PERARES Milestone M9.3

Discussion Paper:
A Cost-Benefit Analysis and Evaluation of Science Shops

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We are very grateful to all science shops mentioned in this research that contributed by delivering data and in helpful discussions. Without their input, this research would not have been possible.

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CBA	Cost-Benefit Analysis
CSO	Civil Society Organization
PERARES	Public engagement with Research and Research Engagement with Society.
PRH	Professional Research Hour
SME	Small and Medium Enterprises
SRH	Student Research Hour
VUB	Vrije Universiteit Brussel

1. INTRODUCTION

Over the past decades science shops have been set up, closed, rebuilt and developed, not only in Europe, but also in Canada, the USA, Africa and Asia (Commissie Wetenschapscommuniatie, 2009). Science shops have been developed in order to provide access to (academic) knowledge for organizations and the broader public who would else not have the financial means to get their questions answered. The aim of these projects is to support private persons, civil society organizations (CSO) or small and medium enterprises (SME) in realizing their future plans (Straver, 2008). Therefore, one of the preconditions of the science shops is that public organizations should be able to use the research conducted by the science shops. The wider goal of science shops is in the impact that influencing research may have on citizen participation (Straver, 2010).

The increasing involvement of civil society organizations leads to an increasing amount of research questions posed by clients and a need to extend the amount of science shops (PERARES, 2010). The main aim of this study is to evaluate science shops in terms of their costs and benefits. The central question is therefore *whether or not science shops are economically efficient*. This can be best assessed with the help of a Cost-Benefit Analysis (CBA), which is a method to determine whether a project, program or policy is feasible given the objectives that have been stated and the assumptions that have been made (Oskam, 2008). In general, a CBA aims at answering whether a project or program should be carried out and if funds are limited, which elements should be selected. In doing this, the specific project is compared to its next-best alternative (Mishan, Quah; 2007).

The concept of science shops is spread around the world. As a consequence, science shops developed in a large variety of ways; depending on the region, area of expertise, focus from policy makers and institute to which the science shop is connected (Commissie Wetenschapscommunicatie, 2009). In order to answer our research question, we will give an economic evaluation of science shops that differ in size, region, target groups and area of expertise.

This analysis represents a substantive addition to the evaluation methods and models available for science shops and is intended to generate further discussion and research within and outside the PERARES project. Chapter 2 will give an overview of the methodology used, where the subsequent chapters will each present a cost-benefit analysis on the economic evaluation of a specific science shop. We will end the analysis with a conclusion and discussion in Chapter 6. This analysis only focuses on the direct costs and benefits of science shops. Indirect costs and benefits are however of large importance and will therefore be highlighted in the discussion of Chapter 6 and annex 1 and 2 that present some individual projects of science shops.

2. METHODOLOGY

2.1 Introduction

This study is based on the theoretical principles of welfare economics (Brent, 2009), where we assume perfect competition, which implies a large number of companies, identical products sold by all, the freedom to enter in and out of the industry and perfect knowledge on prices and technologies (Krugman, Obstfeld*,* 1994). With this economic evaluation we try to assess the social desirability of science shops relative to its next best alternative; i.e. where clients of science shops would turn to if science shops would not exist.

The entrance of science shops in the market may at first give the idea of price discrimination[3]; however, in essence we deal with market segmentation. Market segmentation is the distinction of a market in different groups of buyers and sellers and occurs when a sub-set of the market is made up of organizations that share one or more characteristics with the related market that cause them to demand similar products and/or services (Krugman, Obstfeld, 1994). Because of the financial restrictions of science shop clients, these clients would not engage in the market segment of professional consultancy bureaus if there would not be a science shop. Therefore, clients of consultancy companies effectively engage in another segment of the market than clients from science shops. The different segments of the market are graphically represented in Figure 1 below, where area ODRQ represents the segment of professional consultancy bureaus and area QRE the segment of research conducted by students, under which science shop research falls, as will be explained in the following section.

Hence, the difference in price and provider results in two market segments; that of the professional consultancy bureaus and that of student research. In this study we assume divisibility, which means that the benefits of research conducted by science shops can be measured by the amount of research hours conducted. The unit of measurement used in our analysis will therefore be one research hour, where its valuation will be based on the market price for a research hour conducted by a professional consultancy bureau. In the rest of our analysis, we will indicate a professional research hour by the abbreviation 'PRH' and a student research hour by 'SRH'.

2.2 Quantifying benefits and costs

The framework for quantifying the benefits and costs can happen along the lines of the main actors in an economy: producers, consumers and the government. This follows the basic principles of welfare economics, where the consumer surplus is measured by the difference between the willingness to pay for a particular good or service and the actual expenditure (Oskam, 2008). Clients of the science shops only have to put their own working hours in the projects conducted by the science shop. Therefore, we assume that they get the research for free. If point O till point Q represents the number of PRH against price P, then clients of the science shop Wageningen will demand research hours from point Q till point E. Alterra, a research institute linked to Wageningen UR that conducts research

[3] Price discrimination means that "*the sales of identical goods or services are transacted at different prices from the same provider" (Krugman, Obstfeld; 1994).* This leads to actions that give certain buyers advantages over others; namely clients from science shops, who do not have to pay for research conducted. Because the providers of the service are however different; professional consultancy bureaus versus science shops, it is not likely that the price discrimination will lead to its typical effects; lower prices for some consumers and higher prices for others together lead to an output expansion or decline. Because the price differentiation effectively occurs in a segment of the market, there would be no effect on either the efficiency or output within professional consultancy bureaus with the engagement of science shop research in the market. In essence, there are different firms that sell the same product, but against different prices.

for organizations from outside and thus acts as a professional consultancy bureau, charges an average market-rate of €147.- per hour (Holsteijn, personal communication, 29-9-2010). This means that in Figure 1, based on Mishan and Quah (2007), point P represents 147.

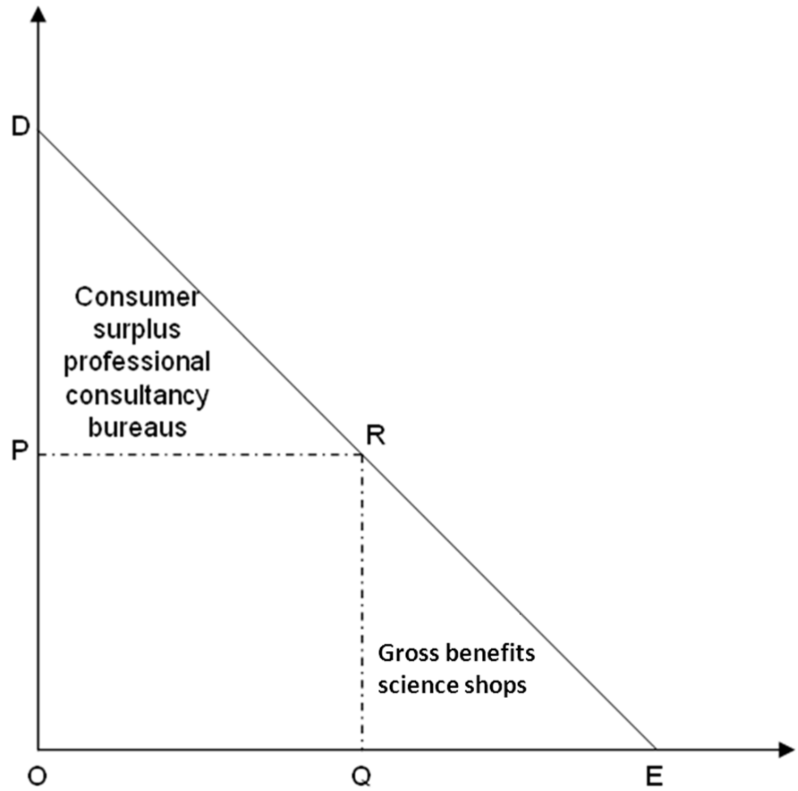

Figure 1: social benefits of science shop research

We do not know exactly how many hours are demanded in the market segment of professional consultancies, but according to the methodology as presented in Figure 1 above, the area ODRQ under the demand curve from point D till point R, represents societies willingness to pay for these hours. The area OPRQ represents the total amount society has to pay for the hours of research conducted by professional consultancy bureaus and the area DPR represents what the clients would additionally have been willing to pay for. As mentioned before, we assume perfect competition, which means that consultancy bureaus will produce till the point where marginal costs equal marginal revenues. Hence, the square OPRQ also includes the costs that professional consultancy bureaus have to make. The triangle DPR is also referred to as the consumer surplus of professional consultancy bureaus. This is the amount of benefit that consumers gain by being able to purchase a product for a price that is less than they would have been willing to pay. Subtracting what clients actually have to pay (area OPRQ) from the willingness to pay of buyers (area ODRQ) gives us the consumer surplus (Mishan, Quah; 2007). Area DPR can therefore be named 'Consumer surplus from professional consultancy bureaus'.

