

Article

Policy Mixes to Achieve Absolute Decoupling: A Case Study of Municipal Waste Management

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Abstract: Studying the effectiveness of environmental policies is of primary importance to address the unsustainable use of resources that threatens the entire society. Thus, the aim of this paper is to investigate on the effectiveness of environmental policy instruments to decouple waste generation and landfilling from economic growth. In order to do so, the paper analyzes the case study of the Slovakian municipality of Palarikovo, which has drastically improved its waste management system between 2000 and 2012, through the utilization of differentiated waste taxes and awareness-raising and education campaigns, as well as targeting increased recycling and municipal composting. We find evidence of absolute decoupling for landfilled waste and waste generation, the latter being more limited in time and magnitude. These policy instruments could therefore play an important role in municipalities that are still lagging behind in waste management. More specifically, this policy mix was effective in moving away from landfilling, initiating recycling systems, and to some extent decreasing waste generation. Yet, a more explicit focus on waste prevention will be needed to address the entirety of the problem effectively.

Keywords: policy mixes; absolute decoupling; waste management

1. Introduction

The unsustainable use of resources and the generation of waste put stress on both society and the environment. The current global production and consumption patterns severely threaten the resilience of planet Earth [1,2], as well as the economic prosperity and the well-being of the societies that inhabit it. Effectively promoting a more sustainable use of resources and effective waste management thus constitutes an important challenge [3]. Resource decoupling is a concept that describes the delinking (or decoupling) of resource use from economic growth [4,5]. Policy mixes that aim to promote such decoupling have been implemented in European Union to address this important challenge. However, the effectiveness of such policy mixes needs to be further explored. This paper contributes to this issue by considering a case study and its waste management policy mix, and analyzing its effects on decoupling.

Studying the effectiveness of policy mixes in waste management is particularly critical for the following reasons. Firstly, decoupling is of particular importance in the area of waste management, since waste has substantial environmental impacts and economic costs that are comparable to those of climate change [5]. Secondly, there have been enormous efforts to divert waste from landfills, improve waste management systems and prevent environmental damages and loss of resources at the European Union (EU) in the past two decades. Although evidence suggests that relative decoupling of waste generation from economic growth and absolute decoupling of landfill waste have occurred, there is no evidence of absolute decoupling of waste generation documented in the EU [6–8]. It is, therefore, essential to evaluate the effectiveness of these policies in a consistent manner.

Thirdly, policy mixes, defined as a combination of policy instruments reinforcing each other in a coherent way, can yield a higher performance towards given policy objectives compared to utilizing single policy instruments in isolation [9]. Achieving absolute decoupling is a complex objective that requires a policy mix consisting of several mutually reinforcing instrument types [10]. Thus, there is a need to evaluate the effectiveness of the combination of different instruments in achieving absolute decoupling of waste from economic growth [11].

This paper investigates how decoupling effects between municipal solid waste generation, landfilling and economic growth occurred in response to the implementation of waste policies, by exploring the case of the Palarikovo municipality (Slovakia). More specifically, the paper analyses the development of a policy mix for municipal solid waste management developed in a rural municipality in Slovakia for more than 15 years. This case is of particular interest for studying the impact of waste management policies on decoupling, since the policy mix used achieved notable results in terms of increased recycling and decreased landfilling rates. The Palarikovo case study has been reported as best practice in several documents available in the grey literature [12].

In the subsequent analysis, the author investigates the effectiveness of the waste management policy mix in terms of achieving absolute decoupling of waste generation and landfilling, through an analysis of quantitative and qualitative data. Hence, this paper aims to contribute to the understanding of the effectiveness of the combination of different waste policy instruments in achieving waste reduction, increase recycling and decrease landfilling.

The paper is structured as follows: Section 2.1 frames the concept of absolute decoupling, highlights the need for sound policy evaluation to investigate absolute decoupling of waste generation, and provides an overview of the effectiveness of common waste policy instruments. Sections 2.2 and 2.3 present the case study, the data harvesting method, and the methodology used for data analysis. In Section 3 the case study and results of the analysis are presented. In Section 4 results are discussed in the context of the literature presented in Section 2. Conclusions are presented in Section 5.

2. Materials and Methods

2.1. Literature Review

2.1.1. Resource Decoupling

The decoupling concept focuses on the relationship between economic growth and performance on the one hand, and resource use and waste generation on the other. The relationship between economic growth and the use of resources has been discussed in the context of theories of material flow analysis and on the Environmental Kuznets Curve (EKC), the latter being a theoretical U-shaped relationship between pollution emission and affluence [4,13].

The EKC visualizes the hypothesis that resource utilization and pollution initially increases with the per capita income and then eventually decline, because the willingness to pay for environmental quality increases with income [6]. This relationship, which was widely used in research since the early 1990s, plays a central role in the evaluation of environmental policy and in providing empirical evidence on delinking trends of resource use and environmental pressure deriving from economic and policy drivers [13,14]. The EKC suggests that it is possible to achieve a reduction of environmental impacts and resource use in a growing economy at a certain point. This concept is usually referred to as “decoupling”.

The need for infinite economic growth has been questioned for decades, for instance in Meadows 1972 seminal work *Limits to Growth* [15]. If we want to achieve a transition to a more sustainable economy, which underpins global equity and prosperity, this objective might clash with the goal of achieving continuous economic growth [16–20]. Yet, decoupling is at the heart of ecological modernization concept, which pertains that economic growth can be a promising goal if it is delinked from environmental harms and resource use [5,19]. The idea that ecological modernization, and

decoupling in particular, is the answer to our pressing environmental and social problems has great influence on policymaking.

Resource decoupling means reducing the rate of use of raw materials per unit of economic activity [21]. The OECD, which has conducted extensive research on the use of decoupling indicators for policy-evaluation purposes in the past two decades [7,21], suggests that decoupling means breaking the link between “economic goods” and “environmental bads” [22]. When defining decoupling, Jackson [17] suggests that it is imperative to distinguish between relative and absolute decoupling. Relative decoupling occurs when the growth rate of the environmentally relevant variables, be it resource use, waste or emissions, is less than that of its economic driving forces (e.g., GDP) over a given period, as displayed in Figure 1. In contrast, absolute decoupling occurs if the growing rate of the environmental variable is stable or negative while GDP keeps growing [17,21–23]. Thus, absolute decoupling is an indication that environmental pressure is either stable or falling, and therefore essential if economic activity is to remain within ecological limits [17]. The decoupling concept is also used for policy evaluation: in particular, measuring the decoupling between environmental depletion and economic well-being over a given period can help to understand the effectiveness of policy implementation [5].

The decoupling concept is particularly relevant for waste generation, which is in the focus of this paper. Mazzanti highlights the importance of achieving at least some degree of absolute decoupling in the light of ever growing rates volumes of waste [24].

