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On the Path of Sustainability in Wastewater Treatment: The Golden Mean Applied to Regional Context

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Abstract. An important part of the environmental degradation is caused by the discharge of untreated or mistreated wastewater. Since centralized treatment systems have proved to be inefficient, tackling the environmental issues requires a regional approach. Wastewater treatment plants (WWTPs) mitigate environmental impacts and contribute to financial savings of other firms. However, the literature evaluating WWTPs' financial performance and economic sustainability does not abound. Thus, this paper analyses the economic sustainability of wastewater treatment companies in Portugal by NUTS II regions, in 2016-2019. Using firms' financial reports from SABI, results show that, by and large, firms in the Centre region display higher financial performances when compared to other regions. These results can be used to investigate whether firms in the central region are implementing the best practices regarding management and technology. Results can also foster enhancements in the governance of regulated utilities.

1. Introduction

Wastewater treatment plants (WWTPs) perform the important task of mitigating environmental impacts caused by organizations and households at the end-of-pipe. However, the literature so far falls short on evaluating these companies own financial performance and economic sustainability. Evaluating the economic sustainability of any business is important because it affects firm survival in the market. Economic viability performs as a substantial barrier to the implementation of a resource recovery technology [1]. On the other hand, the exploration of the system symbioses across neighboring waste generation sites allows to tackle the environmental issues faced by the generation of wastewater [1]. Thus, the purpose of this paper is to analyse the economic sustainability of wastewater treatment companies in Portugal by NUTS II regions to assess the region with the best performance and provide regional policy implications. For this purpose, the SABI database provides financial reports for 55 firms, during 2016-2019.

In what follows, section 2 reviews the literature on financial analysis, section 3 describes the data and methodology; section 4 presents the results and discusses them, and section 5 presents the conclusions, limitations, and line of future research.

2. Literature review

The link between sustainability and corporate financial performance has been an extensively debated topic. On economic grounds, management accounting techniques assist managers to plan and control firms' activities to maximize their profits. These techniques allow to report economic performance of the organization to the shareholders [2]. However, the empirical results on the impact of sustainability practices on corporate profitability are far from being conclusive [3]. For example, some studies conclude that sustainability induces profitability (e.g., [4,5]); while another found that the implementation of sustainability practices in a firm do not impact on firms' profitability [6]; or impact



negatively [7]. One possible reason for the contradicting results can be the different methodologies employed and different periods of time. Despite the crucial role of WWTPs on the environmental and economic sustainability of their clients, the literature on economic sustainability of WWTPs is scarce. Economic sustainability is measured in this paper by financial performance of companies, which is vital for firm survival. Therefore, it is assumed that a good financial health of WWTPs has a positive impact on the environmental and economic sustainability of a given economy. Many studies focus on the performance evaluation of the technology employed in the WWTPs (e.g., [8-10]) and on the technical efficiency of WWTPs. Some studies analyse the environmental performance [11]; the social performance (e.g., [12]) and public-private partnerships, (e.g., [13]). However, the analysis of the own economic sustainability of WWTPs is absent from the literature. A notable exception is the study by [14]. The authors evaluate the performance of wastewater firms using Gray relational analysis and data envelopment analysis based on balanced scorecard criteria. The authors include thirty-five municipal water and wastewater companies in Iran for 2017. They conclude that Gray relational analysis is an accurate tool for performance evaluation of wastewater companies. An important volume of literature on performance management uses financial performance as a proxy for overall firm performance. Thus, at corporate level, one of the most used methods to determine the overall performance, measured through financial analysis is the financial statements analysis and ratio analysis.

3. Methodology and data sources

The analysis of financial reports is an important instrument for the assessment of business strengths and weaknesses. The importance of traditional financial ratios in assessing firm financial health is conventional. Accounting information regarding profitability, liquidity and indebtedness is critical to measuring financial performance. Indeed, studies show that firms with relatively lower earnings, larger declines in operating income and high debt-to-asset ratios are more likely to experience bankruptcy. In the private sector, models predicting deteriorating financial condition typically include accounting data. Business economic sustainability is classified through its business financial performance, competitiveness and the economic impact generated by the firm and its stakeholders. Thus, in this paper the financial performance is a proxy of economic sustainability. Accordingly, the empirical strategy relies on key accounting data incorporated into financial ratios available from published financial reports in SABI database. This research encompasses a numerical and narrative analysis of key financial performance indicators to 55 Portuguese operating in sewerage (NACE Rev. 2 code 37) in Portugal, from 2016 to 2019. The framework comprises measures reflecting considerations in the literature of appropriate financial performance measures for firms. Using 5 indicators, 4 broad financial performance measures are employed in Stata 13.0, assessing profitability, liquidity, financial structure, and financial leverage. Profitability ratio analysis is a good approach to measure firm's performance, because profitability means the ability of a firm to earn a profit. Firms' profitability is essential both for shareholders and creditors because profits allow for dividends and funds for covering debts. The ROE measures the ability of a firm to generate profits from the shareholders' investments, i.e., the financial profitability. The calculation formula is as follows:

