The Effects of Subsidies on Diffusing New Technologies: A Case Study of the Swedish Subsidizing Policy "The Local Investment Program"

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Abstract

Although subsidizing policies are not highly evaluated in environmental economics since they are contrary to "The Polluter Pays Principle" and there is a budget constraint, many countries have in practice introduced several subsidizing policies and some of them have been effective in promoting investments to a certain degree.

This paper explores the conditions under which subsidizing policies are effective in diffusing new technologies using a case of a Swedish subsidizing policy, "the local investment program" (LIP) 1998-2002. In the LIP scheme, municipalities make an investment program for environmental protection in their region and subsidies are granted to excellent programs after screening by the Swedish government. An investment program in general consists of several projects by municipal authorities, municipal companies, private companies and so on. One of the features of the LIP is that subsidies are granted to each project through municipalities, so in order for private companies, individuals and other organization to obtain subsidies their projects have to be included in a program by the municipality.

Most projects would not have been implemented without LIP subsidies, so we could evaluate the LIP promoted additional investments. But there were not many projects using new technologies although it was at first one of the purposes of the LIP. The reasons could be attributed to the fact that the LIP subsidies were granted through municipalities and to win the race for subsidies municipalities tended to avoid including projects with high uncertainty in their program. The competition among municipalities, which had been considered to promote unique programs, might prevent municipalities from introducing projects with new technologies in this case.

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1. Introduction

Subsidies are not highly evaluated as environmental policy instruments. They are contrary to the "polluter pays principle" (PPP), there is a budget constraint so it is impossible to continue subsidies indefinitely. Even so, however, the reality is that many countries have implemented some sort of subsidies as part of their environmental policy, and these have become especially common as means for developing and disseminating technologies with a low environmental load. There exist some researches to show that these subsidies are effective. For example, Jaffe and Stavins [1995] use data from the United States that provides a quantitative analysis of factors in deciding whether to use heat insulating technology in new housing construction. They showed that if insulation technology installation costs fell at the same rate that energy prices rose, the reduction in installation cost was three times more likely to promote adoption of the technology as the rise in energy prices. This indicates that lowering the installation costs of environmental protection technology through subsidies is more effective for dissemination of this technology than raising energy prices through introducing taxes[1]. In other words, it shows that under certain conditions, subsidies can function very effectively, even though they are contrary to the PPP and there exist financial constraints.

In order for subsidizing policies to work effectively, two conditions are required: the first is appropriate assessment. Even if projects that receive grants and subsidies contribute to lightening the environmental load, it would not be a sufficient reason to deem them effective, because the project may have been implemented anyway without a subsidy. If such a project receives a subsidy, the subsidy will not promote additional investments and all that happens is that those who implement the project have their financial burden lightened. Therefore, the projects that the government ought to subsidize are the ones that would not be implemented without a subsidy, but since it is inefficient to subsidize projects that are not cost effective, it is desirable to focus on groups of projects that are "relatively" cost effective. That is to say, the criteria for judging include whether or not the project would occur without the subsidy, and also whether the investment is effective and efficient. These standards are important in terms of equity. For example, if energy saving projects with a very short pay-back time receive subsidies as well, then entities that have been taking a proactive approach to investment in energy saving projects have no scope for efficient investment and are not subsidized, while on the other hand, entities that have not been proactive or that purposely delayed their investment will still have some scope for efficient investment, so they receive subsidies. This is quite unfair. Considering these aspects, granting subsidies on the aforementioned criteria is not the most cost effective way to proceed. Therefore, we must be aware that it is not necessarily sufficient to judge subsidies as policy measures only from a viewpoint of cost effectiveness.

Second, institutional conditions which promote a lot of applications of eligible projects are required. Even if responsible authorities can assess applications appropriately, it is difficult for subsidies to work well in case not many eligible projects are applied in practice.

[1] However, this is the effect on the diffusion of individual factor technologies, and it does not indicate any incentive effect on the overall energy conservation efforts that include actions other than installation of technologies and equipment.

