimation results. But to compare the results with each other sector and the induced employment coefficient in I/O table analysis, it is easiest way to get information.

Table 9. Labor Demand Increase according to Sales Increase in the Environmental Sector

(Unit : bil. won, persons)

	Total		Environment		Non-Environment	
	Min	Max	Min	Max	Min	Max
Food, Beverage	5.1	6.8	2.6	3.5	2.5	3.4
Textiles	6.8	9.2	0.7	1.0	6.1	8.2
Chemical Products	4.4	5.8	3.7	5.0	0.6	0.9
Rubber, Plastic	3.7	4.9	3.1	4.2	0.6	0.8
Non Metal	4.5	6.1	3.2	4.2	1.4	1.8
Fabricated Metal	1.8	2.4	1.2	1.7	0.5	0.7
Others Machinery Equip	4.0	5.4	0.8	1.0	3.3	4.4
Others Electronics	2.7	3.6	1.7	2.3	1.0	1.3
Precision Machinery	2.5	3.4	1.4	1.9	1.1	1.5
Autos, Trailer	0.6	0.8	0.2	0.3	0.4	0.5
Construction(General)	8.4	11.3	1.4	1.9	7.0	9.5
Construction(Special)	8.5	11.4	1.9	2.5	6.6	8.8
Research & Development	2.4	3.3	2.4	3.3	0.0	0.0
Scientific Tech. Service	2.9	3.9	2.9	3.9	0.0	0.0
Business Service	6.5	8.8	1.9	2.5	4.6	6.2
Sewage Treatment etc	2.8	3.8	2.0	2.7	0.8	1.1
Average	4.2	5.7	1.9	2.6	2.3	3.1

Note: 1) environmental industry is classified into smaller industry sectors in this table.
2) The labor demand is increased when we assume that the sales in environmental sector is increased by 1 billion won in each industry sector.
3) Minimum increase in labor demand of environmental sector is calculated based on the elasticity of 0.193 and Maximum increase is based on the elasticity of 0.259.

One billion won increase of sales in the environmental sector of 16 industries can affect labor demand increase differently. When we array labor demand increase by the amount, the top industries which can affect labor demand in large scale are the construction sector, textile sector, and business

service sector in the environmental industry. Food and Beverage, chemical products and non-metal sectors are next in labor demand increase.

Even though there are many differences in estimation process and collecting data method, to check the job creation ability of the environmental industry, it is useful to compare these numbers with the induced employment coefficient of several industries which are derived in Input-Output table analysis. The following Table 10 shows the induced employment coefficient of 2000 I/O table of some industries. Especially, to decide the proper job creation ability status of the environmental industry in labor demand, we select some manufacturing industries that are regarded as major industries in Korea.

Table 10. Induced Employment Coefficients in Some Industries

(Unit : persons/bil. won)

Industry	Coefficient
Organic Basic Chemical Products	5.0
Gas & Water Supply	5.0
Electronic Services	6.6
Pig Iron & Crude Oil	6.7
Synthetic Resins & Rubber	7.3
Real Estate Agencies & Rental	7.3
Nonferrous Metal & Primary Metal	7.3
Electronic Components & Accessories	7.7
Sugar & Starches	8.4
Primary Iron & Steel Products	8.6
Chemical Fibers	8.9
Communication & Broad Casting	9.2
Inorganic Basic Chemicals	9.8
Computer & Office Equipment	9.8
Other Chemical Products	10.9
Radio, TV & Communication Equipment	11.7
Electronic Machinery Equipment & Supplies	14.5
Motor Vehicles	14.6
Ship Building & Repairing	14.9
Wholesale & Retail Trade	46.6

Source : Bank of Korea. 2003. *2000 Input-Output Table*.
Note : This includes the directly and indirectly induced employment.

When we compare these coefficients and labor demand increase in the environmental industry, the degree of job creation ability in some sectors in the industry is comparable to that of the major industries in Korea. Especially, the labor demand increase in Table 9 considers only the direct effect, but Table 10 shows total effect(direct + indirect). Therefore, at least, we can expect powerful job creation ability in construction, business services, textiles, and food and beverage sectors of the environmental industry.

When we remember that the share of sales in the environmental sector of 16 industries is 55 percent of total sales in the environmental sector in environmental industry statistics, the size of sales increases and labor demand can be expanded further. Hence, when we suggest a rather strong assumption that increases in the labor demand between 16 sectors and the other remaining sectors of environmental industry statistics have proportional relationship as indicated in 2004, we can guess that the employment rate rises in the environmental industry by increasing one billion won as follows;

Table 11. Total Labor Demand Increase in the Environmental Industry according to One Billion Won Sales Increase in the Environmental Sector

(Unit : persons)

ε = 0.193			ε = 0.259		
Environment	Non-Environment	Total	Environment	Non-Environment	Total
3.5	4.2	7.7	4.9	5.6	10.3

Note : ε represents the labor demand elasticity of environmental sector sales on labor demand

When we compare the result in Table 11 with the direct induced employment coefficient of the overall manufacturing industry which is presented in 2000 Input/Output tables[5], we can find that the job creation ability of the environmental industry is not that small.