The second segment of the market is represented by triangle QRE, which represents the research hours that are conducted by student research, where the science shop is a part of. The costs of the science shop projects are represented by the total costs, i.e. the variable and fixed costs, for the science shop. The surface of the triangle QRE corresponds to the maximum consumer valuation of the work conducted by student research. The maximum valuation for science shop research is, as represented in Figure 1 above, part of the triangle QRE and part of this maximum valuation is composed of the total costs paid by science shops. Therefore, this part of the triangle can be best referred to as 'gross benefits of science shop research'. For each of the total units of research hours purchased, there is a different maximum valuation; the straight line from point R to each of the axes represents the different prices that people are willing to pay given a certain quantity (Mishan, Quah; 2007). We will however value the price of the research produced by the science shop as the average of the triangle QRE, which is halfway on the straight line RE. We assumed the average of this price to be half of price P, which makes the average willingness to pay for an hour of student research €73.50.

Figure 1 above shows that the economic value of science shop projects is determined by the economic behavior in the context of demand and supply. The estimate of the gross benefits will be entered as benefits in the cost-benefit calculations. Hence, they represent the welfare gain from consumption gained by the clients of the science shop. Costs on the other hand, represent the aggregate inputs measured in monetary units and compose the salary costs and other overhead costs. Another important cost factor is the added time involved in organizing collaborative, democratic processes among members of an usually diverse project team between CSO's and science shop researchers.

2.3 Approaches to measure costs and benefits

There are two lines of thinking in deciding upon the next best alternative for science shop clients. On the one hand, there are the critics of science shops who say that without science shops, clients and student researchers would have found each other just by demand and supply of the market. If this is true, the next best alternative would be student research without science shops acting as an intermediary. On the other hand, there are the proponents of science shops, who argue that without the interference of science shops to regulate demand and supply, the clients would not get their questions answered. In this latter case, the next best alternative would be where civil society organizations would turn to if they would have the financial means to do so; hence, professional consultancy bureaus. Here, we would like to perform a cost-benefit analysis based on both views of the science shops. Therefore, we will first perform a cost-benefit analysis according to the methodology presented in the previous section, where the benefits are represented by a multiplication of the amount of science shop research hours by the average willingness to pay for these hours and the costs are represented by the total costs made by the science shop.

Hereafter, we will perform sensitivity analyses from two viewpoints; the first based on the assumption that if science shops would not exist, the only option left for its clients is professional consultancy bureaus. With this sensitivity analysis we will estimate the amount of SRH that can compose one PRH up till the point where the science shop breaks even. It can namely be assumed that one SRH does not have the same efficiency and productivity as one PRH has. This partly because students do not have the experience and facilities that professional researchers have and partly because of the specific field in which science shops work. Science shops operate on the cutting point between science and society. This does sometimes lead to conflicts in the way of presentation and analysis between students or researchers and civil society organizations. These conflicts take time and may lead science shops to become less efficient than professional consultancy bureaus. Therefore, we will analyze the benefits or losses that the science shop makes with the help of a benchmark for the rate of efficiency between a PRH and a SRH. Based on discussions with supervisors of science shop projects we can set this benchmark at one PRH representing three SRH (Heijman, Oude Lansink, Straver; personal communication, November 2010).

The second viewpoint will be based on the assumption that if science shops would not exist, student and clients would meet each other via the market. In this case, the costs that the science shop as a mediator would have made do not occur. This would obviously make research where science shops interfere less cost-efficient than when the client and the student meet each other without the science shop, namely by the amount of the costs for central coordination of the science shop. A side note here is that those involved in science shop work often argue that science shops do not only connect client and student, but also lead to a higher quality product, because they also supervise and support the whole research process. Here again, we will use a benchmark for the amount of SRH that would also have been conducted if the science shops would not exist. Based on discussions with science shop leaders we decided to use a benchmark that without science shops, only 50% of science shop clients would get their research question answered (Sijtsma, personal communication).

These two viewpoints will lead to four different scenarios performed on the science shops, as they are represented in Table 1 below. In scenarios 1 and 3 we will use a positive view on science shops, where 1 PRH represents 1 SRH. In scenarios 2 and 4 we will use the benchmark of 1 PRH represents 3 SRH. In scenarios 1 and 2 we will use the proponent's viewpoint that without the science shop, its clients would not get their questions answered. Scenarios 3 and 4 use the benchmark of 50% of SRH that would also have been conducted if science shops would not exist.

Table 1: Different scenarios for sensitivity analyses on science shops

Scenario	**1**	**2**	**3**	**4**
SRH-PRH ratio	1 PRH:1 SRH	1 PRH:3 SRH	1 PRH:1 SRH	1 PRH:3 SRH
Without science shop	0	0	50%	50%

2.4 Units of measurement

In this study, we will treat the student input and academic supervision without cost because they are considered to be part of the education process. It could however be argued that by having students conduct science shop research, the research is, at least in some countries, partially government financed (Brown and Mikkelsen; 1990). For example, part of the basic education of Dutch university students is government financed. This would mean that science shops would receive an effective government subsidy when they enroll student researchers. This argument can however easily be rejected by the fact that the education of all Dutch university students is government financed, whether or not they are in that minority of students that choose to do a science shop project.

In the same way that universities are often specialized in certain research areas, also science shops focus on answering research questions from specific academic fields. It is possible that projects from different fields may bring different costs or benefits. Because each science shop focuses on its own field, they do not compete with each other. Therefore, we will treat each science shop as a separate segment of the market and compare this segment with that of professional consultancy bureaus.

As mentioned before, science shops differ a lot in size and shape and have often undergone some large changes over the past years. This is likely to cause variation in the costs and length of projects and research hours conducted at individual science shops. In order to overcome variation in costs or revenues between years, we tried to use a 5 year period for our analysis to measure the costs and benefits of research hours conducted for each science shop. For reasons of the date of establishment or large changes in structure, we did however sometimes have to use shorter periods of analysis. In the following chapters, we will perform a CBA and sensitivity analyses on individual science shops.

3. CASE 1: SCIENCE SHOP WAGENINGEN

3.1 Introduction

The science shop Wageningen is since its establishment in 1985 the place for civil society organizations with research questions in the field of Wageningen UR. At its 25th celebration, the science shop Wageningen has conducted more than 260 research projects. It is the ambition of the science shop Wageningen to start and finalize 10 projects per year. With an average of 13 projects per year over the past 5 years, it easily meets this aim. The science shop guides research projects for civil society organizations that do not have the financial means to turn to professional consultancy bureaus. Prerequisite is that these organizations are prepared to use the research results and that requests need to fall within the research fields of Wageningen UR: sustainable agriculture, food and health, a livable green environment and processes of social change (Aalbers, Padt; 2010).

The science shop Wageningen expects its client to be actively involved in the research. The organization and the researchers of Wageningen UR work together in writing a research proposal and discussing the progress during the research. In the end, the client holds a discussion meeting where the researchers present their results. The organization is normally also responsible for the publicity around the research. This amount of time spent by the science shop clients is considerably more than that of clients of professional consultancy bureaus. Next to the amount of time spent by the client, the science shop and the client will discuss to what extent the organization is able to provide financial support.

Students perform the majority of the research of a science shop project, in which they are supported by a project leader. The project leader looks for the possibilities for a research project within Wageningen UR and assists the student(s). If no student could be found to conduct the research and the research is of considerable importance, researchers of Wageningen UR are hired in. Apart from the students or researchers and project leader there is also a supervision committee that advises upon the research. This committee consists of the client, students or researchers, supervisors, the project leader, the coordinator of the science shop and experts who advise on the project (Straver; 2010).