In this paper, I will consider the conditions in which subsidies effectively promote the dissemination of new technology by focusing on "the Local Investment Program" (LIP), a type of subsidy introduced in Sweden in the late 1990s with the objective of promoting investment in environmental protection through municipalities. Even from an international point of view, the LIP is a large-scale subsidy scheme, and is a unique system in that subsidies from the state for individual projects pass through the municipalities.

The remainder of this paper is organized as follows. The section 2 presents an outline of the LIP and the section 3 surveys previous empirical studies on the LIP. After those, the section 4 investigates the reason why the LIP was not necessarily effective in the dissemination of new technology. The last section concludes the paper.

2. Outline of LIP

In 1997, the Swedish government decided to introduce the LIP, a system by which the national government subsidizes environmental protection investment programs planned by municipalities. Almost all areas of environmental protection and improvement are eligible, and in addition to environmental protection, increasing regional employment was also considered an important objective. The central idea behind this was to make use of the accumulated knowledge and experience in each region for sustainable development, and was formulated in response to Agenda 21, which was adopted in Rio de Janeiro, Brazil in 1992. An important principle of Agenda 21 was to exercise decision making as close to the concerned parties as possible, and the LIP was positioned as a practical application of Agenda 21.

The program implementation period was from 1998 to 2002. Municipalities[2] that would seek LIP grants made investment programs, which bundled investment projects from companies and other entities that wished to participate in the municipalities' programs. Municipalities were in principle the only entities that could serve as owners of these investment programs. The application form required applicants to describe in detail the amount of investment and subsidies required for each of the projects that comprised the program, the expected reduction in the environmental load, and the expected effect on employment. Projects that were required in direct response to regulations or laws and ones with an extremely short return on investment were ineligible for subsidies.

At first, it was the Ministry of the Environment (MOE) that administered the LIP and screened the applications, but it was transferred to the Swedish Environmental protection Agency (SEPA) in 2002, which was the final year of the program. In Sweden, it is natural for subsidies not to be distributed directly by the national government, but instead by an independent administrative agency, and it was believed that the SEPA was ultimately the best organization to take responsibility for environmental subsidies. However, since the MOE distributed the LIP subsidies, they were criticized for possibly distributing them in ways that were advantageous to the central government, although officials in charge of distributing the subsidies at the MOE denied that there were any political considerations involved (SEPA [2005a], p. 39). Sweden has many subsidy measures aside from LIP, especially those directed at installing energy-related equipment. Projects receiving

[2] In Sweden, "kommun" is the basic unit of municipalities. There are 290 municipalities now.

subsidies from other programs were ineligible and consideration was given to ensure that projects complemented one another.

As a result of the screenings, the MOE and the SEPA decided to subsidize 211 programs with a total of 1,814 projects, and total subsidies of 6.2 billion Swedish kronor (SEK), and in the end, 4.7 billion SEK were disbursed. The amount of total investment was 21 billion SEK, making it the largest environmental policy project ever carried out in Sweden up to that time (Table 1, Table 2). The reason the initial planned subsidy and actual amount granted differed greatly is that about 15% of projects approved for subsidies were never implemented. Also, if actual reduction of the environmental load proved to be much less than the initial estimate, the final subsidy granted was reduced.

Table 2 shows the areas in which projects were implemented. All sorts of projects, including conversion from fossil fuels to renewable energy, energy saving, waste reduction, and protection of the natural environment were eligible for subsidies, and in particular, large number of projects concerned conversion to renewable energy, energy conservation, and reductions in CO_2 emissions. During the screening, projects (programs) with different characteristics from several regions competed with one other; for example, a program for wetlands conservation and a project for building bicycle paths and other completely different projects were compared to one another. There was no framework for allocating the subsidies, so not all areas received equitable treatment. Even if a program was approved for a subsidy, not all of the projects gained automatic approval. Some projects were excluded during screening.