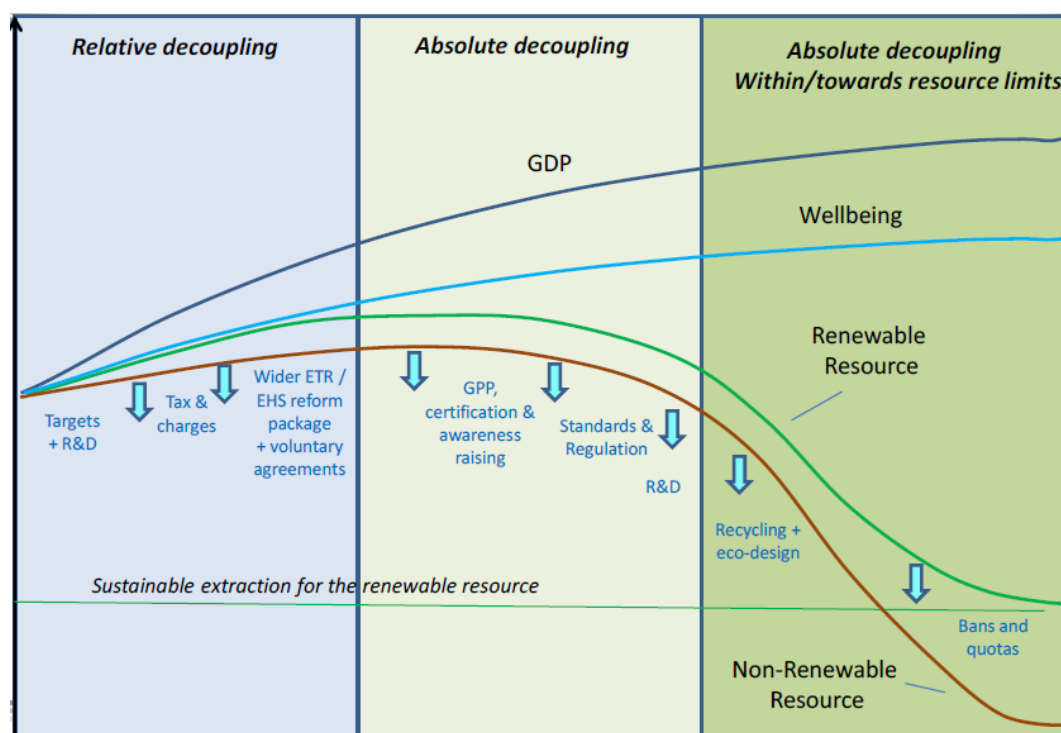


Figure 1. Relative and absolute decoupling of resource use from well being (source: Umpfenbach *et al.* [9]).

2.1.2. Waste Policies in Europe

The European Union (EU), which is in the scope of this paper, has put many efforts into implementing landfilling and recycling policies since the late 1990s and early 2000s. Landfilling, incineration, recycling, reuse and the prevention of waste are addressed in a variety of EU Directives regulating waste management in Member States, first of all in the Waste Framework Directive (2008/98/EC) [25] and in the Landfilling Directive (1999/31/EC) [26], stipulating that the European

Commission should explicitly set waste prevention and decoupling objectives for 2020. In practice, the EU policy framework has been implemented focusing mostly on a reduction of landfilling and an increase in recycling rates, due to potentially high costs on the long run [7]. A study on the current impact of waste legislation across the EU [27] highlights that the implementation of EU waste policies in national regulations has resulted in a general shift away from landfilling and an increase in recycling levels. In 2012, one third of EU Member States have achieved a Municipal Solid Waste (MSW) recycling target above 40%, and were close to achieving the 50% target due by 2020. In addition, at least half of the EU countries have made progress in diverting waste from landfill in the past two decades, with more than half of the Member States landfilling less than 40% of generated waste. Nevertheless, waste generation in the EU has remained stable in the past two decades [27,28].

Finding empirical evidence for waste decoupling in the EU has been the focus of various publications. For instance, Mazzanti and Zoboli [7] investigated the decoupling of municipal solid waste generation, incineration, recycling and landfill in 25 EU Member States during 1995–2005, finding evidence for relative decoupling, meaning that amount of waste was generated was growing at a slower pace than GDP. Johnstone and Labonne [29] confirmed this trend by analyzing data on municipal solid waste generation in OECD countries during 1980–2000. They found evidence that the amount of waste generated grows slower than income, suggesting the occurrence of relative decoupling. More recent evidence suggests that the emission/discharge of many pollutants began to decouple from economic growth in the early 1990s. Progress in this area owes much to the improved recycling rates [21]. This was confirmed by a study by European Environmental Agency (EEA), which analyzed municipal waste generation in the EU between 2000 and 2010, and confirming that in general waste generation has remained stable, and presented clear evidence a decrease in landfilling [28]. On a national level, Van Caneghem [30] found evidence for relative decoupling of waste generation in Finland in the period 1995–2016, thus suggesting that waste generation has remained stable within this growing economy. In accordance with the EEA study, evidence of absolute decoupling was found for landfilling in the EU in the past two decades [7,8,24].

Thus, the waste generation decoupling process appears either to have been extremely weak, non-existent, short-lived or highly ambiguous, due to circumstances that remain undefined [23]. Although there is some evidence for relative decoupling of waste generation and absolute decoupling of landfilled waste in OECD countries, absolute decoupling cannot be observed in terms of waste generation. Thus, the EU policy framework seems to be effective in achieving waste diversion from landfilling, but does not seem to provide incentives for waste prevention.

Mazzanti and Zoboli [5] argue that the literature on this topic is still scarce, and that the analysis of case studies at regional, provincial and municipal levels might provide a better and more reliable basis for sound policy evaluation. They suggest that there is a need to analyze if and how policies contribute to delink waste trends from economic growth empirically.

2.1.3. Policy Instruments for Waste Management

The proper evaluation of the case study needs to introduce some concepts on policy instruments for waste management, which will be analyzed in the context of absolute decoupling further on in this paper. Therefore, in the last part of this literature review we aim to provide an overview of policy instruments targeting household waste generation, and their effectiveness in addressing absolute decoupling.

A first distinction can be made between regulatory, economic and informational policy instruments [31]. For a comprehensive overview on the regulatory and economic instruments for solid waste management, we refer to the work of UNEP [32].

Regulatory instruments concern mostly standards, permits, recycling and final disposal regulations. As already highlighted, the EU has focused on landfilling and recycling regulations with regard to household waste. The EU regulations on waste have been translated into national and local regulations (e.g. closure of landfills), with substantial differences across the different Member States in terms of the quality and progress of the implemented policies and the achieved results [27,28].

Among the economic instruments, waste fees such as the Pay as You Throw (PAYT) scheme (known also as Unit-Based Garbage Pricing, UBP), a waste tax mechanism, are very well diffused in the EU, and a number of Member States have already implemented it based either on volume, frequency or weight. While the effectiveness of these differentiated waste fees in increasing source separation and recycling is recognized in recent studies [11,33–36], their effectiveness in achieving waste reduction in a growing economy is more uncertain, and effects are likely to vary significantly under different circumstances.

Miliute-Plepiene and Plepys [31] analyzed the waste policies implemented in the municipality of Vellinge in Sweden, where a reduction of 20% of per capita household waste was observed in 2012–2013. They concluded that it is difficult to say whether the increased volume-based fees were the cause of the sudden drop in waste generation. They suggested that it was rather the introduction of a separate food collection system and other factors such as a high-income rate and external information and awareness-raising that could have played a decisive role in reducing waste.

Kinnaman and Thomas [37] performed an econometric analysis of fourteen case studies of UBP in literature, and consistently estimated the demand for garbage collection services to be inelastic.

Allers and Hoeben found [38] that the price effect depends on the pricing system, and that weight-based fees have the potential to reduce garbage quantities more than volume-based fees.

Usui *et al.* [35] analyzed the introduction of unit-based pricing schemes in Japan in the long term, and found different responses to the tax depending on household income. They found an increase in generated waste of the long run in many cases, and argued that typically a couple of years after the introduction of a differentiated fee scheme, people become less sensitive to price burdens. Hence, they highlight the importance for municipalities to take additional steps to promote waste reduction after the introduction of the differentiated waste fee. These measures range from supportive informational measures to highlight the environmental and economic positive impacts of the tax [11], to improved collection systems which ease the task for households to sort waste.