$$\text{Return on Equity (ROE)} = \text{Net Profit After Taxes} / \text{Equity} \quad (1)$$

This ratio shows how much profit is generated by 1 Euro of shareholders' equity. In other words, it measures how effectively money from shareholders is being used for the generation of profits. In view of this, a high value of the ROE is desirable because that would mean efficient usage of investors' funds.

The ROA measures the economic profitability and can be used as an indicator of a firm's effort of minimizing the assets, which are not taking part in the process of generation returns. The formula is:

$$\text{Return on Assets (ROA)} = \text{Net Profit After Taxes} / \text{Total Assets} \quad (2)$$

Liquidity ratios measure firms' ability to pay off current debt obligations without raising external capital and its margin of safety through the calculation of metrics, including the current ratio, quick ratio, and operating cash flow ratio. This paper uses the current liquidity ratio measured as

$$\text{Current Liquidity Ratio} = \text{Current Assets} / \text{Current Liabilities} \quad (3)$$

This ratio measures a firm's capacity to pay off its current liabilities (payable within one year) with its current assets (cash, accounts receivable and inventories), to evaluate the coverage of short-term debts in an emergency. The higher the ratio, the better the firm's liquidity position.

Financial structure ratios are very useful to assess long term financial risk since it provides information about firms' capacity to fulfill their long-term financial commitments. This paper uses the ratio of financial autonomy which designates the share of the firm's total applications, i.e. goods and investment applications, financial applications, stocks applications, credit granted to clients, etc., which was maintained by capitals owned by the firm, the equity. It is measured by

$$\text{Financial Autonomy Ratio} = \text{Equity} / \text{Total Assets} \quad (4)$$

When shareholders own most of the assets, the firm is said to be less leveraged; conversely, when creditors own most of the assets, the firm is considered highly leveraged and the firm is regarded as riskier for lenders. The most common is the debt ratio, that shows how many assets the firm must sell to pay off all its liabilities, and it is calculated as

$$\text{Debt Ratio} = \text{Total Liabilities} / \text{Total Assets} \quad (5)$$

This ratio helps investors and creditors to analyze the overall debt burden on the firm as well as the firm's ability to pay off the debt in the future.

SABI database, owned by Bureau van Dijk, contains financial data for 800,000 firms operating in Portugal and 2,600,000 in Spain, including standardised annual accounts, financial ratios, sectoral activities, and ownership. Firms with missing data were withdrawn. The final sample comprises 55 firms for 4 years, summing 220 observations. Since that PORDATA and INE¹ databases show that there were 1280 firms operating in water collection, treatment, and supply, in 2018 (last year available), the sample size (4%) allows to draw conclusions with a margin of error of 12.93%. Table 1 shows the basic statistics.

Table 1. Basic statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Age	220	14	8.57	3	41
ROE	189	7	202.25	-1593	1806
ROA	189	-14	195.51	-2651	83
Current Liquidity Ratio	181	7	20.95	-19	224
Financial Autonomy Ratio (%)	187	-914	9 060.74	-99333	100
Debt Ratio (%)	187	1014	9 060.74	0	99433

Source: Own analysis in STATA 13.0

The mean age of firms is 14 years old. Financial profitability (ROE) is positive on average, although economical profitability (ROA) is negative. The joint analysis of financial autonomy and debt ratios show that firms operating in sewerage, are, on average, highly indebted. Table 2 shows firm distribution across regions and by size. For this purpose, Small and Medium Enterprises are those with less than 250 employees, otherwise firms are considered large.