The composition of project owners in the programs is shown in Table 3. In most cases, municipalities carried out projects themselves, but public and private companies, or in very few cases, individuals or non-governmental organizations (NGOs) were the project owners. There was no particular limit on the types of projects eligible for subsidies, and Table 4 shows by type the number of local government bodies that received subsidies. According to this, Stockholm, Göteborg, and Malmö, which are Sweden's three largest cities, accounted for ¼ of all projects, and the tendency of large cities receiving subsidy were observed. Since subsidies did not flow directly from the national government to the owners of the projects, but through investment programs created by municipalities, if a municipality was deficient in its ability to create or manage programs, even superior individual projects might not be funded because of a lack of synthesis as a program.

Each municipality was required to submit a report on the results of each program after the end of its implementation period. According to these reports, Sweden as a whole reduced its CO_2 emissions by about 545,000 tons, its SO_2 emissions by 590 tons, and its NO_X emissions by 980 tons.

After the LIP ended, the Swedish government followed up by introducing a new investment subsidy program administered through municipalities, known as the KLIMP, the climate investment program. The basic ideas and mechanisms were similar to the LIP, but eligibility for grants was limited to projects that prevented climate change, and even more detailed reports were required upon application[3]. Companies also became eligible to apply for subsidies directly in specific cases.

[3] According to a person in charge of the LIP at SEPA, the employment data mentioned in the reports in particular were considered unreliable.

3. Previous Studies on LIP: Evaluation in Terms of Static Efficiency and Equity

With regard to emission control, a necessary condition for efficient environmental policy measures is equalization of the marginal costs of emission reduction among the sources. As for subsidies, the amount of the subsidy for each marginal benefit must be equal among all projects. The LIP included many types of environmental load reduction projects, and since one project was usually predicted to reduce several environmental burdens, it is difficult to handle them, but Vredin Johansson [2006] used the amount of the subsidies as dependent variable and the environmental load reduction effects (predictions) described on the application forms and the variables indicating project attributes as explanatory variables, and then employed regression analysis to estimate the variables that influenced the amount of the subsidies granted. In other words, she estimated "subsidy functions." Taking reduction of CO_2 emissions as an example, if we use the predicted CO_2 reductions estimate as an explanatory variable, the estimated value of its coefficient shows the marginal subsidy amount, which is the marginal amount that the national government intends to pay for reducing CO_2. After using dummy variables to determine whether there is a difference among the marginal subsidies for each category, her results showed that the amount of marginal subsidy expenditures among categories is not significantly different. This shows that at least subsidies were efficiently allocated[4]. As mentioned in Section 2, the projects that should receive subsidies are the investments that would not be conducted without a subsidy, and not the most cost-effective investments, so it is important to pay attention to the fact that minimizing expenses is not an absolute condition.

Moreover, as mentioned above, the MOE is a governmental organization and its direct participation in granting the subsidies of the LIP were criticized as possibly allowing political consideration toward the ruling party. Again, in order to test the existence of political considerations, Vredin Johansson [2006] extended the model described above, in addition to expected numerical values of the environmental improvements, and employment effects noted on LIP applications, included the percentage of representatives from the ruling Social Democratic Party (the sponsors of LIP) in each local government as an explanatory variable, and analyzed the influence on granting subsidies. The result was that the percentage of Social Democratic Party members in the local government had no significant effect on subsidies. However, the number of members of the Green Party, which is a member of the ruling coalition, had a significantly positive influence.

Vredin Johansson [2006] employed data only from projects adopted by LIP, but Berglund and Hanberger [2003] took data from municipalities that were not adopted for LIP, and used a Logit model for a quantitative analysis to investigate the attributes of the municipalities whose applications were accepted. There was a strong, significant tendency for areas with large populations and programs created by municipalities with independent environmental offices to be adopted for LIP, but like Vredin Johansson

[4] The marginal subsidies that Vredin Johansson [2006] estimated were lower than the standard carbon tax rate. Given this fact, Vredin Johansson [2006] concludes that by assuming that the carbon tax rate expresses the social costs of CO_2 emissions, then LIP was an especially effective way of reducing CO_2.