In Chapter One, we talked about the importance of environmental technology development. As Jeong(2006) indicates, environmental policy is heading toward the integrated pollution control management. The success of the adoption of this policy depends on the development of environmental technology. And the Korean government also has a deep understanding about the necessity of environmental technology developments; it says that "to improve domestic ambient environmental quality and to decrease pollution

5) The direct induced employment coefficient of the overall manufacturing industry is 4.9, and service sector is 18.2.

emission, it is indispensable to develop environmental technology (Ministry of Environment, 2006, *Environment Report 2006*)." The Ministry of Environment promotes technology development projects such as Eco-Technopia 21. The Ministry of Environment has spent and will spend 1000 billion won from 2001 to 2010. That is, the Korean government has spent around 5 percent of its R&D budget to invest in the environmental technology sector and to keep this pattern. Also the Ministry of Environment has plans to procure 100 billion won each year for the development of environmental technology (*Environment Report 2006*). Besides, to accelerate environmental industry development, the government offers financial support to improve pollution prevention equipment installation and natural gas provision facilities. In 2005, the Ministry of Environment spent 82 billion won to support this. And to help the private sector to invest in pollution prevention equipment, the Ministry allows tax reduction or exemption policy.

As the total budget for environmental technology research in 2006 was 217 billion won and in view of the financial and tax exemption support to investigate pollution prevention equipment, it is not an excessive assumption for us to expect 1 percent sales increase of the environmental sector in the environmental industry; that is 214 billion won. So we can expect the job opportunities for around 1,600~2,300 workers in the environmental industry annually with the current policies.

The sales in the environmental industry also increases the labor demand for other industry sectors. According to input-output table analysis of Kim and Choi (2003), the environmental industry brings high influence over other industries; the environmental industry is ranked upper-middle in view of the degree of influence among 28 industries. They define the environmental industry as the industry which can be classified into intermediate goods production with high forward and backward linkage effects. Since they do not have the employment data of the environmental industry, they cannot calculate direct and indirect effect of the environmental industry on employment. But when we consider the several effects of environmental industry's sales on other industries (through production induction coefficient/value-added coefficients, etc), we can imagine easily that the effect

of environmental industry sales on employment is not small.

3. Job Creation by the Public Environmental Expenditure and the Renewable Energy[6)]

In the previous section, we took a look at the availability of jobs in the environmental industry sector which covers manufacture and service sectors. From now on, we focus on the job availability of the natural resource and renewable energy sectors. Especially, the government policy in the natural resource sector can be related to the monitoring, recovering of natural resources, and promoting eco-tourism. The renewable energy sector can be encouraged politically. Therefore, we survey articles about these subjects.

3.1. Job Creation by Public Expenditure in Natural Resource Preservation Area

We investigate the job creation in the natural resource sector first. Kim(2006) suggests the detailed job availability in the natural resource sector. He classifies the job availability in this sector into four categories; preservation and guide of natural resources, monitoring and recovering of natural resources, the environmentally- friendly usage of natural resources, and natural resource preservation in a specific area. Among them, in the sector of specific area natural resource preservation, he suggests the use of the military army. So, in this research, we skip that sector from job creation in the natural resource sector. Based on the consideration of the number of environment preservation area, national parks and forest area, he calculates the job availability, and suggests job creation as follows

6) We summarize and reorganize the report of "Social Job Creation in Environmental Sector" which is published by Kim(2006) and "Analysis of Employment Effects of Renewable Energy" which is Kim's Master's thesis(2004).

Table 12. Job Creation in the Natural Resource Sector

(Unit: person)

Job Classification	Ⅰ	Ⅱ		Ⅲ
	2007	2008~2011		2012
Eco-guide Jobs are related to eco-tourism, eco-marketing and eco-education, etc.	586	1,162	1,785	2,423
Monitoring/Recovering Jobs are related to monitoring and investigating the natural environment state/recovery of damaged natural resources	625	1,815	2,845	5,215
Natural Resource Use Jobs are related to the coordination and improvement of the use of environment friendly natural resource products and forest bio-mass	100	150	250	500
Total	1,311	3,127	4,880	8,138

Source : Reorganize the table from Kim. 2006. *Report of Social Job Creation in Environmental Sector*. PCSD. pp. 90-91.

In the above table, period Ⅰ is defined as introduction period, Ⅱ as expansion period by step, and Ⅲ as settlement period. Jobs are created annually by 44 percent in this sector based on this scenario.

Then, the next question is how much public investment or government expenditure must be made for this? In Kim(2006)'s article, we can find some information about the size of government expenditure for forest management related jobs and monitoring jobs. The summarization of this information is suggested in Table 13.

Table 13. Government Expenditure for Jobs in the Natural Environmental Sector

(Unit: person, million won)

Authorities	Jobs	Employment	Expenditure
Ministry of Environment[1)]	Monitoring	155	1,074
Korea Forest Service[2)]	Forest Management etc.	3,567	37,395

Source : Reorganize Table 7 and Table 11 from Kim. 2006. *Report of Social Job Creation in Environmental Sector*. PCSD. pp. 43, 55.

Note : 1) 2005 expenditure
2) 2006 budget

In Table 13, the Ministry of Environment spent its expenditure for the job creation of monitoring activities for eco/wet preservation area and the Dong-river. The Korea Forest Service's budget is used for the job creation of forest management, afforestation management, monitoring the trail of mountain, plant research, and eco-guide. With the information of Table 13, when we calculate the average expenditure for each worker, the sizes of expenditure is 6,930,000 won per worker incase of the Ministry of Environment and 10,483,600 won per worker in the case of the Korea Forest Service. When we consider a worker in a social job earns 600,000~680,000 won per mont[7)], it is not a reasonable amount of wage level. So if we assume that 700,000 won per month - which is the medium number of that of the expenditure of the Ministry of Environment and the Korea Forest Service - as government expenditure for the unit labor cost of environment-related projects, we can guess the size of expenditure for job creation in Table 12 by simple multiplication.