Finnveden *et al.* [11] suggest that the combination of a weight-based waste fee, information and developed collection systems has the potential to keep waste quantities from growing and even to reduce collected waste by up to 20%. This was observed in several Swedish municipalities, although the reasons for reduced waste are uncertain. As already highlighted by Usui *et al.*, the main driver for change might not be the fee as such, since it is small compared to the total household budget, but rather the norm-activating information. Such information can increase environmental awareness and the feeling that “sorting is doing the right thing”, and reduce illegal waste management. The investigation of the effects of a differentiated waste fee without a norm-activating campaign in Kumasi Metropolis, Ghana, which was analyzed by Sampson *et al.* [39], supports this statement. Here, a PAYT was implemented but 80% of the population was not informed about it. This resulted in reported low adhesion to the scheme, illegal dumping of waste into communal containers at night, non-payment of user charges, and indiscriminate dumping of waste.

The effectiveness of the PAYT in reducing generated household waste quantities thus depends on the combination of different factors. Sterner and Bartelings highlight [40] that economic incentives are important, but not the only driver behind the reduction of household waste, while Schmidt *et al.* [41] found that the PAYT function more as an information instrument than as a financial incentive. However, Finnveden *et al.* suggest that in order to significantly decrease the generation of waste in the long term, more transformational policy instruments will be needed.

2.2. Data Collection

This paper focuses on the case study of waste management policies in the municipality of Palarikovo, a rural town in Slovakia. In particular, the analysis focuses on the effectiveness of the policy mix consisting of differentiated waste fees, information campaigns and regulatory instruments in achieving waste reduction. This case study is part of a wider “ex-post” policy analysis within the DYNAMIX project. This project focused on policies to achieve absolute decoupling and was funded within the 7th Framework Programme (FP7) of the European Commission. This case study has been

selected among others, for the ex-post assessment of 15 policy mixes focusing on different resources, and with the overall aim to test whether decoupling had occurred [42].

The case study was analyzed in subsequent steps:

- in the first stage, the problem definition was investigated and its parameters identified. These were analyzed through an in-depth evaluation based on a common assessment template, which had been developed within the DYNAMIX project for the ex-post assessment of environmental policy mixes.
- in the second stage, data was collected through desk research and a semi-structured interview with the municipality of Palarikovo based on the common assessment template.
- in the third stage, the collected data was interpreted by using the framework identified in the first stage.

Empirical Data Source

In the first stage, a comprehensive desk research focusing on the Palarikovo municipality was carried out and resulting secondary data sources were analyzed. This included a number of reports documenting on the case study. Palarikovo municipality had been cited as a best practice example for increased recycling rates and a reduction in landfilling in the grey literature [12]. Crosschecking different information sources allowed a documentation of the time line of policy implementation, and provided numerous details on its evolution. This information was put together to draft a first description of the case study and identify its main features, such as the size and structure of the system, the variety of policy instruments applied, and punctual data on waste management performance.

In the second stage, a face-to-face interview with the major (in August 2013), and the municipal officer responsible for environment and waste management of Palarikovo, was scheduled. The latter interview partner had been one of the initiators of the waste management system in Palarikovo, and was therefore able to provide a complete understanding of the case-study (see Acknowledgment). The semi-structured interview lasted 5 hours and was based on questions adapted from the common evaluation template developed within the DYNAMIX project [43]. This format gave the interview partner the necessary freedom to explain the different nuances of the problem. The question was presented by a Slovakian native speaker and expert in policy evaluation, to reduce possible ambiguity of the questions. The interview was recorded but not transcribed. The outcomes of the interview were analyzed by two researchers. The interview documented the precise evolution of the system and policy mix and thus allowed the author to determine causes and effects of each of the policy instruments previously identified.

Moreover, a site visit of the collection center in Palarikovo, which was organized by the major, enabled further observations.

In addition to the qualitative interview, the author had access to the complete data series for municipal waste performances (including waste generation, recycling and landfilling rates and breakdowns for several materials) extracted from the databases of the municipality of Palarikovo for the time period 2000–2012. The availability of time series of empirical data was a determining factor for the selection of the Palarikovo case study: the municipality implemented a monitoring system to measure waste quantities. Landfilled waste (calculated as the residual waste sent to landfilling), municipal composting (calculated as the fraction collected in the municipal composting collection centers) and recycled waste (the sorted and collected materials such as paper, plastic, packaging, *etc.* destined to the recycling market) could be directly measured. Total generated waste results from the sum of these three waste fractions. Home composting data in the Palarikovo waste database was estimated statistically by the municipality, based on empirical observation and interviews with households.

Data harvesting allowed the collection of three different types of data. Firstly, information on the different policy instruments implemented in Palarikovo between 1999 and 2013, and the rationale behind the introduction of the policy mix. Secondly, descriptive data on the case study, and on the impact of the policy mix (e.g., social acceptability, economic effectiveness). Thirdly, a quantitative

data series of: waste generated (2000–2013), waste landfilled (2000–2013), recycling rate (2002–2013), municipal and home composting (2003–2013), census data (courtesy of the municipality of Palarikovo, confidential file), and regional GDP, region of Nové Zámky, Slovakia (source: [44]) between 2000 and 2012. To estimate the level of decoupling, landfilling and waste data series and regional GDP were processed. The regional GDP is argued by the author to be a valid indicator of the economic growth of Palarikovo, since the municipality is just 10 kilometers away from the city of Nové Zámky, which is the biggest city in the region where 30% of the total population lives. It is, therefore, assumed that Palarikovo can benefit from the economic activities of the city.

2.3. Methods

In the first stage of the analysis, the criteria for the evaluation of the case study were set within the DYNAMIX project. These criteria for analysis were synthesized in a Common Assessment Template, which was then used for the analysis of all 14 studies mentioned above. A version of the Common Assessment Template adapted to the purposes of this paper is provided in Appendix.

The Common Assessment Template aimed to provide an exhaustive picture of the case study, focusing in particular on the efficiency and effectiveness of policy instruments. This was a tool to quantify the environmental outcome of policies (because it implies a causal link between the policy action and its intended impacts on human behavior and the environment). The effectiveness of a policy mix is constituted by whether or not the intended objectives and targets have been achieved.

The efficiency of the policy mixes was assessed by comparing the achieved level of resource and impact decoupling with the monetary (or other) resources utilized to achieve the outcome. In the Palarikovo case study, landfilled waste and waste generation have been investigated, and GDP representative for the region of Nové Zámky has been used as the economic indicator to assess the level of decoupling. The Common Assessment Template helped us to:

- (a) Identify the mix of policy instruments, their roles, interdependencies and cause-effectiveness.
- (b) Evaluate the instrument mix and its role.
- (c) Improve the understanding of the environmental challenge at hand, assess the level of change resulting from the implementation of a policy in terms of environmental issues (e.g., resource use), as well as to investigate whether decoupling has been achieved (see Figure 1).
- (d) Draw lessons from the application of these policy instruments.

The Common Assessment Template and the full evaluation of this case study are available online for further consultation on the project's website [43].

To estimate the level of decoupling, the authors followed the OECD approach of plotting two indexed time series representing environmental pressure and economic growth on the same graph. From such a graph, it is immediately clear whether economic growth or shrinkage has happened, and whether decoupling—absolute or relative—is occurring, when it started and whether it continues (e.g., through direct comparison with Figure 1). Several examples of empirical computation of decoupling between waste and affluence can be found in the literature in which the data series of material outflows are displayed in relation to GDP growth rates [45].

The numerical estimation of decoupling within a certain time period can be calculated by utilizing the relation suggested by UNEP [21], which is based on the estimation of the decoupling index (DI). The Decoupling Index (DI) refers to the ratio of (1) the change in the rate of consumption of a given resource, and (2) the change in the rate of economic growth (GDP) within a certain time period (typically one year).