Table 2. Firm size, by NUTSs II regions, 2016-2019

Region	SMEs		Large Firms		Total firms	Regional Share
	#	%	#	%		
North	16	29	3	5	19	35
Centre	9	16	1	2	10	18
Lisbon	12	22	4	7	16	29
Alentejo	4	7	0	0	4	7
Algarve	2	4	1	2	3	5
Azores	2	4	0	0	2	4
Madeira	1	2	0	0	1	2
Total	46	84	9	16	55	100

The Northern region concentrates 35% of firms, followed by Lisbon with 29% of firms in the sample. The Islands concentrate only 6% of firms. The majority of firms are SMEs (84%). About 7% of large firms are located in Lisbon and 5% in the North. The central region and Algarve have both shares of 2% of large firms. Considering firm distribution by age (see Table 3), firms in Madeira are the oldest on average (26 years old); whereas firms in Algarve are the youngest (6 years old), followed by Azores (8 years old). In the remaining regions firms are between 13-17 years, old on average. Yet, the oldest firm can be found in Lisbon (41 years old), followed by the Central region (34 years old).

Table 3. Age of firms by NUTSs II regions, 2016-2019

Region	Obs	Mean	Median	Std. Dev.	Min	Max
North	76	13	14	6,2	4	24
Centre	40	13	11	8,6	4	34
Lisbon	64	15	12	10,7	3	41
Alentejo	16	17	17	7,2	9	24
Algarve	12	6	4	3,2	3	10
Azores	8	8	8	3,7	4	11
Madeira	4	26	26	0,0	26	26

Source: Own analysis in STATA 13.0

4. Results and discussion

The average values for each financial ratio are summarized in Table 4.

Table 4. Mean values for financial ratios, by NUTs II regions, 2016-2019

Region	ROE	ROA	Current Liquidity	Financial Autonomy (%)	Debt (%)
North	10	8	13	-2 500	2 600
Centre	46	0	4	50	50
Lisbon	-12	-1	3	-28	128
Alentejo	2	-186	1	-52	152
Algarve	-3	17	2	49	51
Azores	-56	-122	3	-230	330
Madeira	-4	-2	2	41	59

Source: Own analysis in STATA 13.0

Regarding the profitability ratios, although the Algarve region shows the best economic performance (ROA=17); the Central region displays the best financial performance (ROE=46).

The worst performances are shown in Azores in terms of financial situation (ROE= -56) of firms and Alentejo (ROA= -186) when evaluating the economic performance. Firms in the Northern region display better liquidity (LIQUIDITY=13) but by means of indebtedness (DEBT= 2600%). The Alentejo region records the worst liquidity ratio (LIQUIDITY=1); while firms in the Central region display the best position regarding the financial autonomy (AUTONOMY=50%); followed by firms in Algarve (AUTONOMY=49%). Comparing the average results by regions, the Central region appears

to be better off than the other regions in Portugal regarding the financial performance of firms operating in sewerage, in the last 4 years available.

The evolution of the financial and economic performance by regions, in 2016-2019, is shown in figure 1. In the North, financial and economic profitability decreased; liquidity has improved as well as the financial autonomy. Thus, firms in the Northern region have managed to overcome their over-indebtedness and obtain more liquidity, although at the expense of profitability.

In the Centro region, financial and economic profitability improved substantially in the period under analysis, having increased, respectively, from -25 and -7 in 2016, to 207 and 3 in 2019.

Liquidity also improved, but at the expense of indebtedness which increased slightly, lowering the financial autonomy of firms. Financial autonomy decreased from 57% to 52%, which means that nearly half (48%) of the firms' assets are financed by external funds.

The evolution in the Lisbon region is similar to the Central region, except that liquidity in 2019 remained at the level of 2016, which may indicate that the increase in indebtedness from 63% to 75% was not motivated to increase firms' liquidity but to pay debts (liabilities). In Alentejo, financial and economic profitability improved in the period. However, ROA remains negative; meaning that firms continue to have negative net profits, although lower when compared 2016 levels. Liquidity increased slightly, but at the expense of indebtedness, compromising financial autonomy. This shows an over-indebtedness of firms in Alentejo. In the Algarve region, financial and economic profitability decreased by more than half, as well as liquidity. This may justify the loss of financial autonomy by almost 30% and the consequent worsening of indebtedness. However, firms still have a financial autonomy of 52%. in 2019. In Azores, financial profitability, although still negative in 2019, improved substantially, from -311 to -33; economic profitability has also largely improved (from -259 to 58). However, liquidity worsened, as well as financial autonomy, which was 80% in 2016 and -167 in 2019, revealing firms' over-indebtedness. This suggests the use of external funds to cover debts and accumulated losses over the period. Finally, in Madeira, financial and economic profitability decreased and became negative, liquidity remained, and financial autonomy decreased from 44% to 40%, thus increasing indebtedness. This suggests the use of foreign capital to cover losses over the period.