7) This information comes from Table 5 in "*Report of Social Job Creation in Environmental Sector*(Kim. 2006. pp. 32.)".

Table 14. Expected Annual Government Expenditure for Job Creation in the Natural Resource Sector

(Unit: million won)

	Ⅰ	Ⅱ		Ⅲ
	2007	**2008~2011**		**2012**
Total Expenditure	11,012	26,267	40,992	68,359

Note : Total Expenditure = expected job creation in Table 12 × ₩)0,000 × 12

So when we compare the job creation ability between public expenditure in the natural environmental sector with that of the environmental industry sector, the effect of job creation in the natural resource sector is very large in view of job creation size. However, when we consider the job quality, duration, technology level and linkage effect, we cannot underestimate the effect of job creation in the environmental industry sector.

3.2. Job Creation by Public Expenditure in the Renewable Energy Industry[8)]

Recently, we experienced a rapid increase in oil prices and energy consumption. The pollutant emission quantity coming from energy consumption is also increasing. This accelerates climate change, and we start to worry about the disaster from climate change. These several factors force every government to think about energy restructuring. As a result, it provides favorable conditions for renewable energy development.

In Korea, the Ministry of Commerce, Industry and Energy announced the Second Basic Planning for the Renewable Energy Development in September 2003. In this plan, the aim of supplying power generation is as follows

8) The content of this section is selected from the master thesis of Kim. 2004. *Analysis of Employment Effects of Renewable Energy*.

Table 15. The Aim of Power Generation Supply

(Unit: GWh)

	2006	2008	2010	2012
Solar	88	262	767	1,793
Wind	504	1,445	3,526	6,639
Small Hydro	445	918	1,470	2,140
IGCC		79	2,138	6,336
LFG	2,465	3,384	4,000	4,616
Fuel Cell	5	42	894	2,622
Ocean	3	573	843	1,726
Total(Renewable only) (A)	3,059	6,703	13,638	25,871
Total Power Generation (B)	321,179	339,452	355,321	369,973
Share (A/B, %)	1.1	2.0	3.9	7.0

Source : Ministry of Commerce, Industry and Energy. 2004. *The Second Plan of Electronic Power Demand and Supply*.

Based on this plan, the Korean government plans to supply 7 percent of electronic power generation with renewable energy. Therefore, it is worth to check the job creation ability of these sectors. For example, in Germany, the size of employment in the renewable energy industry in 2002 is 120 thousand workers, which is an increase by 70,000 workers from 1998[9]. In this chapter, we introduce a research about the effect of the renewable energy industry on employment in Korea.

The widely-accepted methodology to measure the employment effect in the renewable energy sector in Korea is based on the input-output analysis. In 2004, Soo-Jin Kim studied the employment effect of solar and wind energy industry in Korea with 1998 Input/Output table. In her research, she calculates employment per generated power. To calculate the employment per

9) Durrschmidt W. et al. 2004. *Environmental Policy(Renewable Energy Sources in Figures - National and International Development)*. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. Germany.

generated power, we must consider technical condition. In her research, she sets up nine scenarios based on technical condition, the degree of cost decrease, and technology learning condition. Then we look at the job increase from both the power equipment installation and power generation process. Among her set-up, we pick the medium condition as technology point and maximum scenario in view of generated power, which is similar to the generated power level of government's plan for renewable energy development[10]. The total capacity installation is 3,619 MW, and power generation is 7,925 GWh in the case of wind, and 2,080 MW, 2,369 GWh in the case of solar generation.

First, to achieve the aim of power generation, in the case of wind generation, equipment installation is needed. Based on her scenario, she calculates the labor requirement and total installation cost. Here, to keep the consistency with other sector's job creation ability, we just inform the direct job creation effect of wind generation. The total installation cost in 2015 is 923,697 million won and it will create 15,084 jobs in 2015[11].

Second, the calculation of job creation according power generation is as follows;

① Learning rate : learning rate is calculated based on electronic power production cost according to cumulative power generation. The learning rate decreases when the technology approaches a mature stage. She assumes 8 percent for wind generation in 2015, which is the level of learning rate in Denmark, Germany in the 1990s.

② She assumes 3,619MW as capacity, 7,925GWh as generated power which is similar to the government's plan.

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10) In the "Second plan of electronic power demand and supply" of the Korean government, in 2012, the aim of power generation is 6,639 GWh.(Ministry of Commerce, Industry and Energy. 2004. *The Second Plan of Electronic Power Demand and Supply*.)

11) Kim, Soo Jin. 2004. *Analysis of Employment Effects of Renewable Energy*. Master Thesis. Seoul National University. Appendix Table 5. In this table, she shows the installation size of each year for power generation. So we assume that installation is made every year and we consider only the case of 2015. The same approach is used in the solar part.

③ The installation cost with assumption of ① and ② is $560.23/kW, and the power generation cost is ₩56.04/kWh.

④ Duration period for turbine is 20 years, and utilization is 25 percent. Then total power generation for 20 years with 1KW capacity is 0.0438GWh.

⑤ Labor coefficient for wind power generation is 16.63person/10billion won.

⑥ The mandatory number of managing person is three people for 100MW. Then, the managing person per generation power is 0.014 person/GWh.