We can define ΔPt as the change in the rate of pollution emission between year (t) and year (t – 1) as:

$$\Delta Pt = \frac{(Pt - Pt - 1)}{Pt - 1} \quad (1)$$

While ΔY_t is the change in the rate of economic growth and defined as:

$$\Delta Y_t = \frac{(Y_t - Y_{t-1})}{Y_{t-1}} \quad (2)$$

then the Decoupling Index in year t , can be defined as:

$$DI_t = \frac{\Delta P_t}{\Delta Y_t} \quad (3)$$

In the case of continued economic growth, namely $\Delta Y_t > 0$, the Decoupling Index (DI) may imply one of the following scenarios:

- (1) When $DI > 1$, it means the increasing rate of resource consumption or pollutant emissions keeps pace with or is higher than economic growth and no decoupling is taking place.
- (2) When DI equals 1, it is the turning point between no decoupling and relative decoupling. In the stage of relative decoupling, a higher DI value means higher dependence on resources by economic growth, lower resource efficiency and heavier environmental pollution.
- (3) When $0 < DI < 1$, it means the rate of growth in resource consumption or pollutant emissions falls short of that of economic growth. In this case, relative decoupling is taking place.
- (4) When $DI = 0$, it means the economy is growing while resource consumption remains constant. In other words, when the economy grows continuously, the amount of pollutants does not increase.
- (5) When $DI < 0$ resource consumption or pollutant emissions/discharge decreases while the economy keeps growing and absolute decoupling is occurring.

Thus, it was possible to draw decoupling graphs for waste generation and landfilling and to calculate the Decoupling Index for landfilling and waste generation for the entire time series. The cross analysis of the decoupling graphs with the assessment based on the common template, allowed us to form a holistic picture of the case study, to assess whether and under which conditions decoupling has been achieved, and to draw some conclusions and lessons learned on the effectiveness of the policy mix.

3. Case Study Description and Results of Analysis

3.1. Case Study

The municipality of Palarikovo (region of Nové Zámky—Slovakia) is a rural town with 4380 inhabitants living in 1618 housing units. Until 1999, the municipality was disposing its generated household waste of about 1300 tons of waste/year (300 kg/inhabitant year), almost entirely, in the local landfill. The closure of the old municipal landfill in 1999, due to stricter national legislation, was an impetus to change the approach to municipal waste management and find a cost effective alternative for waste disposal. Therefore, the municipality started implementing an integrated waste management system based on recycling and composting principles in 1999. By adopting an alternative and environmentally friendly waste management system, the municipality of Palarikovo drastically reduced landfilled waste and increased recycling and composting. Since the introduction of the policy mix, the municipality achieved a reduction of 64% landfilled waste compared to 2000 (with a peak of 75% in 2005). Over 12 years, it was possible to recycle 50% of all waste produced. In addition, it was reported that due to recycling activities, 45.10⁶ Megajoules of energy and 27.10³ Tons of greenhouse gases were saved in 2011, resulting in a positive outcome for the environment (source: municipal database, courtesy from the municipality of Palarikovo).

The municipality of Palarikovo developed an integrated waste management system through which it is possible to collect different materials (namely, sorted fractions of paper, glass, packaging, *etc.*) and to introduce them into the recycling market. This is organized around a collection center equipped with a waste pressing machine. Both sorted and unsorted waste is collected door-to door according

a specific schedule. Moreover, the municipality is also equipped with centers for municipal composting. This means that today, the municipality is able to separate more than 20 types of materials. Since 2006, the collection center in Palarikovo is also collecting waste produced by 29 municipalities in the surrounding area that have joined together in a local association for managing waste (Palarikovo Regional Collection Yard).

3.2. Evolution of the Policy Mix

The municipality of Palarikovo has gradually introduced a series of instruments, at first to face the problems of finding a cost effective alternative to landfilling, and later to comply with more restrictive national legislation. The implementation of the system and the introduction of the different instruments did not happen in a structured way, but evolved over a period of 14 years. This developed from a very informal system of waste collection (at the beginning only organic waste from agricultural activities and gardening was collected) into a well-structured system.

The first stimulus for change came in 1999 with the operationalization of stricter national requirements for landfills (606/1992) [46] and in 2002 with the Waste Act (409/2006) [47], setting binding recycling targets for municipalities. At the beginning in 1999, the strategy aimed at eliminating organic waste from residual waste. Between 2000 and 2002, home composting was promoted through local radio and leaflets distributed to the population.

The first collection system was organized in 2002, when the municipality of Palarikovo introduced the first waste management facilities. The municipality started to collect glass, paper, plastic packaging, and home composters were sold for around 7 Euro per piece. In the same year, municipal collection points were established in the municipality, where people could bring separated organic waste themselves. The collection points were guarded by some members of a local non-profit organization, the “Ecologic Society”, who made sure that waste was sorted properly and provided further information to inhabitants. The campaign was again promoted through the local radio and leaflets distributed to the population. Collection points were monitored to measure collected organic waste.

The collection and sorting system was improved in 2004, with the possibility to sort further materials and purchase of collection machinery. This opened the possibility of increasing recycling and gave the municipality access to the Recycling Fund, a state financial support [48]. At this point in time, the first targets on collected materials were set. In 2003, the municipality decided to further incentivize waste sorting, and introduced the first differentiated waste fee, a lump-sum fee, replaced in 2006 by a PAYT tax. From 2006 onwards, the municipality started to gradually introduce a number of materials that people could further separate, such as textiles or light bulbs. This waste management system was still active in 2014, and it was estimated that about 99% of inhabitants had been actively involved in waste separation and collection since 2006.

3.3. Main Instruments of the Policy Mix

A variety of policy instruments have been identified in the Palarikovo case study. These comprise:

- Regulatory instruments: national and EU regulation on landfilling and recycling, [46,47].
- Economic instruments: the lump-sum fee, the PAYT, and the National Recycling Fund [48].
- Informational instrument: long-term information campaign.

3.3.1. Instruments

Regulatory Instruments

The change in EU regulation in 1999 with the EU Directive on Landfilling (1999/31/EC) and the Waste Framework Directive /2008/98/EC), set binding targets for EU Member States in terms of landfilling reduction and recycling. These were reported to be central to initiating the change, as they started to be implemented in the national regulations. In Slovakia, this happened in 1999 with the regulation on landfilling and in 2002 with the Waste Act on recycling. Both required Slovakian

municipalities to find alternative solutions to waste landfilling and increase recycling. Thus, it can be argued that the regulations served as a legislative driver to implement an environmentally oriented solution.

Economic Instruments: The Lump-Sum Fee and the PAYT

In Palarikovo, different tax schemes had been introduced, that aimed to stimulate participation of inhabitants in sorting waste. During 2003–2006 this was organized according to a lump-fee scheme, and participation was voluntary: inhabitants who wanted to participate in the scheme had to sort organic waste. A collection truck was driven around the municipality to collect residual waste and organic waste, while an inspector was checking and reporting who was sorting organic waste. Finally, every half a year the municipality could calculate different waste charges for each inhabitant (about 7.40 Euro for those who were not sorting waste and 4.70 Euro for those who were sorting waste). Thanks to this scheme, about 80% of inhabitants of the municipality participated.

In 2006, as the amount of collected materials was stagnating, the municipality introduced the “Pay As You Throw” tax. The system in Palarikovo was organized in such a way that inhabitants had to pay a fee for every token (100 liters) of residual waste produced, while the collection of sorted waste was free of charge. Each token for collecting residual waste was sold at a price of 1.3 Euro until 2010. The price were then adjusted to 1.80 Euro in 2012, and collected door to door. Each token was registered with a barcode so that the municipality could constantly cross-check who bought the token and how many tokens were missing, in order to plan the collection in advance. The PAYT scheme was well accepted and 99% of the population was reported to be involved at the end of 2006. Illegal waste dumping and incineration were reported to be minimal.