3.2 Cost-benefit analysis Wageningen

In 2010, for each project a maximum amount of €35000.- from the science shop budget was estimated. Given the total budget for projects of €1,670,566.- and the 65 projects that have been finalized over the past 5 years, the average costs of a project performed over the past 5 years are €25,701.-. Table 2 below shows the costs and amount of hours that have been put in science shop research in Wageningen over the past 5 years (Straver; 2004, Straver; 2005, Straver; 2006, Straver; 2007, Straver; 2008b, Straver, 2010). As can be seen from the table, students perform the majority of the research of a science shop project, in which they are supported by a project leader. If no student could be found to conduct the research and the research is of considerable importance, researchers of Wageningen UR are hired in. The amount of SRH worked on a research project is measured by the number of ECTS they received for the particular project. The amount of PRH is calculated as 90% of total variable costs against a salary of €147,- per hour.

Table 2: Costs and hours spent by science shop Wageningen over the past 5 years in euros

	2009	**2008**	**2007**	**2006**	**2005**	**Total**
Fixed Costs	14232	120595	121700	84015	78868	419410
Variable Costs	340442	420826	304060	280238	325000	1670566
Total Costs	354674	541421	425760	364253	403868	2089976
Total amount of SRH [a)]						64200
Total amount of PRH [b)]						16342

[a)] Based on the number of credits that students receive. One credit = 28 hours.

[b)] 90% of total variable costs are composed of salary costs. An internal tariff of €147/hour in 2010 is used.

3.3 Sensitivity analyses Wageningen

Table 3 below shows the benefits with different rates of efficiency of a PRH relative to a number of SRH when other things remain equal, i.e. the total amount of PRH worked in the science shop Wageningen is 16342, the hourly wage of a PRH remains at €147.-, the average benefits of one science shop hour remains at €73.50 and the total costs of science shop Wageningen over the past 5 years remains at €2,089,976.-.

Table 3: Sensitivity analysis on the efficiency of science shop Wageningen hours as opposed to PRH hours

PRH/SRH ratio	Total amount of SRH hours / 5 years	Total benefits € / 5 years	Benefit - Costs € / average year
1 PRH = 1 SRH	64200	5,919,837	765,972
1 PRH = 2 SRH	32100	3,560,487	294,099
1 PRH = 3 SRH	21400	2,774,037	136,812
1 PRH = 4 SRH	16050	2,380,812	58,167
1 PRH = 5 SRH	12840	2,144,877	10,980
1 PRH = 6 SRH	10700	1,987,587	-20,478
1 PRH = ∞ SRH	0	1,201,137	-177,768

Based on this, we can evaluate the costs and benefits in the way described by the methodology above. We can now net benefits according to the first scenario of the sensitivity analysis, where 1 PRH:1 SRH and without the science shop client and student would not meet each other. Under this scenario, a total amount of 80,542 in combined PRH and SRH have been supplied over the past 5 years in science shop Wageningen. Based on this and the average willingness to pay for one science shop hour of €73.50, the total benefits over the past 5 years are (64200+16342)*73.5= €5,919,837.-, and the benefits per year €1,183,967.-. With the average costs per year being €417,995.-, we arrive at a positive net benefit per year of €1,183,967.- – €417,995.- = €765,972.-. Table 3 above shows that under scenario 2, where 1 PRH:3SRH and no SRH would be conducted without the science shop, the science shop Wageningen would result with a net benefit of €136,812.

In the most extreme case, where a student hour is not of any use, the science shop Wageningen would make a loss of €177,768.-. It is however very unlikely that a student hour won't be of any use. Therefore, in analyzing the cut-off point in the efficiency of a student hour, we can see that the science shop Wageningen will break even somewhere in between when one research hour represents 5 or 6 student hours. Trial and error shows that this break-even point occurs when 1 student hour would be equal to 5.31 research hours. This break-even point is graphically represented in Figure 2 below. Here, the science shop would break even in its costs and benefits; costs and benefits would be equal to €417,995.

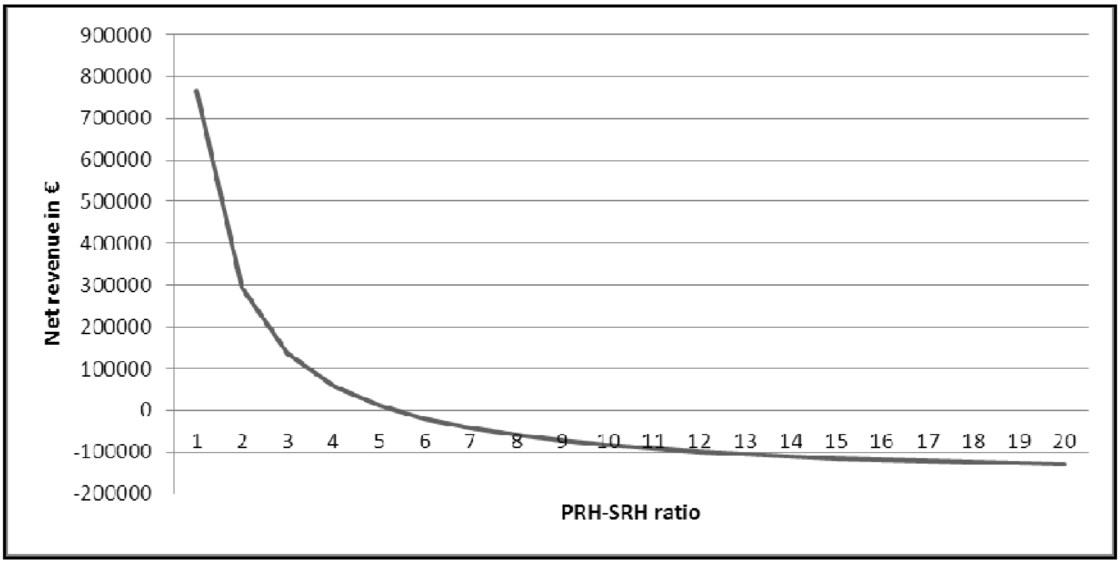

Figure 2: Science shop Wageningen revenues with changing SRH/PRH ratio

Table 4 below shows a sensitivity analysis under scenario 3; when one PRH represents one SRH and without the science shop 50% of the SRH would still be conducted. Under this scenario, the benefits of the science shop Wageningen are reduced to €765,972 - €471,870 = €294,102.

Table 4: Sensitivity analysis on the efficiency of science shop Wageningen hours as opposed to SRH hours

	With science shop	Without science shop
Revenues SRH/year	943,740	471,870
Revenues PRH/year	240,227	0
Total revenues/year	1,183,967	471,870
Costs/year	417,995	0
Benefit-Costs	**765,972**	**471,870**

Under the most strict scenario, where three SRH equal one PRH and 50% of the clients of the science shop would have been able to find students without the help of the science shop, the science shop Wageningen would make a loss. Namely, this would lead to the result of scenario 2 minus the revenues that would be made without the science shop in the table above: €136,812 - €471,870 = €-335,058.

3.4 Conclusion

The table below shows an overview of the different scenarios discussed. As can be seen, there is a large range of results of the analysis. However, only under the quite unlikely circumstances of scenario 4, the analysis would lead to a negative result.

Table 5 Overview of cost-benefit scenarios science shop Wageningen

Scenario	**1**	**2**	**3**	**4**
SRH-PRH ratio	1PRH:1SRH	1PRH:3SRH	1PRH:1SRH	1PRH:3SRH
Without science shop	0	0	50%	50%
Net benefit Wageningen	765,972	136,812	765,972	136,812
Without science shop (€)	0	0	471,870	471,870
With – Without (€)	**765,972**	**136,812**	**294,102**	**-335,058**

4. CASE 2: SCIENCE SHOP BRUSSELS

4.1 Introduction

In Belgium, science shops have been established since the academic year 2002/2003, initially with a pilot of 3 years initiated by the universities of Brussels and Antwerp and subsidized by the Belgian government. As of 2006, the government obliged every university to establish a science shop, which led to the network of Flemish science shops that coordinates all Dutch-speaking Belgian science shops. This network consists of two active science shops who together answered 40 research questions in 2009; those of Brussels and Antwerp, and three rather inactive science shops; those of Leuven, Hasselt and Gent, who together only answered one research question in the same year. The strength of the network of science shops is in the fact that five science shops possess the means to answer a question from society; however, with only two of the five science shops actively functioning, this may also become a weakness.

The coordination of the network, under the name wetenschapswinkel.be, is in hands of a central unit connected to the *Vrije Universiteit Brussel* (VUB). The wetenschapswinkel.be is the central contact point for non-profit organizations that search for scientific support via research or advice. It most important tasks are in promotion- and information, assembling and distributing requests of new organizations and supporting regional science shops and taking care of the national and international networks. As of 2008, the science shops are officially part of the range of responsibilities of “science and communication” in Belgium. Science and communication is financed by the Flemish government, but the exact way of financing depends, amongst others, on the size of the science shop. At least till 2011 the science shops will be financed by the government, but the budget is decreasing because of the economic crisis.