Based on the above assumptions, she calculates the employment level per generation power as 0.2765 person/GWh. So, if we just combine these two numbers with 7,925 GWh, we can expect 2,303 jobs created with 455 million won of power generation cost in 2015. Finally, when we combine the job creation from equipment installation and power generation, we find that 924,152 million won will be spent for equipment installation and power generation in 2015. and 17,387 jobs can be created in the same year.

In the case of a solar power plant, the total installation cost in 2015 will be 1,807,500 million won, and 17,509 workers are expected to be hired[12]. And the job creation from power generation is calculated as follows;

① Learning rate : learning rate is calculated based on electronic power production cost according to cumulative power generation. The learning rate decreases when the technology approaches a mature stage. She assumes 22 percent for solar power generation in 2015, which is the level of learning rate in Europe during 1976~1996.

② She assumes 2,080MW as capacity, 2,369GWh as generated power which is similar to the government's plan.

③ The installation cost with assumption of ① and ② is $1.18/kW and the power generation cost is ₩100.68/kWh.

④ Duration period for solar batteries is 30 years and utilization is 13 percent.

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12) Kim, Soo Jin. 2004. *Analysis of Employment Effects of Renewable Energy*. Master Thesis. Seoul National University. Appendix Table 8.

Then, total power generation for 30 years with 1KW capacity is 0.034GWh.
⑤ Labor coefficient for wind power generation is 9.687person/10billion won.

Based on the above assumptions, she calculates the employment level per power generation power at 0.4371 person/GWh. So, if we just combine this number with 2,369GWh, we can expect 1,036 jobs created with 244 million won of power generation cost in 2015. Then, the total cost is 1,807,744 million won and the job creation is 18,545 in 2015.

The total direct job creation from wind and solar power generation in 2015 is summarized as following Table 16.

Table 16. Job Creation in Wind and Solar Power Plant (2015)

(Unit: million won, person)

		Installation	Power Generation	Total
Wind	Cost	923,697	455	924,152
	Job	15,084	2,303	17,387
Solar	Cost	1,807,500	244	1,807,744
	Job	17,509	1,036	18,454

Until now, we investigated job creation in the environmental industry, public expenditure in natural resources, and some renewable energy development. When we think about the efficiency of job creation, that is in view of the number of job creation with constant spending, it looks like that the degree of job creation due to public expenditure is the highest. But when we think about the demand change, labor quality or human capital growth, duration of job etc, the way of enhancing job creation and environmental protection can be different according to the status of the economy and the environment of a country. Therefore, even if we can observe different numbers of job creation in each different sector, we must consider several factors to decide which policy is desirable to solve the environment and employment problems together.

Chapter 4. Policy Implications

Environmental policy will be heading toward an integrated management of pollution instead of managing each pollutant separately. This change requires the development of environmental technology to control the pollution. Also, it is important to keep economic growth and environmental protection at the same time for sustainable development. To do that, on the one hand, the government regulates pollution emission continuously, and on the other hand the government can suggest and develop the best available technology to keep up economic growth and protect the environment. Given this point of view, it is desirable for government policies to focus on job creation in the environmental sector.

Before we think about the policy, let's check the distribution of environment-related jobs. When we look at the environment-related job distribution in Korea, we can find the fraction of low-skilled labor is high overall. The Occupation Employment Statistics shows that the share of low-skilled labor in the environmental industry is around 90 percent. The majority of industries whose fraction of low skilled labor is high are private business services industry and public services industry. Technology service, social overhead capital related industries, manufacture, and direct environmental service industries show relatively high fraction of high-skilled workers. So, the government needs to upgrade the labor quality in the environment-related sectors. And it is timely for the government to consider the ways to enhance high-skilled labor force.

The following Table 17 shows the job creation ability by spending 1 billion won in the environmental industry, public expenditure for natural resource protection, and power generation of renewable energy (wind and solar). Even though it is quite difficult to compare these numbers together because the situation is somewhat different, just consider the direct effect of 1 billion won spending on job creation only. It is worth to compare these numbers to know which policy to choose.

Table 17. Job Creation per One Billion Won Spending

(Unit: person)

	Calculation Method and Assumption	Job Creation	
Environmental Industry	We assume that ε = 0.256.	10.3	
Public Expenditure	Total Job Creation/Total Expenditure (in 2012 and in the case of natural resource protection)	119.0	
Renewable Energy	Total Job Creation/Total Cost for Installation and Power Generation(in 2015)	wind	18.8
		solar	102.0

Note : In the case of the job creation number in the environmental industry and renewable energy, the table only contains direct effect on job creation.

This suggests that, in the short run, the best policy to create job is related to the policy that enhances private business services and public services industry. It will create 119 jobs per one billion won spending. Therefore, the policy to promote monitoring, eco-tourism, forest management etc. can be helpful to solve unemployment problems as a quick prescription during economic recession. This policy can affect the regional inequality of unemployment also. Since natural resources are spread over the nation, the employment of natives can solve the local unemployment problem.

However, a large portion of created jobs from expenditure in the natural resource sector is low-skilled workers. In the long run and in view of the size of market for the industry, the desirable policy is to promote the environmental industry. Especially, the policy must focus on the development of environmental technology. That is, in the long run, the government must consider the labor quality in the market.

As we saw before in the Occupation Employment Statistics, the portion of high-skilled workers in manufacture, direct environment treatment service, scientific technology services, and construction is high. Those are the key areas of the environmental industry. So, the promotion of the environmental industry is a desirable policy for human capital accumulation. Furthermore,

since the market for the environmental industry has increased, the expansion of demand in this sector can guarantee longer job duration. The industries that show high labor demand increase according to environment sales growth are industries in chemical products, other machinery products, construction, scientific research businesses, and the sewage treatment system. Among them, industries in other machinery industry and construction show relatively high demand increase of non-environmental sector workers too when we compare those with the labor demand increase of the environmental sector in the same industry. So, by using this labor demand structure, the government can control the job distribution among environment and non-environment workers with a policy that intensively promotes some industries in the environmental sector.