[2006], their results showed that there was no significant effect from the Social Democratic Party holding the majority in any local government.

Based on the results of these quantitative analyses, allocation of the LIP subsidies was not particularly inefficient, while there were no systematic political considerations toward municipalities controlled by the ruling party, even though such considerations were not entirely absent. All in all, it is possible to say that projects were screened in an appropriate manner.

However, the strong tendency that LIP subsidies go to cities with large populations may reflect the various "capabilities" of those municipalities. While selected municipalities had an opportunity to increase their capabilities through their experiences with the LIP, municipalities with relatively less capability were not granted that opportunity, and we cannot overlook the concerns of increasing disparities among municipalities. There is a possibility that these situations may discourage the areas whose municipalities were not selected for the LIP to deal proactively with environmental problems (SEPA [2005a], p. 42).

4. Effects on Dissemination of New Technology

One of the crucial things when evaluating the LIP is whether the LIP subsidies were granted to investment projects that would not have been implemented without them. Although there are no data for the LIP as a whole, according to a SEPA survey conducted for district heating projects subsidized by the LIP, about 80% of respondents indicated that without the LIP they would not have implemented their projects or implementation would have been delayed or the scale of the project would have become smaller. Moreover, since the criteria for subsidies considered projects with an excessively short return on investment period as ineligible (SEPA [2005b], p. 16), it is reasonable that the aforementioned criteria were met in other fields as well.

The SEPA has published reports by each category on the effects of the LIP. According to these reports, it has been evaluated that while somewhat incremental technologies were introduced, few new technologies were introduced (SEPA [2004a], SEPA [2004c]). According to the SEPA [2005a], the central government initially presented installation and dissemination of new technologies as one of the important objectives of the LIP. In fact, "introduction of new technology" was made a condition for private companies that administered projects, but that requirement did not yield sufficient results, and most entities used incremental technology. It goes without saying that introduction of new technology is not easy, but a question remains on why the LIP was ineffective in the dissemination of new technology. If the fact that few projects employing new technology were implemented was true, there are three possible causes.

(1) 30% limit

The SEPA has pointed out (SEPA [2005a], pp. 45-46) that there were not many applications for projects using new technology and that the European Union's "30% rule," was one of the reasons. The "30% rule" is a rule that avoids distortion of the competition conditions within the EU by stating that subsidies to private companies may not exceed 30% of the total amount of investment in principle. This means that there

were many cases where projects were not planned from the start, because it would be considered difficult to cover the risk of adopting a new technology if the subsidy only approved up to 30% of the total investment at maximum. However, the 30% rule applied only in cases where the project owner was a private company, and was not applied to other administering authorities. As Table 2 shows, in many projects for which a municipality was a project owner, the subsidy rate was over 30%. Nevertheless, municipalities and municipal companies almost did not plan projects that employed new technology. Moreover, when a project owner tried to obtain the LIP subsidies in case of replacement of their facilities, even private companies can actually receive subsidies over 30% as follows. Denoting the amount for an investment project that uses more environmentally friendly but well established technologies as CA, and the amount for a project that uses expensive new technologies as CB, the limit of the subsidy for selecting higher-priced equipment with a lower environmental load is not 30% of the difference (CB-CA) but 30% of the total investment amount CB.

Considering these facts, it may be true that the 30% limit may have had disincentive for installing new technology, but it was not crucial and other reasons also existed.

(2) Institutional Features of LIP

In the LIP scheme, a municipality forms an investment program by putting together some projects planned by several project owners, municipality itself, municipal companies, private companies and so on. The program is then assessed by responsible authorities of the state and is determined whether it would be subsidized or not. Since project owners do not receive subsidies directly from the state, even if projects employing new technology were proposed by private companies, they were not adopted within the LIP framework unless the municipality included them in its investment program. In other words, the attitude of the municipality was of decisive importance.