Here, we will focus on the science shop Brussels, which is a cooperation between the *Erasmushogeschool Brussel* and the VUB, each with its own field of research. By now, a total of 208 requests have been answered by the science shop Brussels. The EhB focuses itself mainly on economics and language sciences, where the fields of research of the VUB are mainly in agogics, psychology, communication sciences, (medical) sociology and gerontology. The main aim of the science shop Brussels is to bring citizens closer to scientific research. Through its projects, it contributes to a more goal-oriented and interactive communication between the science world and its citizens.

The main tasks of the science shop Brussels are to assemble questions from non-profit organizations, translate a question into a research question and act as a mediator between the organization and the researcher and assist in bringing research results under the attention of the wider public. In practice, an organization submits a research question at the science shop. Thereafter, a mediator visits the organization for an interview on admission. The advisory body, consisting of employees from the university, decides on whether the question will be researched or not and if so, in which form. At the moment, all of the research is conducted in the form of a master thesis (Commissie Wetenschapscommunicatie, 2009).

4.2 Cost-benefit analysis Brussels

For our analysis of the science shop Brussels, we used a 5 year period to measure the costs and benefits of research hours conducted by the science shop (Vanderbrande; 2005, Wetenschapswinkel.be; 2006, Commissie Wetenschapscommunicatie; 2009, Universitaire Associatie Brussel; 2009, Universitaire Associatie Brussel; 2010). All research of the science shop Brussels is conducted in the form of a master thesis. This happens for 80% in the research fields human and social sciences (psychology, agogics, communication sciences and sociology). To measure the student research hours put into science shop work, we used the average amount of credits that students receive for their master theses. There is some variety in the number of credits that students receive for their research, depending on the study; 21 ECTS for psychology, 15 for agogics, 24 for communication sciences. Here, we use an average of 20 ECTS per research (de Bal, personal communication), which corresponds to 560 hours of student research. This leads to a total of 71680 SRH over the past 5 years. The science shop Brussels solely works with students because they do not have to be paid for their research conducted; hence, PRH are not used for research here. Table 6 below shows the costs and amount of hours that have been put into science shop research in Brussels between 2005 and 2009.

Table 6: Costs and hours of research conducted in the science shop Brussels

	2009	**2008**	**2007**	**2006**	**2005**	**Total**
Costs from central unit [a)]	6360	6360	6360	6360	6360	31800
Costs from science shop Brussels	66880	66880	66880	66880	66880	334400
Total Costs	73240	73240	73240	73240	73240	**366200**
Total amount of SRH [b)]						**71680**
Total amount of PRH [c)]						0

[a)] Yearly labor costs of €25,000.- between 2005-2007 (0.3 FTE) and €20,000.- between 2008-2009 and other costs of €6800.- divided by the number of science shops (5)
[b)] Student research hours, all from master theses (20 ECTS)
[c)] Professional research hours

4.3 Sensitivity analyses Brussels

When other things remain equal, i.e. the total amount of PRH worked in the science shop Brussels is 0, the average willingness to pay of one science shop hour remains at €73.50 and the total costs of science shop Brussels remain at €366,200.- we can analyze the benefits with different rates of efficiency of SRH relative to PRH (table 7).

Table 7: Sensitivity analysis on the efficiency of science shop Brussels hours as opposed to PRH hours

PRH/SRH ratio	Total amount of SRH hours	Total benefits €/5 years	Benefits-Costs in €/average year
1 PRH = 1 SRH	71680	5268480	980456
1 PRH = 2 SRH	35840	2634240	453608
1 PRH = 3 SRH	23893	1756160	277992
1 PRH = 4 SRH	17920	1317120	190184
1 PRH = 5 SRH	14336	1053696	137499
1 PRH = 6 SRH	11947	878080	102376
1 PRH = 7 SRH	10240	752640	77288
1 PRH = 8 SRH	8960	658560	58472
1 PRH = 9 SRH	7964	585387	43837
1 PRH = 10 SRH	7168	526848	32130
1 PRH = 11 SRH	6516	478953	22551
1 PRH = 12 SRH	5973	439040	14568
1 PRH = 13 SRH	5514	405268	7814
1 PRH = 14 SRH	5120	376320	2024
1 PRH = 15 SRH	4779	351232	-2994
1 PRH = ∞ SRH	0	0	0

Based on this, we can evaluate the costs and benefits in the way described by the methodology above. If we assume that one SRH is as efficient and productive as one PRH, then a total amount of

71680 productive hours have been supplied over the past 5 years. Based on this and the average willingness to pay for one SRH of €73.50, the total benefits over the past 5 years are 71680*73.5= €5, 268, 480,-, and the benefits per year €1,053,696.-. With the average costs per year being €73,240.-, we arrive at a positive benefit per year of 1,053,696 - 73,240 = €980,456.-. Table 7 above shows that under scenario 2, where 1 PRH: 3SRH and no SRH would be conducted without the science shop, the science shop Brussels would result with a net benefit of €277,992.-.

As can be seen from figure 3 below, the break-even point where benefits equal costs at the science shop Brussels occurs somewhere between when one PRH represents 19 or 20 SRH.

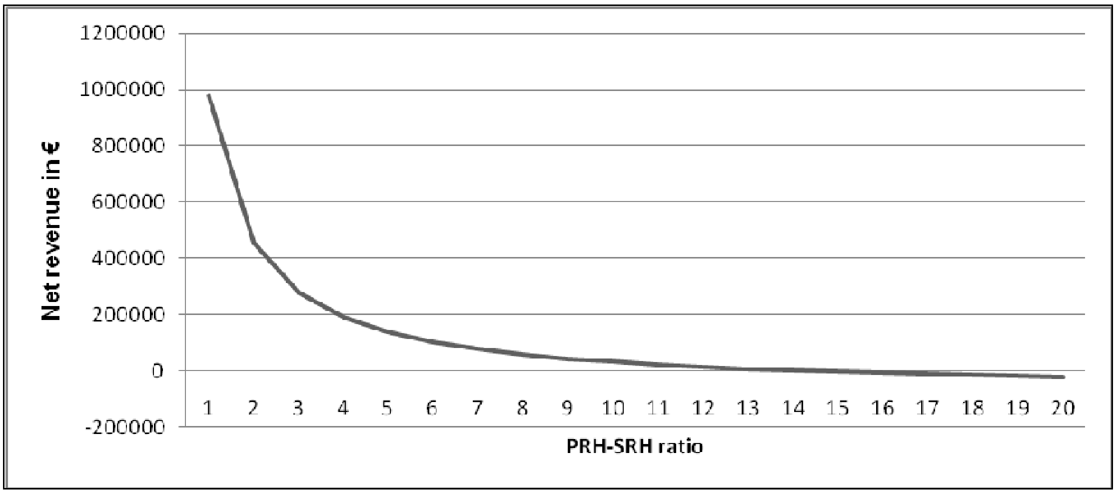

Figure 3: Science shop Brussels revenues with changing PRH-SRH ratio

Table 8 below shows a sensitivity analysis under scenario 3; when one PRH represents one SRH and without the science shop 50% of the SRH would still be conducted. Under this scenario, the additional benefits of the science shop Brussels are reduced to €982,016 - €526,848 = €455,168.-.

Table 8: Sensitivity analysis on the efficiency of science shop Brussels hours as opposed to SRH hours

	With science shop	**Without science shop**
Revenues SRH/year	1,053,696	526,848
Revenues PRH/year	0	0
Total revenues	1,053,696	526,848
Costs/year	71,680	0
Benefit-Costs	**982,016**	**526,848**

Under the most strict scenario, where three SRH equal one PRH and 50% of the clients of the science shop would have been able to find students without the help of the science shop, the science shop Brussels would make a loss. Namely, this would lead to the result of scenario 2 minus the revenues that would be made without the science shop in the table above: €277,992 - €526,848 = €-248,856.-.

4.4 Conclusion

The table below shows an overview of the different scenarios discussed. As can be seen, there is a large range of results of the analysis. They are however quite comparable with the results of science shop Wageningen. Again, only under the quite unlikely circumstances of scenario 4, the analysis would lead to a negative result.