To sum-up the region that performed better in financial and economic grounds was the Central region; followed by the Lisbon region. Such results validate the golden mean rule in the regional context.

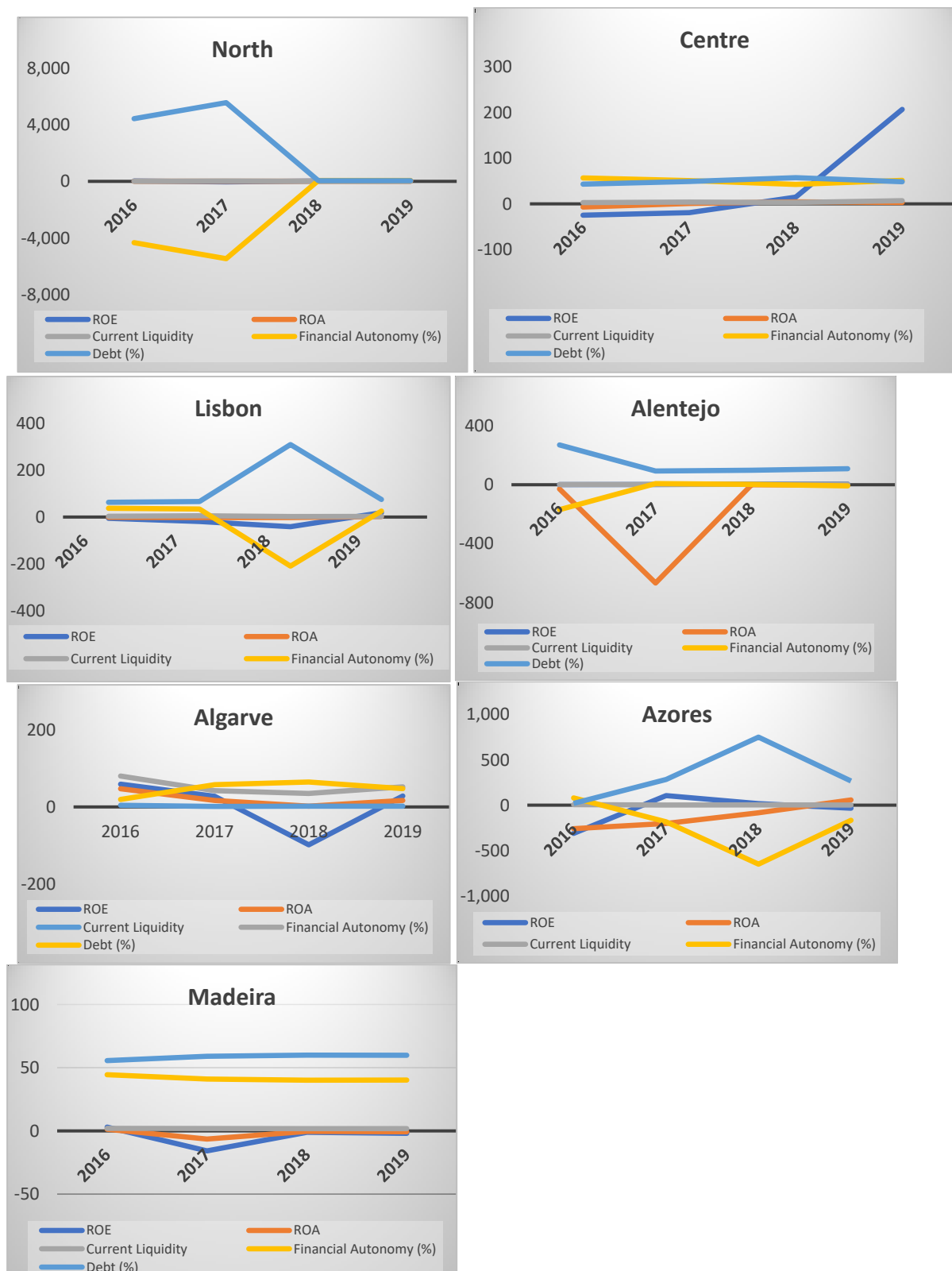


Figure 1. Evolution of financial and economic performance by NUTs II regions, 2016-2019.