Financing: The National Recycling Fund

The National Recycling Fund [48] is a national governmental economic instrument to support municipalities in implementing waste separation, collection, recovery and processing. Through the collection and reporting of established quotas of recyclable materials (such as paper, glass, packaging, *etc.*), Slovakian municipalities becomes eligible to be granted funding from the Recycling Fund. This recycling fund has provided Palarikovo with the necessary financial means to implement an integrated waste management system. In 2009 for instance, the total contribution of the Recycling Fund was 220 540 Euro. This money was invested in a car press, containers and container lifters. The National Recycling Fund is the main and most secure source of funding to cover the costs of running the waste management system and to buy machineries and equipment.

Information Instruments: Information and Awareness-Raising Campaign

Palarikovo municipality implemented an intense awareness-raising programme on household composting and sorting household waste to inform inhabitants and motivate them to participate. The implementation of the programme started in 2000 with an intensive awareness-raising campaign on biologically decomposable municipal waste, the promotion of domestic composting and the distribution of home composting kits. In 2002, Palarikovo introduced the first waste management facilities and also founded a local NGO, a citizens association called “Palárikovská ekologická spoločnosť” (Environmental Association of Palárikovo), to involve local people. The campaign focused on providing information on waste management facilities and best practices, especially organic waste, through door-to-door information (e.g. by means of leaflets), local media, radio and education campaigns, especially in schools. A major factor of success in promoting this awareness and education campaign was the support of the NGO Friends of Earth Slovakia. This NGO organized an annual meeting with farmers to promote organic waste composting, meetings with schools to provide education for students, as well as visits to the collection center. Over the years, different instruments and communication channels have been implemented to inform people and raise awareness. These were easy to implement and well accepted by inhabitants. Many education initiatives took place

in schools, public spaces and during public events. These were reported to have high participation rates, and to be effective in increasing the feeling of inhabitants to belong to a community, and their willingness to contribute to waste sorting.

Overall, the participation of inhabitants in waste sorting was reported to be crucial in order to guarantee the efficiency of the integrated waste management system and therefore the information and awareness-raising campaign played a major part in the success of implementing the new system.

3.4. Effectiveness of the Policy Mix

3.4.1. Economic Effectiveness

The main objective set by the municipality of Palarikovo was to reduce spending of the municipal budget for municipal and household waste management.

The budget for managing waste is constituted by a combination of taxes paid by inhabitants (through the PAYT scheme), funds from the National Recycling Fund (by reaching quotas of collected materials) and selling collected materials on the secondary raw materials market. To further process collected and separated materials, the municipality has contracted different companies operating at national and international level in the recycling sector. The municipality of Palarikovo, together with the network of companies contracted to recycle collected materials, performed a constant monitoring of secondary raw material prices in order to assess if it is economically viable to sell them. Generally, it was argued that the sum of the money received from the National Recycling Fund and the revenues earned by selling the materials on the market was sufficient to cover the total cost for waste management in Palarikovo. The system was thus cost neutral.

Still, this calculation is performed without internalization of environmental costs: beyond fees and costs for landfilling management and maintenance, landfilling has environmental costs due to resource depletion, environmental pollution and greenhouse gas emission. If these factors are taken into account to roughly estimate cost effectiveness, implementing such a strategy was surely more cost effective than landfilling as the main waste management practice.

3.4.2. Effects on Decoupling

Revised Waste Data Series

The waste data series provided by the municipality needed some adjustments to correct biased data. While data on landfilled waste (time series available in 2000–2012), separated material for recycling (2003–2012) and municipal composting data (2004–2012) were directly measured, data on household composting was estimated based on an *in situ* observation on household behavior in sorting organic waste (2003–2012). Data on household composting was not estimated for 2001 and 2002. In addition, separated material data in 2003 might be biased, and represent total municipal collection (composting + recycling) instead of solely separated material for recycling, since first municipal waste collection points in 2002 were collecting both waste fractions. Biased data can lead to misinterpretations on the mechanisms eventually driving waste decrease.

First, an estimation of household composting in 2001 and 2002 was needed. A decrease in landfilled waste from 2000 to 2002 resulted in an increase in home composting (promoted by the municipality through the information campaign), since no other waste fraction was sorted or collected. Such a reduction of landfilled waste in 2001 and 2002 makes sense, since Palarikovo is a rural town, where about 50% of produced waste is organic, and more than 70% of the households own a garden. If estimated home composting in 2003–2012 is taken into account, each inhabitant diverts 50 kg/year of produced waste into home composting. This value is very indicative, but can be used for a rough estimation of home composting in 2001 and 2002.

Secondly, data might be biased due to unknown illegally dumped and incinerated waste. However, since these were reported to be minimal or absent between 2000 and 2012, they are estimated to be equal to zero.

Figure 2 shows the revised waste data series for household waste treatment achieved in Palarikovo between 2000 and 2012.

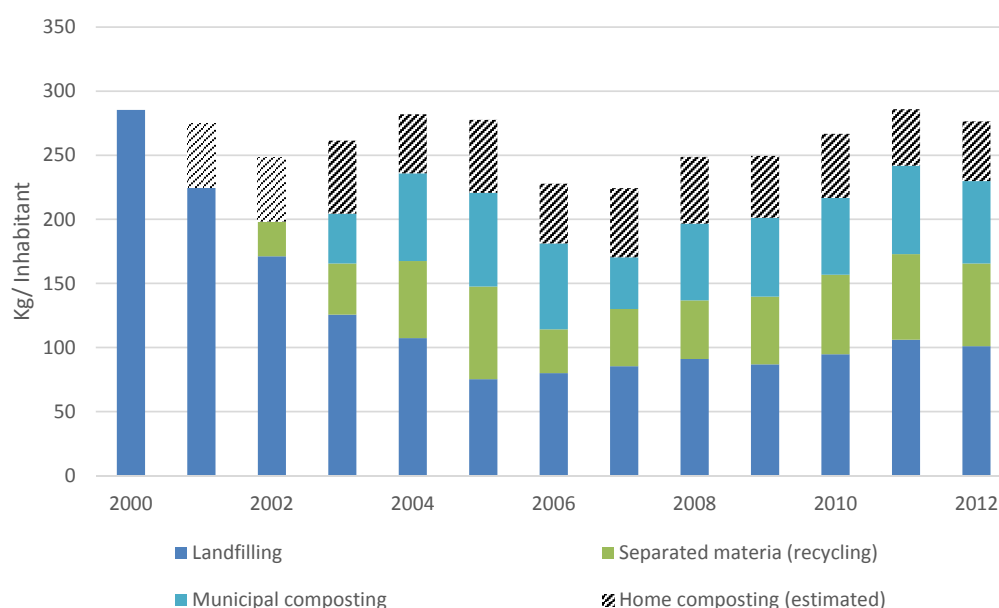


Figure 2. Municipal and household waste treatment in Palarikovo between 2000 and 2012. Home composting in 2003–2012 was estimated based on *in situ* observation on household behavior in sorting organic waste (source: courtesy of Palarikovo municipal waste database 2013, confidential data). Home composting in 2001 and 2002 was estimated by the author. The size of each bar indicates the estimates of total generated waste.

The revised waste data series was used to estimate decoupling effects. As suggested by OECD [22], the interpretation of the graph is based on the observation of the curves, which show the trend of regional GDP [44], total waste generation and total landfilled waste in Palarikovo. In Figure 3, data is normalized on the common baseline year 2000, when the policy mix started to be developed and data started to be collected. A more detailed analysis was possible thanks to the numerical computation of the Decoupling Index (DI), calculated by using the Equation (3). The Decoupling Index was therefore calculated for estimated waste generation and landfilling between 2000 and 2012, and is displayed in Figure 4.