Table 9 Overview of cost-benefit scenarios science shop Brussels

Scenario	1	2	3	4
SRH-PRH ratio	1 PRH:1 SRH	1 PRH:3 SRH	1 PRH:1 SRH	1 PRH:3 SRH
Without science shop	0	0	50%	50%
Net benefit Brussels	980,456	277,992	982,016	277,992
Without science shop	0	0	526,848	526,848
With - Without	980,456	277,992	455,168	-248,856

5. CASE 3: CHEMISTRY SHOP EINDHOVEN

5.1 Introduction

At the science shops in Eindhoven, research is completely conducted by students who, guided by scientists from the university, try to answer questions that mainly come from individual persons and small and medium enterprises (SME). The students are supported by the facilities of the university and their work can lead to for example a tangible product such as a technical tool for patients or a research report that analyses harmful substances in materials. There are four science shops in Eindhoven that conduct research for civil society organizations. These science shops are the architecture shop, the chemistry shop, the electro shop and the physics shop. Each of these science shops is linked to a faculty of the university. The different science shops meet once every two weeks to discuss the progress under the different science shops.

In this part of the analysis, we focus on the chemistry shop Eindhoven. This science shop has been established in 1973 under the name "*Milieu Aksie Groep T*" and changed names to Chemistry Shop Eindhoven in 1975. The aim of the chemistry shop is to function as an information center, specialized in chemistry and the environment, for society. Initially, the chemistry shop Eindhoven was based on the idea to conduct research for individual persons against low costs. During the year 2006-2007 the chemistry shop started with including cases from SME. The idea behind including this sector is that, because of the low costs of student work, it becomes affordable for small or new companies to have their research conducted by the chemistry shop. Apart from the attractiveness for its clients, the chemistry shop provides possibilities for students to apply their knowledge to other areas of chemistry and development.

5.2 Cost-Benefit Analysis

We used a four year period for our analysis to measure costs and benefits of research hours conducted by the chemistry shop Eindhoven. The chemistry shop yearly receives around €20,000 to conduct projects and often a small amount from clients, especially from SME, for projects conducted.

By far most costs of the chemistry shop come from salary costs. These are composed of the salary costs for the board of the chemistry shop and salary costs for students who conduct the research. The exact composition of the board of the chemistry shop Eindhoven has changed somewhat over the past years; however, the positions have remained largely the same. Currently, the board of the science shop Eindhoven consists of the chairman, secretary and public relations officer. Apart from the board members, there are two persons who deal with requests coming in the science shop. The science shop Eindhoven aims at extending SME-research next to research for private persons and facilitating research studies for students. This is represented by a separate SME coordinator that deals with requests from the sector. Policy and executive work fall under the tasks of the SME coordinator.

The chemistry shop Eindhoven is overseen by a supervision committee linked to the chemistry shop where a group of persons within the Chemical Engineering faculty check research conducted by the chemistry shop and advises on policies within the chemistry shop. All of the research of the Chemistry Shop Eindhoven is conducted by students who are a member of the science shop. They get paid for their work by a student assistantship salary of €16 per hour. Hence, the total amount of SRH conducted at the Chemistry Shop Eindhoven is composed of the 0.9 FTE that each of the on average 5 board members spend on the Chemistry Shop per year plus the hours for conducting research. Here, we used 2080 hours for 1 FTE and the student assistantship wage rate of €16.- for executive work. The total salary and other costs are represented in Table 7 below, which shows the total costs and amount of hours that have been put into science shop research in Eindhoven over the past 4 years.

Table 10: Costs and hours of research conducted in the chemistry shop Eindhoven

	2009-2010	2008-2009	2007-2008	2006-2007	Total
Salary Costs	26281	31086	27653	28556	113576
Other Costs	2840	4523	5767	4008	17138
Total Costs	29121	35609	33420	32564	130714
Total amount of SRH [a)]					16459
Total amount of PRH					0

[a)]0.9 FTE for 5 board members €16.- / hour for executive work

5.3 Sensitivity Analyses Eindhoven

The table above shows the costs and benefits in the way described by our methodology. If we assume that one SRH is as efficient and productive as one PRH, then a total amount of 16,459 productive hours have been supplied over the past 4 years. Again, we use €73.50 as the average willingness to pay for an hour of science shop research. Based on this, the total benefits over the past 4 years are 16,459*73.5= €1,209,737.- and the average benefits per year €302,434.-. With the average cost per year being €32,679.-, we arrive at a net positive benefit of 302,434 - 32,679.- = €269,755.-. Table 11 below shows that under scenario 2, where 1 PRH:3SRH and no SRH would be conducted without the science shop, the science shop Eindhoven would result with a net benefit of €68,132.-.

The chemistry shop Eindhoven realizes that there is not much known about the actual research qualities of students and that good results identified by SME are not always guaranteed (Jaarverslag 2006-2007). Therefore, we can again analyze the minimal rate of efficiency that students must have in order for the science shop to break even. Table 8 below shows the benefits with different rates of efficiency of SRH relative to one PRH when other things remain equal, i.e. the average benefits of one science shop hour remains at €73.50 and the total costs of the chemistry shop Eindhoven over the past 4 years remain at €130714.-.

Table 11: Sensitivity analysis on the efficiency of student hours for the chemistry shop Eindhoven

PRH/SRH ratio	Total amount of SRH / 4 years	Total benefits € / 4 years	Benefit - Costs in € / average year
1 PRH = 1 SRH	16459	1209737	269755
1 PRH = 2 SRH	8230	604868	118538
1 PRH = 3 SRH	5486	403246	68132
1 PRH = 4 SRH	4115	302434	42930
1 PRH = 5 SRH	3292	241947	27808
1 PRH = 6 SRH	2743	201623	17727
1 PRH = 7 SRH	2351	172820	10526
1 PRH = 8 SRH	2057	151217	5125
1 PRH = 9 SRH	1829	134415	925
1 PRH = 10 SRH	1646	120974	-2436
1 PRH = ∞ SRH	0	0	-32679

In the most extreme case, where a student hour is not of any use, the science shop Eindhoven would make a loss of €32,679.- per year. It is however very unlikely that a student hour won't be of any use. Therefore, in analyzing the cut-off point by the efficiency of a student hour, it can be estimated that the chemistry shop Eindhoven breaks even somewhere in between when one research hour represents 9 or 10 student hours. Here, the science shop would break even in its costs and benefits; costs and benefits would be equal to €32,679.- on average per year (figure 4).

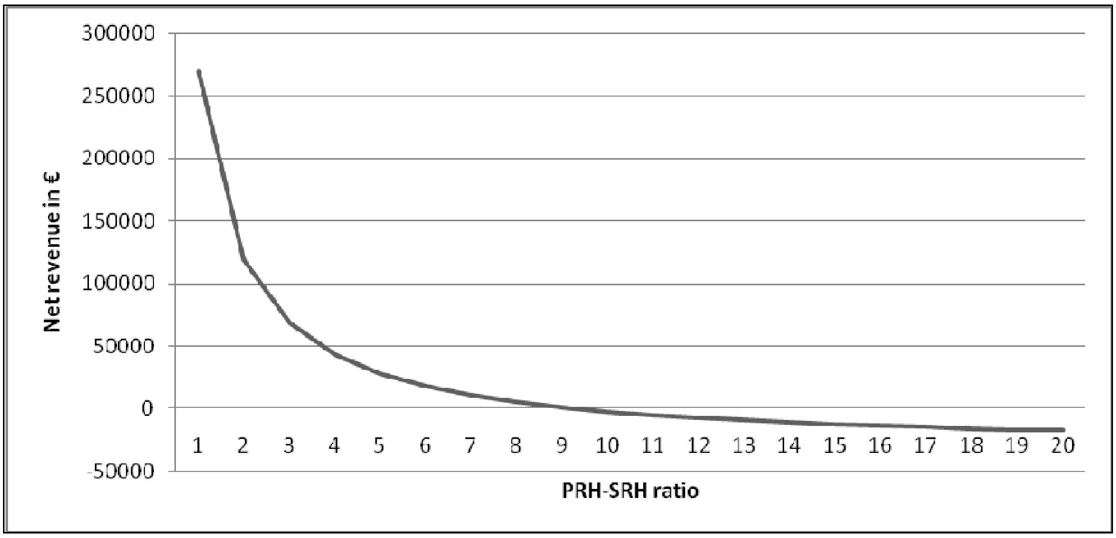

Figure 4: Chemistry shop Eindhoven revenues with changing PRH-SRH ratio

Table 12 below shows a sensitivity analysis under scenario 3; when one PRH represents one SRH and without the science shop 50% of the SRH would still be conducted. Under this scenario, the additional benefits of the science shop Eindhoven are reduced to €269,756 - €151,217 = €118,539.-.