For example, if the government wants to have a job creation effect that can affect overall jobs by developing the environmental industry, it is appropriate for the policy to focus on the construction and other machinery industry sector. However, if the government wants to increase jobs directly related to the environment, then it is effective for the policy to support other sectors.

The renewable energy sector has a reasonable job creation ability if the conditions for development of renewable energy are satisfied. But as we mentioned earlier, the development of renewable energy is very restricted in Korea. First of all, it is not developed nationwide because of climate conditions. Wind and solar power generation does not meet the economic efficiency in some regions. Second, cost wise, it is still expensive to supply electricity so, without subsidy from the government or voluntary participation of energy users into renewable energy use, it is hard to spread the demand for renewable energy over the nation. In this regard, it is limited to create jobs through renewable energy development even though job creation ability in this sector is relatively reasonable. But when we consider the high increase of energy price, maybe there will be a time to start restructuring the energy industry. Then, it will be worth to think about the enlargement of renewable energy demand and supply to achieve sustainable development in view of job creation and environmental protection.

The last thing that we consider is the location change of manufacturers or production site of industries according to the stringency of an environmental policy, even though we did not mention about the effect of stringency of environmental policy on location before. When we survey empirical articles about location change, we realize that it is not easy to identify the effect of the stringency of environmental policy on location change because it is always mixed with other effects that can encourage change of location, i.e. transportation cost, labor cost, market size, etc(Hwang, 2006). In empirical research on the relationship between foreign direct investment and stringency of environmental policy, Lho(2002) shows that the pollution haven effect is insignificant. Therefore, it is hard to indicate the stringency of environmental policy as a reason of employment loss according to production site change.

Chapter 5. Conclusion

One of the aims of sustainable development is to continue economic development without damaging the environment. Conversely, if the government can increase jobs with environmental protection, this policy can be a sustainable development strategy. In line of this, we focus on job creation with environmental protection activities which are affected by the government policy.

However, when we think about government policies, it is very difficult to define them as one variable in an economic model because there are various types and targets in policies. To avoid this ambiguity, we treat in this research only three cases. First, it is related to the environmental industry development. Second, it is public expenditure for natural resource protection. Last, it is about the renewable energy industry. Based on available data and literature, we calculate the effect of unit spending on job creation.

Before analysing the job creation in each sector, we check the job distribution of employment in Korea. According to the Occupational Employment Statistics which is announced by the Korea Employment Information Service(KEIS), in public and private business service sector, low-skilled labor is dominant in environment-related jobs. However, in the technology service, construction, manufacture and direct environment treatment sector, high-skilled labor is hired more. The policy direction has changed to an integrated approach from treating each pollutant separately, so it is time to consider that labor policy in the environmental sector pursues the way to enhance labor quality in the environmental service section.

The best way to achieve this goal is to support the environmental industry. The environmental industry has a high potential to be a major industry in the future. And because the environmental industry itself is relatively technology or research oriented(refer to Table 6), it is quite an appropriate place to improve the labor quality. When we estimate the labor demand function in this industry, the elasticity of labor demand according to environmental sector sales is 0.193~0.256. It means that the increase of sales

by 214,275 million won can create around 1,600~2,300 jobs, and this is merely a direct effect. So the indirect job creation will be higher than this estimate.

In the case of public expenditure in natural resource protection, Kim(2006) suggests 8,138 jobs in 2015. These are related to eco-tourism, eco-guide, natural resource monitoring and recovering, and forest management related jobs. When we assume the salary for them is ₩700,000 per month, the government or the public sector must spend 68,359 million won. Job creation in this sector looks more effective than that in the environmental industry support. But when we consider labor quality and job duration, it is useful for the government to solve only the temporary unemployment problem.

When we look at the renewable energy industry, it is also effective to invest in this sector in the view of job creation and labor quality improvement. Wind power generation creates 17,387 job opportunities with 924,152 million won worth of power generation cost in 2015. Solar power generation creates 18,454 job opportunities with 180,990 million won worth of power generation in2015. But because of the climate condition and demand for energy in Korea, the job creation effect in this sector is limited.

A government chooses a policy effectively according to the situation. Sometimes, some can argue that if money is spent in other sections that can create more jobs, then it is not an efficient way to invest or spend money for the development of the environmental sector in the view of job creation. But when we consider the characteristics of the environment, unpredictable, asymmetry of recover and destruction, the value of environmental protection can be larger than some job creation.