Tables 5 and 6 show the statistics on firms' size and age (firms younger than 10 years old, and older) by regions.

Table 5. Statistics on Financial Ratios, by firm size and Nuts II regions, 2016-2019

Region	Year	SMEs					Large Firms				
		ROE	ROA	LIQ	AFIN	DEBT	ROE	ROA	LIQ	AFIN	DEBT
North	Mean	10	8	14	-2 657	2 757	5	1	1	16	84
	Min	-907	-45	0	-99 333	0	3	1	1	15	83
	Max	118	33	224	100	99 433	7	1	2	17	85
	sd	120	13	35	15 411	15 411	1	0	1	1	1
Centre	Mean	46	0	4	50	50					
	Min	-202	-28	-19	0	0					
	Max	1 806	30	48	100	100					
	sd	310	10	9	32	32					
Lisbon	Mean	-15	-1	4	-37	137	7	3	1	32	68
	Min	-1 593	-113	0	-3 300	3	3	1	0	17	49
	Max	682	83	38	97	3 400	19	10	2	51	83
	sd	261	31	6	477	477	6	3	1	14	14
Alentejo	Mean	2	-186	1	-52	152					
	Min	-26	-2 651	0	-725	41					
	Max	17	10	5	59	825					
	sd	12	682	2	212	212					
Algarve	Mean	-3	17	2	49	51					
	Min	-223	-13	0	7	20					
	Max	59	47	5	80	93					
	sd	98	21	1	30	30					
Azores	Mean	-56	-122	3	-230	330					
	Min	-311	-259	1	-650	20					
	Max	105	58	6	80	750					
	sd	179	140	2	305	305					
Madeira	Mean	-4	-2	2	41	59					
	Min	-16	-6	2	40	56					
	Max	3	1	2	44	60					
	sd	8	3	0	2	2					

Notes- sd is the standar deviation; LIQ is the current liquidity ratio, AFIN is the Financial Autonomy (%) and DEBT is the Debt Ratio (%).
Source: Own analysis in STATA 13.0

Table 5 shows results for ratios of large firms only in Lisbon and North regions, which is expectable considering that Lisbon and Porto are the biggest cities in the Country and larger firms tend to locate in the biggest metropolises due to proximity of a wide range of complementary services and institutions. On average, firms in Lisbon perform better than in the Northern region; the liquidity is on average at the same level and the financial autonomy is the double of that recorded in the north (32% and 16% respectively). Results by firm size confirm the findings of the analysis for the whole sample in Table 4, i.e., the Centro region displays better financial profitability and financial autonomy; The Northern region shows higher levels of liquidity and Algarve shows better economic profitability. Azores show the worse financial profitability; firms in Alentejo show the worst economic profitability and display the lowest levels of liquidity; and the Northern firms are the most over-indebted.

Table 6 shows unveils some interesting patters of financial and economic performance according to age of firms. In the Northern region youngest firms possess better liquidity and Financial autonomy; however older firms display better profitability (financial and economic).

Table 6. Statistics on Financial Ratios, by age of firms and Nuts II regions, 2016-2019

Region	Youngest					Oldest				
	ROE	ROA	LIQ	AFIN	DEBT	ROE	ROA	LIQ	AFIN	DEBT
North	-9	6	23	59	41	23	9	6	-4291	4391
Centre	113	-4	5	46	54	-9	4	4	54	46
Lisbon	1	8	6	53	47	-18	-5	2	-63	163
Alentejo	8	-916	0	-725	825	1	-4	2	4	96
Algarve	-66	-2	1	18	82	43	31	3	72	28
Azores	29	-76	2	-333	433	-311	-259	6	80	20
Madeira						-4	-2	2	41	59

Notes- LIQ is the current liquidity ratio, AFIN is the Financial Autonomy (%) and DEBT is the Debt Ratio (%).

Youngest firms are <10 years old and oldest are otherwise. Source: Own analysis in STATA 13.0

In the Central region, youngest firms appear to have a better financial performance and higher liquidity; notwithstanding, older firms show better economic performance and are less indebted. Regarding firms in Lisbon region, youngest firms perform better than older ones; while in Alentejo, it is the opposite. Indeed, although younger firms show better financial profitability; the remaining ratios indicate that older firms perform better. The situation of Algarve reveals a superior management knowledge by older firms, with all indicators showing better values for older firms. In Azores, youngest firms show better profitability, but older firms possess higher liquidity and show an excellent financial autonomy. Finally, the only firm in Madeira is 26 years old. This firm has a negative profitability; however, its financial autonomy is better than older firms in the North, Lisbon and Alentejo. Regarding liquidity, its values are alike those found in older firms in Lisbon and Alentejo, recording the lowest values in the Country.