Table 12: Sensitivity analysis on the efficiency of chemistry shop Eindhoven hours as opposed to SRH hours

	With science shop	**Without science shop**
Revenues SRH/year [a)]	302434	151217
Revenues PRH/year	0	0
Total revenues/year	302434	151217
Costs/year	32679	0
Benefit-Costs	**269756**	**151217**

Under the most strict scenario, where three SRH equal one PRH and 50% of the clients of the science shop would have been able to find students without the help of the science shop, the science shop Eindhoven would make a loss. Namely, this would lead to the result of scenario 2 minus the revenues that would be made without the science shop in the table above: €68,132 - €151,217 = € -83,085.-.

5.4 Conclusion

The table below shows an overview of the different scenarios discussed. As can be seen, there is a large range of results of the analysis. They are however quite comparable with the other science shops. Again, only under the quite unlikely circumstances of scenario 4, the analysis would lead to a negative result.

Table 13: Overview of cost-benefit scenarios science shop Eindhoven

Scenario	**1**	**2**	**3**	**4**
SRH-PRH ratio	1 PRH:1 SRH	1 PRH:3 SRH	1 PRH:1 SRH	1 PRH:3 SRH
Without science shop	0	0	50%	50%
Net benefit Eindhoven	269,755	68,132	269756	68,132
Without science shop	0	0	151217	151,217

With - Without	269,755	68,132	118539	-83,085

6. CONCLUSION AND DISCUSSION

6.1 Introduction

A previous study conducted by Brown and Mikkelsen (1990) has shown that, compared to professional consultancy bureaus, community-based research is relatively economical. One main reason for this is that science shops often rely on student or community volunteers. Obviously, the studies would be much more expensive if citizen groups would have to pay professional researchers.

In this paper, we analyzed whether science shops are feasible from an economic perspective according to two views on the next-best alternative; the first one professional consultancy bureaus, the other one the assumption that if science shops would not exist, students and clients would find each other via demand and supply of the market. In this chapter we will provide a conclusion on the results obtained and highlight some important items for further discussion and improvement in order to rightfully assess the social desirability of science shops.

6.2 Conclusion

Science shops have been developed in a large variety of ways; depending on the region, area of expertise, focus from policy makers and institute to which the science shop is connected. This does not make analyzing their costs and benefits easier. Based on the analysis conducted in this study however, science shops can broadly be defined in two groups; the large science shops that are characterized by a central coordination point that collects research requests and divides them over the different departments. These science shops have quite a large budget to their possession, are regulated by a university and do not work independently. In our analysis, the science shops Wageningen and Brussels can be categorized as larger science shops. On the other hand, we have the smaller science shops that work independently and aim for a different public, mainly SME. Students often work for these science shops as extracurricular activities and therefore, research is often conducted in a different way at these science shops. Here, we used the chemistry shop Eindhoven to analyze these smaller science shops. Another small science shop is the science shop Zittau, which is analyzed in Annex 1. We did not include this science shop in our core analysis because this science shop is a special case in the sense that it does not focus mainly on providing and guiding student research, but has a large focus on the development of SME in the region and providing trainings for students.

For these different science shops, we analyzed the social desirability relative to its next best alternative; where clients of science shops would turn to if science shops would not exist. The analysis has been based on the assumption that science shops provide scientifically valid services for groups of people that would otherwise not be served. For proponents of the science shops, this means that the next-best alternative for clients of science shops would be the market of professional consultancy companies. Science shops offer their services against much lower prices than professional consultancy bureaus do and thereby fulfill another segment for the market of answering research questions of society. Without this segment, CSO or SME would not enter the market because of their financial restrictions. However, this difference in pricing does imply price discrimination in the market.

Critics of science shops argue that without science shops, clients and students would have found each other just by demand and supply of the market. In this case, the next best alternative would be student research without science shops acting as an intermediary. It is however quite unlikely that without the existence of the science shops, all clients would be able to find a student to conduct their research. However, if this would be true in theory, it is still likely that science shops do not only connect client and student, but also lead to a higher quality product, because the science shop supervises the whole research process of the student.

For the four science shops mentioned above, we performed a cost-benefit analysis and a sensitivity analysis based on both views on the next-best alternative for science shops. In the comparison between science shop research and that of professional consultancy bureaus, we estimated the amount of SRH that can compose one PRH up till the point where the science shop breaks even. This based on the idea that students at science shops are often less efficient than researchers working for professional consultancy bureaus; partly because students do not have the experience and facilities that professional researchers have and partly because of the specific field in which science shops work. Based on discussions with project leaders and supervisors of science shops we came to a ratio of 3 SRH that would lead to the same quality and efficiency of one SRH and 50% of science shop work that would also have occurred without the existence of the science shops. In comparing the science shops with normal student research, we analyzed the amount and percentage of the value of extra hours that could be conducted without the costs of the science shop. Table 12 below shows the CBA results per science shop and a sensitivity analysis on when the science shop would break-even based on both views.

Table 13: Comparison of CBA results and sensitivity analyses between science shops

Scenario	**1**	**2**	**3**	**4**
SRH-PRH ratio	1 PRH:1 SRH	1 PRH:3 SRH	1 PRH:1 SRH	1 PRH:3 SRH
Without science shop	0	0	50%	50%
WAGENINGEN				
With science shop (€)	765,972	136,812	765,972	136,812
Without science shop (€)	0	0	471,87	471,87
With – Without (€)	765,972	136,812	294,102	-335,058
BRUSSELS				
With science shop (€)	980,456	277,992	982,016	277,992
Without science shop (€)	0	0	526,848	526,848
With – Without (€)	980,456	277,992	455,168	-248,856
EINDHOVEN				
With science shop (€)	269,755	68,132	269756	68,132
Without science shop (€)	0	0	151217	151,217
With – Without (€)	269,755	68,132	118539	-83,085

Because of the large difference in size and structure of the science shops, it is difficult to compare their costs and benefits. The table above does however show that the CBA on the science shops Wageningen and Brussels result in much larger benefits. This can be easily explained by the size of the science shops. With an average of 13 projects per year over the past 5 years, and a maximum working budget of €35,000.- per project, science shop Wageningen is one of the larger science shops. But this also counts for Brussels, characterized by a central coordination point that oversees all Belgian science shops and has a budget of nearly €70,000 per year. There is however quite a large difference in annual budget between these two science shops, which is reflected by their difference in PRH-SRH ratio. This difference in fixed costs for coordination can mainly be explained by the fact that also researchers of Wageningen University conduct research for the science shop, where research of science shop Brussel is only conducted by students.

The chemistry shop Eindhoven is one of the smaller science shops, fully managed by students and with an average working budget of around €32000.-. It can however easily keep up with the larger science shops in terms of its PRH-SRH ratio and the percentage of extra quality that needs to be added to a science shop hour in order to break lead to the same valuation of a normal SRH.

All science shops end up with negative results under the scenario that one PRH equals 3 SRH and 50% of the SRH would also occur without the help of the science shop. Most striking in these losses is the small loss for Wageningen. This is due to the fact that the science shop acts for a relatively large part as a professional research bureau and therefore the loss of 50% of the SRH does not have a large effect on the science shop Wageningen compared to the others. However, again the ratio of 1PRH: 3 SRH combined with the 50% of SRH that would also have occurred without the science shop is probably quite a strict calculation in the cost-benefit analysis. We can therefore conclude that the best-guess of for the economic efficiency of the analyzed science shops would be half way between the most positive scenario (scenario 1) and the most negative scenario (scenario 2). This would lead to the net benefits as presented in table 14 below. From this, we can conclude that both large and small science shops are economically efficient.

Table 14 Best guess of economic efficiency of science shops

Science shop	Net benefits (€)
WAGENINGEN	215457
BRUSSELS	365800
EINDOVEN	93335

6.3 Discussion

The analysis provided in this study gave some useful insights in the costs, benefits and efficiency of science shops. There are however a number of other important aspects to keep in mind when evaluating the social desirability of science shops. Here, we will touch upon the most important of these.

In our CBA, the benefits have been represented by a multiplication of the amount of science shop research hours by the average willingness to pay and the costs have been represented by the total costs made by the science shop. We used €147.- as the threshold value of price P for an hour of research conducted at a professional consultancy bureau and assumed that from this the demand curve was a straight line to each of the axes. We are however aware that another threshold value as the price for a professional research hour or another slope of the demand curve would lead to very different results.