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Appendix

Table A. Estimated Variance of Panel Generalized Least Square Methods

	Homo	Hetero	Homo with AR	Hetero with AR
Food	0.15684859	0.17715935	0.11185130	0.14788544
Textiles	0.15684859	0.33090608	0.11185130	0.34307862
Chemical	0.15684859	0.09958710	0.11185130	0.08426979
Rubber	0.15684859	0.06675770	0.11185130	0.06357893
Non-metal	0.15684859	0.32382792	0.11185130	0.17860209
Fabricated	0.15684859	0.09012871	0.11185130	0.04970752
Oth. Mach.	0.15684859	0.00529676	0.11185130	0.00364827
Oth. Elect.	0.15684859	0.20062390	0.11185130	0.00627763
Precision	0.15684859	0.19588956	0.11185130	0.07286455
Auto	0.15684859	0.20131254	0.11185130	0.20650477
Const.(gen.)	0.15684859	0.02509026	0.11185130	0.02259579
Const.(spec.)	0.15684859	0.28139364	0.11185130	0.19009367
Research	0.15684859	0.08827856	0.11185130	0.03386218
Sci. Tech. Ser.	0.15684859	0.09674498	0.11185130	0.05251827
Nusiness Ser.	0.15684859	0.50345541	0.11185130	0.32274077
Sewage	0.15684859	0.00368644	0.11185130	0.01139246
Auto-correlation	-	-	0.5631	0.5631

국문요약 (Abstract in Korean)

제1장 서 론

1. 서론

한국 경제는 현재 경기침체기를 벗어나고 있으나 실업 문제 등 여러 가지 경제현안에 쌓여있다. 이러한 상황에서 정부는 환경보호와 경제발전 간에 상충관계(trade-off)가 있다고 쉽게 오해할 여지가 많다. 그러나 2004년 황석준과 강만옥은 그들의 연구를 통해 노동수요와 환경정책 간에 trade-off의 관계 보다는 상호 긍정적인 작용이 있었다는 점을 실증적으로 보여주었다. 이 연구 이후 2년이 지난 지금 환경산업과 환경직무에 대한 새로운 자료가 추가되었고, 따라서 이들 자료를 바탕으로 환경정책과 고용간의 관계에 대한 좀 더 자세한 연구를 진행할 수 있어 본 연구를 통해 좀 더 구체적으로 환경정책과 고용간의 관계를 살펴보았다.

한편 환경정책은 너무 광범위하여 정의하기가 어렵고 각 환경정책 하나하나가 한 연구의 과제가 되므로 우리는 환경정책을 다음과 같이 크게 세 가지로 분류하여 연구를 진행하였다. 첫째는 환경산업진흥에 영향을 미칠 수 있는 정책, 둘째는 자연자원보호를 위한 공공투자에 관련한 지출, 셋째는 신재생에너지산업 분야이다. 이들은 각각 민간, 공공 및 에너지 분야의 대표적인 환경보호 관련 정책이므로 이들의 고용에 관한 효과를 알아보는 것은 전체 고용효과를 가늠할 수 있을 것으로 판단된다.

2. 선행연구

여러 문헌에서 이미 검증되었듯이 규제가 생산비용을 올릴 수 있지만 반면에 규제는 환경보호를 위한 강력한 동기를 제공하고 경우에 따라서 산업경쟁력을 강화시켜 고용에 크게 영향을 미치지 않거나 오히려 고용을 창출하기도 한다. 두 번의 환경정책과 고용에 관련된 OECD 보고서는 고용에 대한 환경정책의 효과가 크지는 않지만 긍정적인 영향이 있다고 보고하여 고용창출의 가능성을 긍정적으로 평가하였다. 이 밖에도 많은 실증적인 또는 이론적인 연구들이 노동시장에 있어 환경정책의 고용효과는 적어도 부정적인 영향이 없다는 점을 밝히고 있다.

제2장 환경부문의 고용

1. 전 산업의 환경관련 고용

중앙 고용 정보원은 2001년 이후부터 연간 한국고용직업분류표를 작성하여 보고하고 있다. 고용직업분류표를 통해 환경관련 직종을 살펴보면 환경공학엔지니어, 환경/위생 관련 노동자, 환경기기조작원, 환경관련 사무원 및 청소원 등으로 분류할 수 있다. 이들 직업종사자들은 고용직업분류표의 2.4%에 달하고 있으며 이들 중 10% 는 숙련기술노동자들이고 90%는 비숙련단순노동자들이다. 이러한 점은 환경관련고용시장에 있어 비숙련단순노동자들이 주류를 이루고 있어 환경고용시장에서의 노동자들에 대한 질적 전환이 필요한 시기가 되었음을 보여주고 있다. 아래의 <표 1>은 이들 노동자들의 분포를 각 분야별로 살펴본 것이다.

<표 1> Distribution of Worker Skill by Category (2003)

Category	Low Skilled(%)	High Skilled(%)
Direct Environmental Services	42.8	57.2
Public Services	89.7	10.3
Private Technology Services	16.3	83.7
Private Business Services	99.2	0.8
Social Overhead Capital Related	41.7	58.3
4 Manufactures	39.8	60.2

Sources : Korea Employment Information Services. 2004. *Occupational Employment Statistics*.
Note : Low skilled is the share of low skilled workers among total environment- related workers in the category. High skilled is the share of high skilled workers among total environment-related workers in the category.

이 표는 앞에서도 언급하였듯이 정부가 환경분야 노동자들의 기술구조를 증진시키려 한다면 단순한 고용확대보다도 환경기술의 발전과 환경우호적인 산업구조로의 전환 등에 정부지출을 증대시킬 필요가 있음을 시사하고 있다.

2. 환경산업의 고용

환경산업에 대한 통계는 환경부가 2년 주기로 수집하며 발표하고 있다. 2004년 환경산업통계를 보면 환경산업 종사기업의 15% 는 제조업에 종사하고 있고 5%의 환경산업

에 속하는 기업은 건설업, 나머지 80%는 서비스 분야에 종사하고 있다. 환경산업의 매출액은 2004년도에 21조에 달하고 있으며 총 매출액의 40%는 제조업분야에서 17%는 건설업 그리고 43%는 서비스 분야에서 발생하고 있다. 환경산업 종사자의 분포는 아래의 <표 2>와 같다.