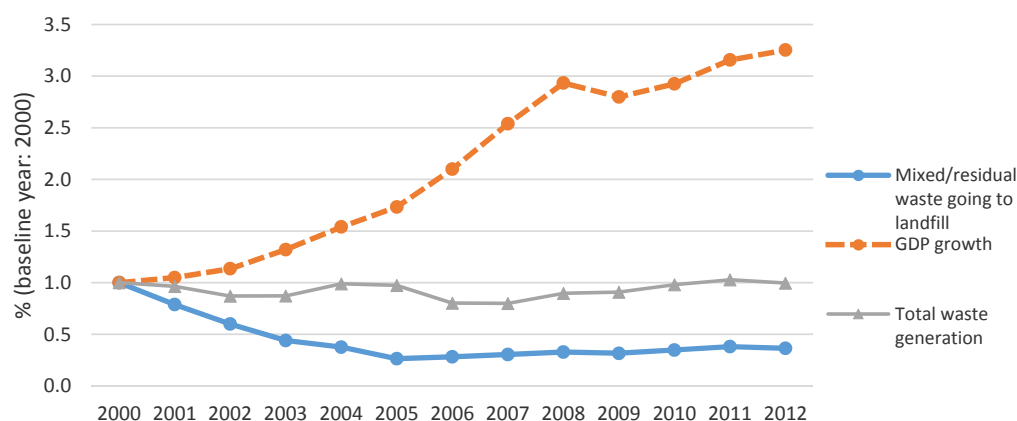


Figure 3. Relation among regional GDP, estimated waste generation and landfilling rates evolution in Palarikovo in 2000–2012 (year 2000 = 100).

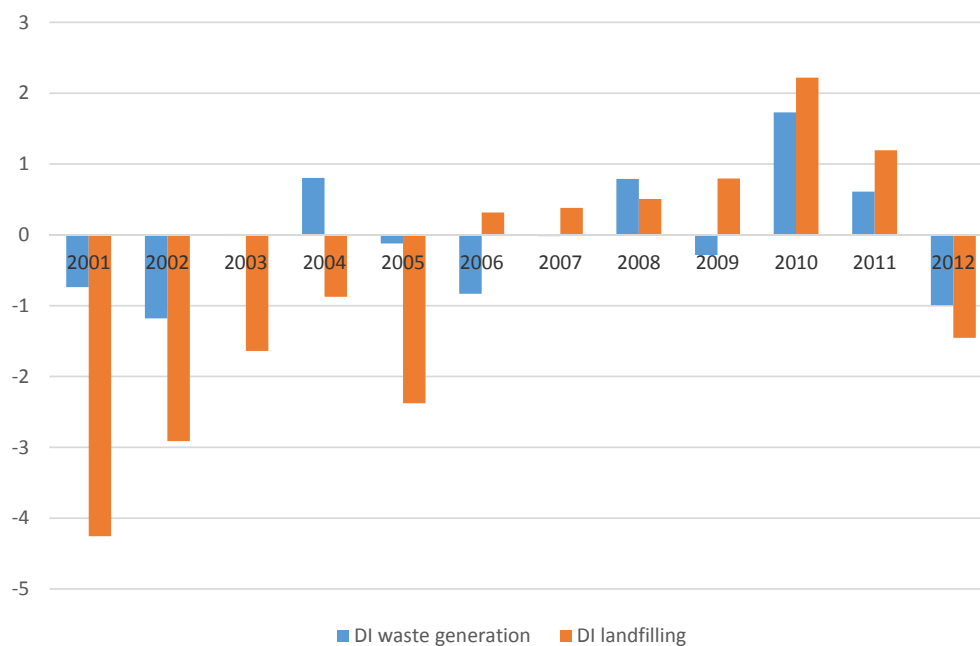


Figure 4. Decoupling index for estimated waste generation and landfiling in Palarikovo in 2001–2012. $DI > 1$ = no decoupling; $0 < DI < 1$ = relative decoupling; $DI < 0$ absolute decoupling calculated according to Equation (3).

Figure 3 suggests that regional GDP grew rapidly (it tripled in eight years) between 2000 and 2012, with an expected dip in 2008 due to the economic crisis. At the same time, landfilled waste rapidly decreased in 2000–2005 and then stabilized at 35% of the 2000 values until 2012. The landfiling curves represented in Figures 3 and 4 show the occurrence of absolute decoupling for landfiling until 2005. After 2005, landfilled waste slightly increased again, suggesting an undefined situation of relative (or even absent) decoupling in 2006–2011. The data suggests that absolute decoupling started to occur again in 2012.

The total generation of waste (including landfilled/residual waste; sorted and collected household waste for recycling; composted municipal waste; household composting) presents some decreasing phases between in 2001 and 2002, and then again in 2005–2007 and in 2012, which would suggest the occurrence of absolute decoupling. Alternated to phases of relative and no decoupling can be observed in Figure 4.

Figures 2 and 3 also suggest that total generated waste often tends to equal the initial value, about 280 kg/inhabitant/year.

4. Discussion

In this section, evidence from the case study and the results of the computation of the DI will be discussed. First, the combination of different instruments identified in the case study is discussed. Possible effects of policy mix on households behavior in sorting or reducing waste are taken into account, in order to validate the results of the DI, explain fractions of waste apparently “missing”, and conclude if decoupling has occurred. Finally, limits of the policy mix in achieving absolute decoupling are discussed.

4.1. Policy Mix: Instruments and Estimated Impact. Did Absolute Decoupling Occur?

This case study shows that two types of instruments seem to be central in the policy mix: the long term information and education campaign, and the differentiated waste fee schemes, first with the lump-fee sum and afterwards with the PAYT.

These instruments were complemented by other structural, legislative and economic instruments: the waste collection system, the implementation of national legislation on landfilling and recycling, and the National Recycling Fund. The first question one might want to discuss is: did the policy mix enable absolute decoupling? And if yes, which were the drivers?

In order to answer to this question, we assume that the implementation of the different instruments has an effect on the household behavior, and in particular, in the taking decisions to sort or generate less waste.

Building on the arguments of Finnveden [11], we can argue that three extreme alternatives are plausible explanations of the reduction in household waste:

- (1) Waste reduction is due to prevention of waste with the same composition, as the average residual waste and sorted waste.
- (2) Waste generation remains constant, while a decrease in residual waste is due to an increase in source separation for composting (50%) and materials recycling (50%) (or vice versa).
- (3) All reduction in generated and residual waste is due to illegal treatment: e.g., burning of combustible waste in private stoves or dumping of food and garden waste in the forest.

The author argues that absolute waste reduction occurs if (1) is verified, while absolute reduction of landfilled waste occurs if (2) is verified. Situation (3) is the most undesirable and clearly indicates a failure of the policy mix, in line with the arguments of Sampson *et al.* [39].

The policy mix and its effects on decoupling will be now discussed chronologically.

2000–2002

At the beginning of 2000, stricter national legislation on landfilling posed some financial burdens on the municipal budget. The municipality was therefore forced to find cost effective alternatives to landfilling, and later on, measures to increase recycling.

Bans and restrictions on existing landfills and the national Waste Act on compulsory recycling in early 2000s triggered the diversion of a considerable amount of waste from landfilling and an increase in recycling rates, confirming evidence already highlighted in macro-studies such as Mazzanti and Zoboli [7]. The introduction of landfilling restrictions and bans alone was not enough to guarantee high diversion rates, as shown by Figure 5, which benchmarks landfilling waste in Palarikovo and in Slovakia. For instance, landfilled waste in Slovakia (source: [49]) increased in the same time frame (2000–2012, see Figure 5), in spite of national regulations on landfilled and recycled waste, as also confirmed in a recent study [50].