The focus of this paper is the economic sustainability of WWTPs in 2016-2019, due to data limitations. However, economic effectiveness does not warrant ecologic and social sustainability because the financial indicators do not reflect it. Consequently, the assessment of sustainable development needs an integrated approach, i.e., a set of multi-dimensional indicators, which evaluate both separate parts of the system and their relationships. On the other hand, there is an inconsistency regarding the future development of sustainability assessment tools. In fact, on the one hand it is required a more specific assessment performance approach, i.e., more case- and site-specific; and on the other hand, there is a demand for broader tools for differing case circumstances. In addition, there is also the need for more standardized tools that give more transparent results. Because Sustainability indicators are multi-dimensional, multidisciplinary indices, often context-specific, there is no *single broad* measure of sustainable development. There are no perfect sustainability indicators, hence their development involves a methodological compromise among consistency, technical feasibility and data availability. Sustainability indicators should allow to: understand sustainability, i.e., to identify key elements of sustainable development and show the state of local sustainability; supporting decisions; involving stakeholders; directing to provide feedback on progress; and solving conflict and building consensus by showing the advantages and disadvantages of different alternatives.

5. Conclusions

Being a scarce but renewable resource, water possess high economic value and thus water-related issues, namely its scarcity and reuse, have attracted larger attention in academia worldwide in recent years. Accordingly, the European Commission (EC) endeavors efforts to stimulate Europe's transition towards a circular economy. This action is expected to boost firms' competitiveness, foster economic growth, and generate employment. Because an important part of the environmental degradation is caused by the discharge of untreated or mistreated wastewater, the reuse of water is a central part of

the National Strategic Plan for the Water Supply and Wastewater Sanitation Sector in Portugal. However, investment in resource management has been utterly neglected.

Wastewater treatment plants mitigate environmental impacts and contribute to financial savings of other firms. Though, the inefficiency of centralized treatment systems showed that the environmental issues must be tackled at regional level. Furthermore, the assessment of WWTPs financial and economic performance should be a major concern among those scholars and stakeholders distressed with the impact of economic viability on a resource recovery technology. Yet, the literature evaluating WWTPs' financial performance and economic sustainability does not abound. This paper is an attempt to fill the gap by analysing the financial and economic sustainability of WWTPs across Portuguese NUTS II regions, in 2016-2019. Using firms' financial reports from SABI, results show that, overall the Centre region performed better in financial and economic grounds, when compared to the rest of the Country. Such results validate the golden mean rule in the regional context.

Results by firm size corroborate the findings for the whole sample in the period of 2016-2019, due to the large share of SMEs in the sample. However, when the sample is split by age of firms some patterns arise. Indeed, even though both younger and older firms show a superior performance measured by the financial and economic ratios, overall, older firms account for a greater number of ratios where performance is superior. This can be explained by the accumulation of knowledge and firms' experience in the market. Notable exceptions are found in the Lisbon region where youngest firms perform better than older ones in all ratios; and Alentejo where older firms appear to perform better. Thus, these findings seem to indicate that the Lisbon region provides location factors that facilitate and promote the superior economic and financial sustainability of younger firms, other than market experience. Financial analysis shows if a firm can get profit from its activity and to draw some conclusions on firms' ability to generate enough incomes to cover its costs and achieve a reasonable profit, i.e., to be economically and/or financially sustainable. Through the application of this financial performance measurement framework using a benchmarking methodology, it is possible to identify relatively strong and weak firms and regions. The adoption of this framework of analysis can help policymakers to design industrial and regional policies with a view to early identification of those firms and regions more sustainable in financial and economic terms. Also, these findings can be used to investigate whether firms in the central region are implementing the best practices regarding management and technology. Results can also foster enhancements in the governance of regulated utilities. Avenues of future research include using other indicators of financial and economic as well as environmental and social performance; and analyse the feasibility of the technologies used at the regional level. Furthermore, such a methodology applied to financial data from AMADEUS, another database from Bureau van Dijk, that covers a great number of European countries, could be particularly useful for performance assessment in the context of European Union countries.

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