<표 2> Worker Distribution in the Environmental Industry

	Manufacture	Construction	Service	Total
Total Employee (A)	97,380	135,384	139,378	372,142
Employee in Environmental Sector (B)	57,103	22,544	88,314	167,931
B/A	58.6	16.7	63.4	45.1

Sources : Ministry of Environment. 2006. *Report on Environmental Industry Statistics*. Korea.

제3장 환경산업 및 공공투자에 의한 고용창출

1. 추정모형의 이론적 배경

일반적인 노동수요 함수(본 연구에서는 노동수요라 함은 환경산업에서 환경부문에 종사하는 노동자에 대한 수요를 의미한다.)는 기업의 이윤극대화 조건에서 도출된다. 우리는 패널분석방식을 통해 환경산업의 환경부문종사자에 대한 노동수요함수를 추정하였다. 주된 분석기법으로 각 오차항에 이분산성과 자기상관을 고려한 패널 일반회귀분석방법과 임의효과 모형 등을 이용하여 노동수요함수를 추정하였다.

2. 환경산업의 고용창출

먼저 환경산업부문의 환경부문종사자에 대한 노동수요를 추정한 결과 환경부문의 매출액증가에 대한 노동수요의 탄력도는 최저 0.139에서 최대 0.259로 추정되었고 이는 환경부문 매출액이 평균수준에서 1% 증가할 경우 환경부문 종사자에 대한 노동수요가 평균을 기준으로 0.193~0.259%로 증가함을 의미한다. 아래의 <표 3>은 이들 추정결과를 바탕으로 환경부문의 매출액이 십억원 증가할 때 각 탄력도에 따라 환경산업의 고용자에 대한 수요가 얼마나 증가할 것인가를 계산한 결과이다.

<표 3> Total Labor Demand Increase in Environmental Industry according to One Billion Won Sales Increase in the Environmental Sector

(Unit : persons)

ε = 0.193			ε = 0.259		
Environment	Non-Environment	Total	Environment	Non-Environment	Total
3.5	4.2	7.7	4.9	5.6	10.3

Note : ε represents the labor demand elasticity of environmental sector sales on labor demand

우리가 위에서 계산된 결과를 2000년 산업연관분석표의 산업별 고용유발계수와 비교해 보면 2000년 제조업의 전반적인 고용유발계수가 십억원당 4.9명임을 볼 때 (서비스업의 경우에는 18.2명) 환경산업의 고용창출능력이 적지 않은 것으로 판단할 수 있다.

3. 공공부문의 환경지출 및 신재생에너지 부문에 의한 고용창출

3.1. 자연자원 보존을 위한 공공지출에 의한 고용창출

아래의 표는 김재현(2006)에 의해 제시된 자연자원분야에 대한 공공부문의 고용창출에 관한 자료를 정리하여 본 것이다. 주로 크게 이들 직종은 에코-가이드, 자연자원 감시 및 복원관련직무, 자연자원의 친환경적상품개발 등과 관련된 직종에 대한 고용창출 가능 인원이다.

<표 4> Job Creation in the Natural Resource Sector

(Unit: person)

Job Classification	Ⅰ	Ⅱ		Ⅲ
	2007	2008~2011		2012
Eco-guide Jobs are related to eco-tourism, eco-marketing and eco-education, etc.	586	1,162	1,785	2,423
Monitoring/Recovering Jobs are related to monitoring and investigating the natural environment state/recovery of damaged natural resources	625	1,815	2,845	5,215
Natural Resource Use Jobs are related to the coordination and improvement of the use of environment friendly natural resource products and forest bio-mass	100	150	250	500
Total	1,311	3,127	4,880	8,138

Source : Reorganize the table from Kim. 2006. *Report of Social Job Creation in Environmental Sector*. PCSD. pp. 90-91.

이러한 <표 4>의 시나리오에 맞춰 고용을 창출할 경우 정부가 지출해야하는 환경관련 정부지출액을 <표 5>와 같이 계산하여 보았다.

<표 5> Expected Annual Government Expenditure for Job Creation in the Natural Resource Sector

(Unit: million won)

	Ⅰ	Ⅱ		Ⅲ
	2007	2008~2011		2012
Total Expenditure	11,012	26,267	40,992	68,359

Note : Total Expenditure = expected job creation in Table 12> × ₩)0,000 × 12

<표 5>에 따르면 예를 들어 2012년에 683억원을 지출하여 8130명의 고용을 창출할 수 있으므로 환경산업의 고용창출 능력과 비교하여 보면 정부의 공공지출은 고용창출능력이 크다고 하겠다. 그러나 고용의 질과 안정성 등을 고려해 볼 때 공공지출을 통한 고용창출능력은 다소 한계가 있어 이 점을 고려하여 정책을 마련할 필요가 있다.

3.2. 신재생에너지산업에 대한 공공지출에 의한 고용창출

2004년 김수진은 1998년 산업연관표를 이용하여 한국에서 태양광과 풍력에너지 발전에 따른 고용효과를 연구하였다. 김수진의 시나리오에 기초하여 2015년 태양광과 풍력발전에 따른 설치비용 및 전략생산비용과 고용창출인원을 <표 6>에서 보여주고 있다.