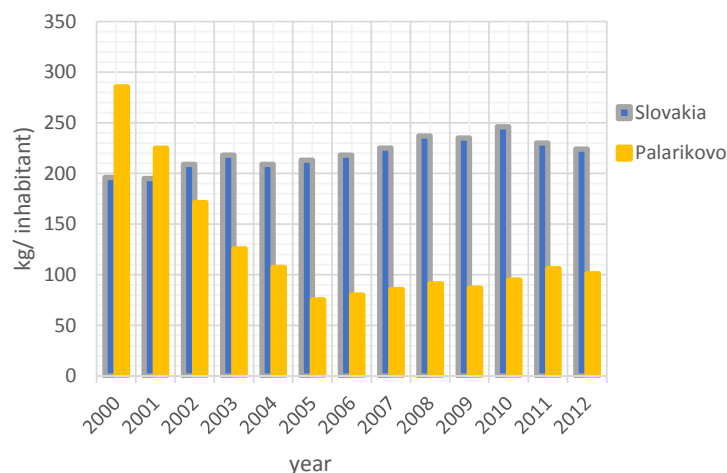


Figure 5. Municipal waste landfilling rates in Slovakia and Palarikovo in 2000–2012. Landfilled waste was calculated in both cases as municipal household residual waste, once the recycling-composting and incineration fractions are subtracted.

The information and education campaign started in 2000 resulted in citizens having a better understanding of waste management and recycling, and being aware of their role in the waste management process: people felt emotionally attached to the programme, and were proud to contribute. It was also interesting to notice the high level of acceptance achieved, from zero to 99% involvement in seven years. The waste management system dramatically improved, and it is therefore possible to argue that the campaign was successful in engaging inhabitants and providing them with all necessary tools to sort waste. Results confirm that information instruments such as education and awareness-raising campaigns are important factors to achieve effective waste management and increase consumers' recycling behavior [31]. It is also possible that the success in this case was achieved due to the small size of the village that usually results in stronger perceptions of belonging to a collective.

The information campaign proved to have a key role in 2000–2001 to increase household composting and divert this fraction from landfilling. Households found it convenient to compost organic waste at home, most likely to reuse it within their gardening activities. Nevertheless, the author argues that households might have a limited capacity to reuse home composted organic waste in gardening activities, e.g. in small gardens. Therefore, all exceeding bio waste would possibly have been landfilled in this phase, as no other collection options were available. From 2002–2003, the first separated material and municipal composting facilities were implemented. The sorting and collection of waste was again voluntary, but nonetheless effective, and collection rates started to increase. It can be argued that municipal composting facilities were collecting the organic waste that households did not find convenient to compost at home. Increased municipal composting and increases in the collection of separated material for recycling explain a further decrease in landfilled waste (Figure 2).

Notably, data in 2002 reflects the impact of two years of information campaign in the absence of further economic incentives. Being a scheme voluntary, it is unlikely that waste was illegally incinerated or dumped.

While the effects of the information campaign on decreased landfilling and increased recycling are evident, effects on waste generation are less clear. On the one hand, waste generated in 2003 was the same as in 2000. The most plausible explanation of “missing waste” is that this perception is due to biased data, and generated waste most likely remained stable in 2000–2002. Decreases in residual waste can therefore be explained by alternative (2), namely that waste has mostly been diverted from landfilling towards composting and recycling.

2003–2005

In 2003, the municipality wanted to stimulate further waste sorting, and introduced a lump-fee sum. The introduction of the lump fee-sum resulted in a further decrease of landfilled waste and increased recycling and composting rates (Figure 2).

Each inhabitant was charged 7.40 Euro each half year if the household was not sorting waste, and 4.70 Euro if the household was sorting waste. For a household of 4 people, not sorting waste had an average cost of 59 compared to 38 Euro, which is an additional of 21 Euro/year. This represented a relevant sum for the average household budget in Slovakia in 2002. Thus, the economic incentive might have been particularly strong.

In line with Kinnaman [37], arguing that the type of waste fee schemes applied might have different responses on waste generation depending on how they provide the economic incentive, the author suggests that the lump-sum fee here examined had an impact on landfilled waste, but not on waste generation. In fact, this fee puts an economic burden on recyclable material that ends up in residual waste, regardless of the quantity: if recyclable waste is found in the residual fraction, the household is automatically charged with the higher fee. In other words, the household needs to sort everything what can be sorted, in order to benefit from the lower fee. This would explain data in 2004 and 2005, when landfilled waste reached its minimum in the time series.

On the other hand, this tax does not pose any economic burden on the quantity of produced waste: a household which would properly sort 50 kg of material/year will not pay less than a household

sorting 100 kg of material/year. In 2004 and 2005, total waste generation equals the value in 2000. Illegal dumping and incineration were reported to be minimal. Again, evidence points to alternative (2), and suggestion an absolute decoupling of landfilled waste has occurred.

2006–2007

In 2006, in order to further stimulate waste recycling, the municipality introduces a fee called “Pay as You Throw”, the PAYT. The fee was organized in such a way that people had to pay for 100 liter tokens for residual waste, while sorted waste was collected for free. This waste tax has the characteristics of a volume-based waste fee, and resembles the subscription programme described by Kinnaman [37]. He argued that the incentive for a household to reduce waste is not as strong, because households generating, for instance, 70 liter of waste each week would normally contract for 100 liters per week, and will thereafter face a zero marginal cost for up to 30 liter of additional waste each week. In addition, collection of sorted waste was free, and thus there is no evident economic incentive to reduce waste.

Nevertheless, total waste generation in 2006–2007 was about 20% less than 2005, prior to the implementation of the PAYT, and the Decoupling Index suggests the occurrence of absolute decoupling (Figure 4). Apparently, each year 200 tons of waste has been prevented. Due to decrease in sorted material and municipal composting. Where did this waste disappear to?

Figure 2, suggests that in 2006 and 2007, recycling and municipal composting started to decrease, but this did not correspond to an equal increase in landfilling. In addition, we exclude that waste reduction is hidden in undetected increase of home composting, and bio waste was anyway collected for free. This could not explain the “missing amounts” of sorted waste other than bio waste, such as plastic or paper. Hence, we can exclude alternative (2). Since illegal landfilling and incineration was reported to be irrelevant, and would not justify the missing fraction of sorted waste which was anyway collected for free, we can also exclude alternative (3). Therefore, it can be argued that, households started to produce less waste. This suggest that generated waste started to decrease and absolute decoupling happened (alternative (1)).

These results are in line with the findings from Finnveden [11], namely that the combination of a waste fee, information campaigns and the development of collection systems has the potential to keep waste quantities from growing and even to reduce collected waste by up to 20%.

A plausible hypothesis is that the combination of a waste fee, information and collection systems between 2000 and 2006 resulted in an effective combination of increased awareness (it is good to do it), increased trust in the institutions (the collection system is visibly effective and fair), and differentiated economic incentives (poor waste sorting has higher cost). These factors have most likely resulted in the public perceiving that waste has a cost. This process culminated in 2006 with the introduction of a new taxation mechanism, which might have induced the inhabitants to produce less waste under the misleading premise “the much you throw, the much you pay”, suggested by the name. Thus, a possible explanation is that households became more aware of the environment after years of intense information and education campaigns; and stimulated by economic incentives, they started to produce less waste.

2008–2011

The developments between 2008 and 2011 are not surprising. Figures 3 and 4 suggest the occurrence of relative or no decoupling of landfilled and generated waste. In line with the findings of Usui *et al.* [35], a couple of years after the initial decrease, waste quantities start to grow again due to the rebound effect. Total amounts of separated material, municipal composting and landfilling rates also started to increase, until generated waste reached the same quantities of 2004–2005 and 2000 in 2010–2011.

The composition of waste in 2010 and 2011 is very similar to that in 2004 and 2005, prior to the implementation of the PAYT.

In the Palarikovo case study, this might be explained as follows: once the inhabitants found out that there was no real economic incentive to produce less waste, they might have become less sensitive to the economic incentives, and therefore less willing to reduce and sort waste (as these are time-consuming activities), as highlighted again by Usui *et al.* This would also explain the progressive increase of landfilled waste and the occurrence of relative decoupling.