The CBA analysis only took the direct costs and benefits into account. Costs and benefits can however be disaggregated into three categories: direct, indirect and intangible. Direct are those costs directly related; such as overhead and labor costs, which are taken into account in related markets. Indirect costs refer to the inputs and outputs that occur outside the science shops. These indirect effects could be measured by the earnings foregone or enhanced due to the work of the science shops. These are reflected by the value of production lost or gained by society. Intangible costs or benefits refer to the internal valuation of people to costs incurred or benefit obtained by science shop work (Brent, 2009).

It can easily be assumed that the projects conducted by science shops have not only led to direct costs and benefits, but also to indirect ones. These indirect costs and benefits are however very difficult to measure in monetary terms. Including all costs and benefits of the projects conducted by science shops will be very hard. Not only is it difficult to indicate a monetary value to all costs and benefits, but also to measure externalities. In economic theory, different techniques to measure nonmarket valuation have been developed. Among these are the stated and revealed preference techniques. The stated preference techniques rely on answers from surveys where revealed preference techniques draw statistical inferences on values from people's market behaviour. (Oskam, 2008). However, science shops often do not possess these kinds of data and acquiring them is outside the scope of this research. In order to still be able to show the indirect costs and benefits that may occur in science shop work, we analysed the impact of two specific projects, namely the ring road around Erp conducted by science shop Wageningen, in annex I and the development plans for the socio-economic disadvantaged region in Hungary by the ESSRG science shop in annex 2. These examples shows that research conducted by science shops can lead to new approaches to problems that may in turn lead to new insights. The effect of this work does not only lead to costs and benefits on the specific project, but also on related markets.

Moreover, science shops themselves, do not only focus on answering research questions for clients, but do also bring a valuable contribution to the education of students by offering practical topics for, amongst others, master theses. In this way, they do not only aim at answering research questions of private persons, CSO or SME in realizing their future plans, but also bring a valuable contribution to the training, and possibly motivation, of students for their further jobs. Moreover, the fact that science shops are generally linked to universities makes them the ideal bridge between science and society and allows them to often bring new, innovative approaches to answer research questions. This is further explained in annex 2. This is in light with one of PERARES' goals to embrace the dialogue between research and society.

With this analysis we tried to provide a substantive addition to the evaluation methods and models available for science shops and to provide a paper intended for further discussion and research within and outside PERARES. We do realize that the core analysis provided in this paper does not pay attention to the indirect costs and benefits that occur in science shop research, but we hope that it provides a starting point for an economic evaluation of science shops.

ANNEX 1: SCIENCE SHOP ZITTAU

Introduction

The full name for the science shop Zittau is *The Science and Technology Transfer e.V. Zittau*. The science shop Zittau is a non-profit organization that is linked to the university of Zittau/Gorlitz and the International University Institute Zittau as well as regional initiatives and SME. At the science shop Zittau, different enterprises conduct activities and in these offer businesses, clubs, initiatives and the general public in the region a contact point that connects them to university institutions. The science shop Zittau has been initiated based on a student initiative of the Founders Academy at the university of Zittau/Gorlitz, based on the idea to develop a more active participation in German and international science shop networks.

The science shop Zittau aims at offering attractive qualification trainings for founders of businesses and students in the region. An example is the project Career Service that has been introduced in order to prepare students to begin their career as qualified workers and managers of firms. When the present Founders Academy project ends, the data bank will be converted into the Zittau Science Shop. Some of the main tasks of the science shop Zittau are to offer students the possibility to follow workshops and trainings, to join certain groups, such as the investors club for engineering students, and to offer projects that are likely to give a stimulus to the economic development by helping businesses in the region. Hence, the science shop Zittau is quite different from the three science shops analyzed in the previous chapters in the sense that it does not only focus itself on analyzing research questions from society, but also on providing trainings for students and businesses.

Cost-Benefit Analysis

Table 3.1 below shows the costs and amount of hours that have been put into science shop research in Zittau over the past 4 years (Sewell, Personal Communication). Based on this, we can evaluate the costs and benefits in the way described by the methodology above. If we assume that one SRH is as efficient and productive as one PRH, then a total amount of 1851 SRH have been supplied over the past 4 years. Based on this and the average willingness to pay for one SRH of €73.50, the total benefits over the past 4 years are 1851*73.5 = €136,049.- and the average benefits per year €34,012.-. With the average costs per year being €17,364.-, we arrive at a positive benefit per year of €34,012.- – €17,364.- = €16,648.-.

Table 3.1: Costs and hours of research conducted in the science shop Zittau

	2010	2009	2008	2007	Total
Fixed Costs	4000	4096	3445	9020	20561
Variable Costs	14000	16286	9490	9117	48893
Total Costs	18000	20382	12935	18137	69454
Total amount of SRH	780	491	280	300	1851
Total amount of PRH	0	0	0	0	0

1.1 Sensitivity Analyses

It can however easily be assumed that one SRH does not have the same efficiency and productivity as one PRH has. Therefore, we can analyze the minimal rate of efficiency that students must have in order for the science shop to break even. Table 3.2 below shows the benefits with different rates of efficiency of a SRH relative to a PRH. When other things remain equal, i.e. the hourly wage of a PRH remains at €147.-, the average benefits of one science shop hour remains at €73.50 and the total costs of science shop Zittau over the past 4 years remains at €69,454.-.

Table 3.2: Sensitivity analysis on the efficiency of science shop Zittau hours as opposed to PRH hours

PRH/SRH ratio	Total amount of SRH / year	Total benefits € / year	Benefits - Costs € / year
1 PRH = 1 SRH	463	33994	16630
1 PRH = 2 SRH	231	16997	-367
1 PRH = 3 SRH	154	11331	-6032
1 PRH = 4 SRH	116	8498	-8865
1 PRH = 5 SRH	93	6799	-10565
1 PRH = 6 SRH	77	5666	-11698
1 PRH = ∞ SRH	0	0	-17364

In the most extreme case, where a student hour is not of any use, the science shop Wageningen would make a loss of €-17,364.-. It is however very unlikely that a student hour won't be of any use. Therefore, in analyzing the cut-off point in the efficiency of a student hour, we can see that the science shop Zittau will break even when one PRH represents almost two SRH. This break-even point is graphically represented in Figure 4 below. Here, the science shop would break even in its costs and benefits; costs and benefits would be equal to €17,364.

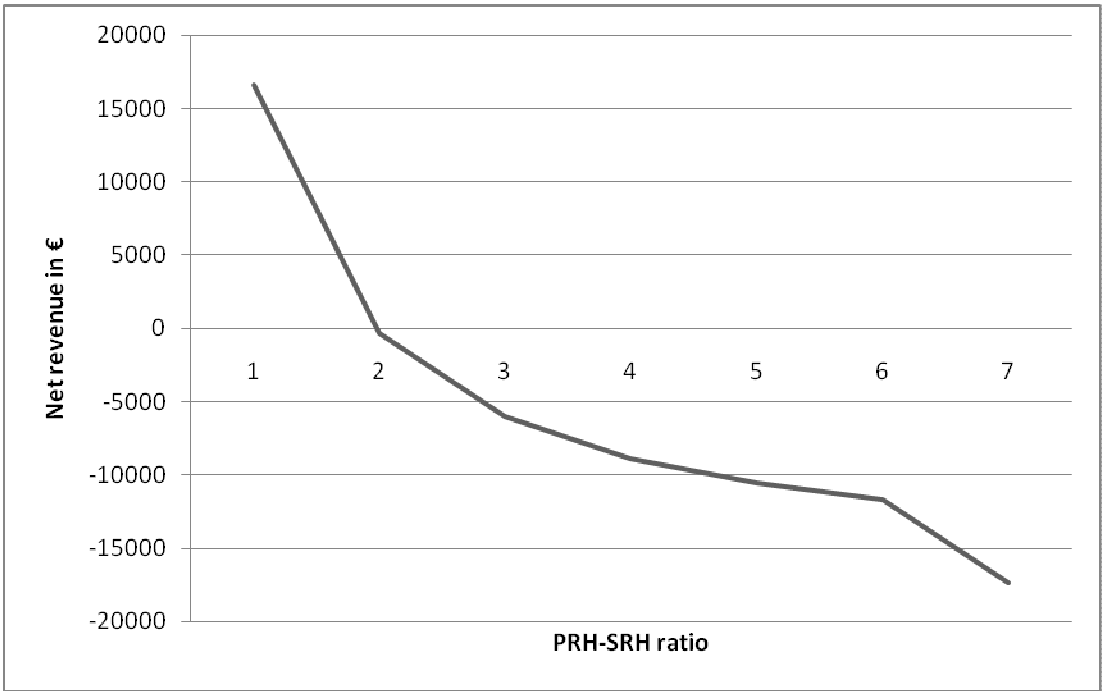

Figure 3.1: Science shop Zittau revenues with changing PRH/SRH ratio

The science shop Zittau does not conduct research as other science shops do. Therefore, it makes it difficult to compare the science shop hours conducted with professional consultancy bureau hours. Student hours conducted at the science shop Zittau are not conducted as part of a master thesis and would therefore not occur if the science shop would not exist. The exclusivity of the hours conducted at the science shop Zittau makes a sensitivity analysis on the amount of extra hours that could be conducted without the science shop, under the assumption that client and student would meet each other by demand and supply of the market unnecessary.