<표 6> Job Creation in Wind and Solar Power Plant (2015)

(Unit: million won, person)

	Installation		Power Generation		Total
Wind	Cost	923,697	Cost	455	924,152
	Job	15,084	Job	2,303	17,387
Solar	Cost	1,807,500	Cost	244	1,807,744
	Job	17,509	Job	1,036	18,454

제4장 정책적 시사점

환경정책은 현행의 개별 환경오염매체에 대한 관리에서 통합적인 오염관리방식으로 전환될 것으로 보인다. 이러한 정책의 변화는 통합오염매체를 관리하기 위한 환경기술의 발전을 요구한다. 이러한 관점에서 환경보호와 지속적인 고용창출을 위한 정부정책은 직접적인 환경분야에서의 고용창출을 유도하는 것이 바람직할 것이다. 더욱이 나아가 환경관련분야에서의 고용자들의 능력과 질을 높일 필요가 있고 따라서 정부에서는 상위 환경기술노동자들을 확장하기 위한 방법을 고려할 시점이 되었다.

아래의 <표 7>은 각각 환경산업, 자연자원에 대한 정부의 공공지출 그리고 신재생에너지(태양광과 풍력)발전을 위해 정부가 재정을 지출할 경우 단위 지출액 (십억원) 당 고용창출 인원수를 계산 또는 추정한 것이다.

<표 7> Job Creation per One Billion Won Spending

(Unit: person)

	Calculation Method and Assumption	Job Creation	
Environmental Industry	We assume that ε=0.256.	10.3	
Public Expenditure	Total Job Creation/Total Expenditure (in 2012 and in the case of natural resource protection)	119.0	
Renewable Energy	Total Job Creation/Total Cost for Installation and Power Generation(in 2015)	wind	18.8
		solar	102.0

Note : In the case of the job creation number in the environmental industry and renewable energy, the table only contains direct effect on job creation.

이 계산 결과에 따르면 단기적으로는 고용창출에 효과적인 정책은 민간 또는 공공부문의 서비스와 관련된 고용창출을 유도하는 정책이 된다. 그러나 우리가 공공지출에 따라 창출된 고용의 많은 부문이 비숙련단순노동자로 구성되어 있음을 상기할 때 장기적으로는 또한 시장상황을 비추어 보면 환경산업을 증진시키기 위한 정책이 보다 바람직할 것이다.

예를 들자면 정부가 환경산업을 통해 전반적인 산업의 고용을 증대시키기를 원한다면 건설부문과 기계산업분야의 환경산업을 지원할 경우 전반적인 산업에 대한 효과적인 고용창출을 유도할 수 있을 것으로 보이며 환경과 관련된 직접적인 고용창출을 유도하기 위해서는 환경산업의 다른 부문에 대한 투자를 늘리면 가능할 것으로 판단된다.

신재생에너지 분야의 경우, 이 분야에서의 고용창출능력은 신재생에너지의 발전여건이 성숙되어지면 가능성이 큰 것으로 판단된다. 그러나 아직 신재생에너지 분야에 대한 발전이 초기 단계이고 여러 기후 및 기술관련 조건 상 우리나라에서는 다소 제약이 있을 것으로 판단된다.

마지막으로 환경정책의 강화에 따른 기업의 해외이전을 생각해 볼 수 있다. 그러나 전반적으로 환경정책강화가 기업이전의 주요한 요인으로 작용한다는 것을 확인하기는 쉽지 않으며 상대적으로 환경적인 고려는 기업 경영의사결정에 영향을 크게 미치지 않음을 고려할 때 이를 통한 고용감소는 적은 것으로 보여지고 있다.

제5장 결 론

앞으로의 환경정책이 통합적인 환경정책으로 나아갈 것으로 예상되므로 환경 분야에 있어서의 고용정책은 환경서비스분야의 환경관련 노동자의 기술 및 전반적인 수준을 향상시키는 방향으로 나아가야 한다.

이를 위한 가장 좋은 방법은 환경산업을 지속적으로 지원하는 것이다. 전반적으로 환경산업은 미래에도 주요 산업이 될 여지가 많고 환경산업은 상대적으로 기술과 연구 관련분야에 집중되어 있어 상위 기술 노동자에 대한 수요를 증대시킬 여지가 크기 때문이다.

공공지출을 통한 고용창출은 환경산업지원에 비해 규모면에서는 효과적인 것처럼 보인다. 그러나 종사자의 기술수준과 직업의 안정성 등을 고려하면 공공지출을 통한 고용창출은 단기적인 실업문제를 해결하기 위한 정책으로 추진하는 것이 바람직할 것이다.

신재생에너지 분야는 고용창출 및 노동자의 기술수준 향상 측면에서는 효과적인 정책이다. 그러나 우리가 우리나라의 기술수준이나 에너지 수요구조를 고려한다면 신재생에너지 분야를 통한 고용창출은 효과가 제한적일 것이다.

따라서 정부는 정부가 처한 상황에 맞게 정책을 효과적으로 추진해야한다. 이 때 한편으로는 만약 다른 산업에 투자가 이루어진다면 더 많은 고용을 창출할 수 있을 것이라는 의견에 부딪히게 된다. 그러나 우리가 환경의 특수적인 성격, 즉, 예측불가능성, 파괴는 쉬운데 비해 복원은 어려운 비대칭성 등을 고려하면 단지 규모면에서 고용을 많이 창출한다는 점에 기초하여 정책의 우선순위를 결정할 수는 없다. 따라서 환경의 가치가 보이지 않는다고 해서 무시되어져 환경관련 산업을 통한 고용창출능력을 과소평가하는 것은 정책의 선택기준으로 바람직하지 않을 것이다.