2012

Finally, in 2012, absolute decoupling for waste generation and landfilling seems to have occurred again. It is plausible that the increase of 30% in the price per token represented a sufficient economic incentive to reduce household waste. This highlights that people are sensitive to economic incentives. Due to lack of data from 2013 onwards, it is not possible to further determine the evolution of waste generation.

4.2. Limits of the Policy Mix and Outlook

The presented case study suggests that, although the policy mix has the potential to drastically improve the waste management system, its impact on waste generation is weaker, and limited to a restricted time frame. Waste was generated in 2011–2012 in the same quantities and with the same composition as in 2004–2005. In addition, in spite of impressive reductions in landfilled waste since 2000, residual waste never decreased below 1/3 of total generated waste.

These factors indirectly highlight some failures, which mostly reflect the current consumption patterns. In 2006, the Palarikovo waste management system was already well established and able to collect and prepare for recycling of more than 20 different types of materials, and the population was well informed of these mechanisms. Nevertheless, the amount of residual household waste produced in Palarikovo was never insignificant, suggesting that even within an efficient and exemplar waste management system, a fraction of waste tends to remain unsorted. In fact, once bigger waste streams (such as plastic, paper, glass, *etc.*) are addressed, it becomes more complex to address the unsorted fraction. This happens due to the increased complexity and low quality of residual waste (e.g. unrecyclable materials such as diapers, complex products with many aggregated parts, broken goods, bulky waste, white goods, *etc.*). Therefore, an important question is how it is possible to address the residual waste fractions. In order to answer this question, it would be important to know its exact composition, as highlighted by Sahimaa *et al.* [51].

Another limit in drastically reducing generated waste is the system of financial reliance on the National Recycling Fund. This requires the municipality to reach certain quotas of collected materials in order to receive funding. Thus, the municipality was encouraged to produce (sorted) waste, in order to get funding, and be able to finance most of the municipal waste management system. Thus, in the case of Palarikovo, a shift of the Waste Hierarchy has been performed—from landfilling to recycling and composting. Yet, many opportunities are lost in terms of waste reuse and prevention. Thus, it can be argued that the dependence on the National Recycling Fund clashes with goals of reducing generated household waste.

Evidence from this paper suggests that part of the problem can be addressed with a mix of information instruments and economic incentives. Since the population responded well to the information campaign and showed high willingness to trust and cooperate with the institutions, future policy actions might leverage on this factor, and focus on waste reduction instead of solely recycling. This might include campaigns on food waste reduction, creation of repair shops, public workshop on up-cycling and reuse, markets for second hand goods exchange (such as books, toys, clothes, *etc.*), *etc.* Further financial incentives from the government might also be necessary, in order to ensure the cost neutrality of the waste management system.

5. Conclusions

The analysis of the case study suggests that absolute decoupling between landfilled waste and regional GDP has occurred from 2000 to 2005, while absolute decoupling of waste generation occurred

between 2005 and 2007. Findings are surprising, particularly since the policy mix was not conceived to impact the quantity of total generated waste.

These results were reached due to a policy mix, which included a good combination of information campaigns, differentiated waste fees, and developed a collection system. It can be also argued that the same instruments, if implemented alone, would not achieve the same results.

It can be concluded that the policy mix was very effective in promoting a move away from landfilling and increase recycling systems. To some extent to policy mix also resulted in a decrease generated waste, yet this is much less evident effect and can only be observed for a limited in time period.

These policy instruments could therefore play an important role in municipalities that are still lagging behind in waste management and help them to move away from landfilling and initiating recycling systems. At the same time, this policy mix was not sufficient to meet higher waste management criteria, such as the complete avoidance of landfilling or achieving a permanent decrease in absolute waste generation. The author suggests that a mix of information campaigns and economic incentives that target waste prevention should be taken into account in order to decrease total waste generation and address complex residual waste.

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Appendix

Adapted Common Assessment Template.

- (1) Resource/Issue
- (2) Geographical area of policy mix coverage
- (3) Policy context

I. Needs Assessment: The Environmental Problem/Resource Challenge

- Are there any economic or social problems related to the issue and environmental problems—e.g., is there important price volatility, (risk of) unavailability of resources for the economy or society?
- Who is the target group affected that have been, are or will be beneficiaries of the policy response?

II. Policy Context and Policy Needs (Past (Specific Focus), Present and Future—Wider Context)

- What policy challenge(s) did the problem pose and what policy challenges does it still pose? What is the policy context? What policies have been put in place to address the issues, what policies are currently in place and which ones are already foreseen for future introduction?
- Policy response need: what sort of policy response did (and does) the problem call for?

III. Historical Performance and Projections into the Future: Insights on Decoupling

- What has been the trend *vs.* GDP and what type of decoupling has been achieved?
- If possible, relate data on the environmental problem to data on GDP at EU, or national or local level, depending on the geographical scale of the case-study

(4) Drivers Affecting Change: Resource Use/Environmental Issues

- What are the drivers affecting resource use (driving demand for the resource and leading to resource overuse) or other environmental impacts? Detail demographic, societal, economic, political and other drivers applying more (or less) pressure on the specific issue.

(5) Situation/trend prior to introduction of policy mix

- Provide information on the baseline situation before the policy mix was introduced.

(6) Description of policy mix(es)

- Provide details of stated objective(s) and target(s), in quantitative terms to the extent possible, and timetables within which they are to be achieved. Include if intention is to fulfil supranational/international objectives (e.g. Kyoto, Nagoya, EU legislation) or national objectives.
- Describe the instruments in the mix and whether one type of tool (i.e. regulatory, economic, information) is dominant.
- For each instrument, what is its aim? What requirements does it place on relevant players (for example, phasing out a certain substance, meeting minimum recycling targets, etc.)? What reporting requirements exist?

(7) Evolution of policy mix

- Describe the evolution of the policy mix throughout its existence—provide details of the introduction of the first policy tool(s), then all subsequent relevant tools, and related revisions/reforms (e.g. progressive increases in rates applied through economic tools, broader extension of regulation requirements, etc.).

(8) Evaluation of policy mix: effectiveness (environmental sustainability)

- Does/did the policy mix result in a positive environmental outcome?
- Were its stated objective(s) met?
- Were the instruments used sufficient to meet the objectives?
- Did other, unforeseen/unintended positive outcomes or impacts (environmental, social, economic) result? Did other such negative outcomes or impacts result?
- Were these objectives set at a level to meet environmental needs?
- Which sectors/actors were identified as having key impacts/influences on the problem/issue? Was the policy mix applied to a sector previously not targeted by policies on the issue under question, or in a new area/issue – thereby aiming to stimulate change?
- Describe the relationships between the instruments. Describe the level of ‘connectivity’ (strong, weak) between each instrument and the primary one(s).
- Are there any indicators, monitoring systems, review processes or other monitoring mechanisms in place to track progress? Please describe these and provide details of review/monitoring exercises.

(9) Evaluation of policy mix: efficiency (economic sustainability)

- Is/was the policy mix considered cost-effective?
- What has been the level of impact on resource use of the policy mix (the effect)?
- Did the measures generate revenues (e.g. in the case of taxes) and if so, was revenue recycled/re-injected into the economy, and to what levels and activities? Did revenue recycling have positive amplifying effects?

(10) Overall assessment

- What is your overall view on the success(es) or failure(s) of this policy mix?
- How did the policy mix enable decoupling?
- How could it have been improved to achieve its original objective(s) and to achieve absolute decoupling?

(11) Beyond the case: developing the policy tool kits-*ex ante*

- The environmental challenge: What are the remaining needs for the future?
- What insights on policy mixes may be relevant for the addressing the future challenges?

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