ANNEX 2: SOCIAL COSTS AND BENEFITS, THE CASE OF ERP

In and around Erp, a village in the province Brabant in the Netherlands, there is a considerable amount of heavy traffic. This is partly caused by traffic that has a destination in Erp, but also partly by traffic that uses Erp to get from A to B, both outside the village. The traffic causes a considerable amount of inconvenience to the inhabitants of Erp, who have been trying to come up with a good solution for a long time. Residents on one side wanted a ring road to cut the heavy flow of traffic through the village. Those in the opposing party argued that a ring road would destroy the landscape. In 2004, the municipality decided to build a ring road to the North and South of Erp in order to relieve the through road of traffic. At this time, one of the opposing parties, *Erp Alert*, asked science shop Wageningen to research the alternatives for this solution.

The science shop Wageningen conducted a research on the alternatives for the traffic situation around Erp and how traffic problems like these can in general be approached. Firstly, residents were asked to describe their ideal scenario, which resulted in a list of four items. The solution should namely result in a (1) reduction of the traffic burden, (2) increased safety, (3) improved accessibility and (4) conservation of landscape quality.

In search of the best alternative, a distinction between on the one hand the origin and destination and on the other hand the level (local or regional) of the traffic had to be made. For this, the science shop came to a new approach, the so called 'diamond concept'; traffic that neither comes from nor has its destination in Erp, should stay in the surrounding roads instead of passing through Erp. In this new structure, the science shop took the following principles into account; the size of the residence area, the possibility to enforce lower speed limits, the prevention of traffic passing through Erp and the accessibility of the main roads from Erp. The science shop came to the conclusion that the option of a feeder road to the industrial park with traffic curbing measures in the village center would be the best solution (Hoofwijk *et al.,* 2007).

These conclusions led to recommendations for the municipality of Erp and province of Brabant in solving the traffic problems on both a local and regional scale. An analysis for the best solution to overcome the traffic problems had been conducted by several professional consultancy bureaus before the question was posed to science shop Wageningen. New in the approach of the science shop was that the analysis took place on a larger level than that on which local interest groups normally operate. In autumn 2008, after the science shop report had been published in August 2007, the municipality decided to abandon the planned ring road in favor of the feeder road in the South of Erp and traffic curbing measures in the center of Erp, as proposed by the science shop (Brabants Dagblad, 2008a; Brabants Dablad, 2008b).

Effects of a project can be defined by the difference between a development with the project (project alternative) and without the project (zero rate). Because it's the difference that is important in a cost benefit analysis, the construction of the zero tariff is as important as the construction of the project alternative in order to make a reliable choice. The zero-tariff is a combination of the second best means and solutions for the problem. Hence, it is not the 'status quo' but the best alternative (Eijgenraam *et al.,* 2000). In the science shop project of Erp, we can measure the project alternative defined by the science shop against the zero rate if the research of the science shop would not have taken place.

These two projects are compared in the research of the science shop as represented in table 1 and 2 (Hoofwijk *et al.,* 2007). The benefits of infrastructure projects are largely determined by the internal valuation of traffic participants or the inhabitants of the area (Eijgenraam, 2000). Based on tables 1.1 and 1.2 below, we can see that the alternative solution proposed by the science shop is likely to score

9 points higher in the internal valuation of the inhabitants of Erp, where the zero-rate is of the Northern ring road will lead to the same internal valuation as is currently the case.

Table 1.1. Northern Ring Road

Description	- Sustainable and safe residence area, maximum speed 60 km/h - Good functioning small diamond - A prohibition for on-going heavy traffic in the center of Erp
Score against the current situation	
Prevention of on-going traffic	-2
Guidance of destination traffic	+1
Inconvenience in Erp	+2
Inconvenience in Keldonk	0
Inconvenience somewhere else	-1
Approachability residence area	+1
Approachability Molenakker	+1
Damage to the landscape, inheritance, nature	-2
Total score	**0**

Source: Hoofwijk et al., 2007

Table 1.2. Feeder Road

Description	- Sustainable and safe residence area, maximum speed 60 km/h - Good functioning small diamond - New road that connects to the N279 to bundle the traffic to the 80km/h road.
Score against the current situation	
Prevention of on-going traffic	+2
Guidance of destination traffic	+1
Inconvenience in Erp	+2
Inconvenience in Keldonk	+2
Inconvenience somewhere else	-1
Approachability residence area	+1
Approachability Molenakker	+2
Damage to the landscape, inheritance, nature	0
Total	**+9**

Source: Hoofwijk et al., 2007

The points examined in the tables above partly rely on stated preference techniques since the science shop researchers asked for the inhabitant's most important problems to be solved in the current traffic situation. With this approach, the social costs and benefits of the inhabitants of Erp are quite well assessed. However, the direct costs of constructing the ring road against the feeder road have not been assessed. In the direct costs examined above, it is important to, amongst others, include the costs for preparation, investments during the period of construction and in the future (Eijgenraam *et al.,* 2000). Moreover, in measuring the indirect costs and benefits of this project, it is also important to include the social costs and benefits of the participants of the traffic and the influence the project has on the markets in which they engage.

Despite the shortcomings on this analysis, the example of the ring road of Erp does show that the research of the science shop Wageningen had a large influence in coming to a better decision for the traffic problems, which is likely to have brought large social benefits to the inhabitants of Erp.

ANNEX 3: THE NEED FOR COMMUNITY BASED RESEARCH, THE CASE OF THE MEZOCSAT MICRO-REGION OF HUNGARY

The ESSRG Science Shop in Hungary is the first one established in the country as part of the Environmental Social Science Research Group (ESSRG) of Szent Istvan University, Hungary. Partly, the research of this science shop is conducted by researchers and partly by students. In this latter case, research is conducted in the form of participatory action research (PAR).

An example of such a PAR was the design of a rural development plan of the Mezocsat micro-region of Hungary in order to strengthen cooperation among local stakeholder and initiate development projects. Master students could participate in this project by following a 5 credits course at either the Szent István University in Gödöllő or the Pázmány Péter Catholic University or students could voluntarily conduct in-depth interviews with local inhabitants in the region. Together, this formed a group of 29 students that were involved in conducting interviews, organizing community forums and developing project ideas with local inhabitants. Next to the students, a science shop coordinator was involved in the project.

The project resulted in a participatory rural development plan, consulted and co-created with the public in the micro-region and formed the basis of an article by Borkodos and Pataki (2009) on the role of science and society. In this article, they provided the participatory action research (PAR) combined with an educational model of service learning as a methodology to fulfill academic institutions' responsibilities to establish science-society relationships and mutual dialogues. Borkodos and Pataki (2009) apply this methodology to sustainability planning in one of the most socio-economically disadvantaged rural areas of north-east Hungary. Part of this work was the development of an environmental education trial that would provide more attractive services for eco-tourism, promoting local products by organizing annual local product festivals and a rural development plan for the Mezocsat micro-region of Hungary. With the help of this case-study area, the article shows that community-based research is necessary to tackle problems that include empowering local people and providing space for dialogues, amongst others. Hereby, it is necessary for researchers to stay sensitive and receptive to local needs.

Hence, science shops can help bridge this gap between the academic world and small communities. However, the article goes further by arguing that this may not only be beneficial for these communities, it can also provide new teaching opportunities that make students more enthusiastic for the research they conduct. By offering credits for their work done, the capacity of academic institutions can largely expand. Furthermore, Borkodos and Pataki (2009) found that this kind of research can bring researchers to discover new fields of research. An example of this is the issue of environmental justice among Roma-communities in the studied Mezocsat micro-region.

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