As mentioned above, the LIP subsidized programs that were regarded excellent, irrespective of field or technological level, that is, there was basically no quota for each category. For municipalities to receive subsidies under the LIP scheme, they must propose an excellent program and win subsidies in a competition with other municipalities. The strong emphasis on competition among municipalities was intended to prompt the planning and implementation of projects that were uniquely creative rather than homogeneous [SEPA [2005b], pp. 41-42]. In fact, in many cases, each municipality investigated the details of the projects other municipalities were proposing, and used them for reference in forming their own investment program to increase the likelihood of a project's adoption. As a result, it turned out municipalities tended to prefer projects with less uncertainty, which used established technologies rather than projects that used new technologies, and the tendency was strong especially in small municipalities[5].

These factors stem from the institutional characteristics of the LIP.

(3) State Attitude

SEPA [2004a] describes the assessment phase of LIP by the responsible authorities that an application with a certain percentage of grant was perceived to be high the responsible authorities did not ask municipalities to lower the demand, but rather rejected the application or the measure. Municipalities looked at this process, and after that, it is

[5] Personal communication with officials of some small cities and two big cities.

natural they would hesitate to include projects with new technology requiring high subsidy rate in their program. It may be true that the state had a tendency to reject projects with new technology, but the institutional feature of LIP (treating new technology and established one on the same ground) promoted the state to do so at the assessment process under the condition municipalities competed for subsidies.

5. Conclusions and Policy Implications

The reason that the LIP did not promote the implementation of new technology, could be attributed to the fact that municipalities did not actively engage in employing projects that used new technology. The LIP subsidizes excellent programs without restrictions on field or technology, projects with new technology or established one, projects by private companies or municipalities themselves, that is, all projects were equally treated in principle. It means the LIP scheme made established technology and new technology compete on the same ground. This scheme could lead to high efficiency in the short run, but it would make municipalities hesitate to include projects using new technology which were considered to be uncertain in the investment program. A competition for subsidies among municipalities and the state attitude at the assessment process might accelerate this tendency, although the element of competition was originally emphasized for promoting innovative projects. If promoting new technology is priority, it is not proper to treat new technology and established one on the same ground and a certain "quota" for new technology is required. It seems this type of subsidizing policy like the LIP is effective for disseminating incremental technology but not proper for new technology.

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Table 1 Outline of LIP

Year	Number of Projec	Subsidy 1000SEK	Average of Sub. 1000SEK
1998	456	2,320,457	5,089
1999	413	1,432,779	3,469
2000	507	1,487,356	2,934
2001	315	733,038	2,327
2002	123	236,349	1,922
Total	1,814	6,209,979	3,423

Source：Johansson[2006], Table1

Table 2 LIP Subsidies by Group

Principal	Num. of project	Amount of Subsidy	Average Subsidy
Waste disposal	180	678,514	3,770
Construction	32	220,804	6,900
After treatment	24	397,734	16,572
Energy saving	201	561,929	2,796
Renewable energy	376	1,612,444	4,288
Multidimensinal projects	86	771,117	8,966
Industrial projects	34	46,767	1,376
Nature conservation	195	401,247	2,058
Supportive measures	257	289,661	1,127
Traffic	180	629,245	3,496
Water & Sweage system	241	594,998	2,469
Other	8	5,519	690
Total	1,814	6,209,979	2,085

Source：Johansson[2006], Table2

Table 3 LIP Subsidies by principal

Principal	Num. of Project	Share to Total	Share of Subsidy to Total Project
Municipal authority	979	54	41.0
Municipal subsidary	319	18	25.0
Company	254	14	24.0
Association	84	5	39.0
County Council	29	2	36.0
Private individual	17	1	31.0
State	15	1	39.0
Municipal association	1	0	22.0
Other collaborative	36	2	32.0
Other	43	2	27.0

Source：SEPA[2005], Table2, Table3

Table 4 Type of Municipalities

Type	Total	Share(%)
Capital	487	27
Suburb	106	6
Large	76	4
Middle	303	17
Industrial	238	13
Rural	132	7
Sparcely populated	59	3
Other large	202	11
Other small	143	8

Source: SEPA[2005], Table4