Incentivizing criteria for steering the implementation of gas distribution investment projects

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Abstract

Natural gas distribution involves delivering gas to end customers via local low-pressure pipelines and is a public service. As part of the procedure for awarding the gas distribution service, contracting authorities define the scope of programmatic guidelines whereas firms participating in the open bidding process propose development plans through which they propose investment projects typically classified into extensions, upgrades, and maintenance development plans. According to the scale and scope of development plans, such investment projects must undergo, or are exempt from, a cost-benefit analysis. The criteria for classifying investment projects are called development conditions. This paper focuses on such criteria, proposing a new methodology aimed at incentivizing investment projects and simplifying the evaluation process. Results confirm that an improvement can be made in making development conditions more adequate to the needs of different territories. Policymakers can benefit from this paper, as investors and contracting authorities require a common methodology at the heart of the analysis of gas distribution network extension.

Keywords

Natural gas distribution, CBA, investment projects, Italy

1. Introduction

The natural gas supply chain resembles a cycle that starts from the procurement stage, passes through transportation and storage, and ends with sales activity. The development of the natural gas market transpired until a little over a decade ago in a context in which natural gas companies were substantially integrated along the supply chain and infrastructure development was synergistically associated with sales contract dynamics.

In Europe, the natural gas distribution sector has been characterized by vertically integrated companies whose efficiency is hard to measure (Goncharuk, 2008; Tovar et al., 2015). However, since the early 1990s, European laws have pursued the goal of creating a single competitive market. This invited significant challenges to the regulations as the typical regulatory approaches based on the cost of service may struggle to provide an adequate incentive for distribution companies (Muthuraman et al., 2008). In Europe, the energy market liberalization process has increasingly focused on market integration (Pollitt, 2005).

Natural gas distribution is a public service of economic interest (European Commission, 2022), typically a local monopoly (Bergendorff et al., 1983; Joskow, 2007) entrusted to distribution companies via different approaches: in-house, via open tendering procedures, or through public-private partnerships (Dorigoni & Portatadino, 2009; FiedZiuk, 2013).

Local authorities entrusting the service (including in associated form) carry out policy, supervision, planning, and control of distribution activities. Special service contracts regulate their relations with the service operator.

Implementing successive European regulations aimed at the liberalization of the electricity and natural gas markets have been several important measures aimed at defining the rules of the sector.

Open tendering intends to increase the efficiency and effectiveness of the service through the use of the market and the incentive logic of competitive comparison among potential awardees (Adedokun et al., 2013).

However, due to its rigidity, this mechanism may struggle in case of the information asymmetry (Thörnqvist & Woolfson, 2012) of the contracting authorities (CAs) with respect to successful bidders, with forecasting difficulties related to the objective unpredictability of the needs associated with the development of gas distribution networks, as well as the rapid evolution of the energy scenario (Beccarello & Di Foggia, 2022a).

On the other hand, the regulatory mechanism inserts itself into such neuralgic points of the system as the recognition of the investment in tariffs (Beccarello & Di Foggia, 2022b). In this case, a different vision of the protection of public interest is accessed, which entrusts the regulators with evaluation activities regarding the proper allocation of investments to be recognized in the tariff, depending on the quality of service guaranteed to users.

A proper allocation of investments in natural gas distribution needs cost-benefit analysis (CBA), which must be applied homogeneously on specific predefined bases and parameters; that said, the results of CBAs should be interpreted carefully (Tol, 2012) because CBAs are often applied in complex situations (ARERA, 2018).

The previous literature has proposed a social CBA of investment projects in natural gas distribution (Gullì, 2016). Underlying the CBA in support of Italian natural gas distribution tenders is the concept of minimum development conditions (DCs), which is a threshold, defined as the number of meters per gas redelivery point. In fact, the costs related to the investments compatible with the DCs are integrated into the tariff, while the company bears the share of the investments exceeding the DCs within the threshold offered by the company in the tender; similarly, citizens bore the cost of investments exceeding this threshold as indicated in Decree 226/11.

The research question behind this paper is to test whether the streamlining mechanism is aimed at simplifying the evaluation activities of development plans (DPs) in territorial scopes, which reflects the characteristics of both territories and existing facilities and networks to delineate the application areas of CBA.

From the results of the empirical analyses of official data, we provide policy proposals with a twofold objective: to increase the industry's attractiveness through the proposed methodology and the competitiveness of the natural gas distribution industry.

The added value of this paper lies in the fact that the proposed criteria approach may concur to the development of natural gas distribution market. Indeed, common criteria facilitate efficient firms, resulting in stronger economic growth. As the market becomes more efficient, social welfare increases.

The remainder of the paper is organized as follows. Section two contains the background of the market structure and introduces some administrative aspects useful in contextualizing this paper. Section three contains the research methodology, variables, and approach used to simulate the DCs.

Section four reports the analysis results discussed in section five, in which considerations are made regarding the implications for CBAs. Conclusions follow.

2. The context

As part of the procedure for awarding the gas distribution service concession, the CA shall prepare the document containing the scope of the programmatic guidelines. Correspondingly, the bidders in the open bidding process shall draw up the DPs through which they undertake, if they win, during the concession period to proceed with interventions on the natural gas distribution facilities and networks listed in the DPs. The interventions are classified into extensions, upgrades, and maintenance; to this regard, based on the transmission network, a recent work analyzed conditions under which upgrading existing connections or extending the pipeline to new sites is beneficial (Mikolajková et al., 2017).

In Italy, the projects aimed at extending natural gas distribution networks must undergo two different verifications: the profitability and financial sustainability of the project and a CBA.

The guidance document is a pivotal elaboration of the aspects of infrastructure management during entrustment and management. It contains the proposal to extend, maintain and upgrade works, based on which the bidders draw up the DPs.

The guidance document is prepared by the CA and must outline the network extension interventions deemed compatible with the needs of the territory, the areas with possible supply problems that need network-upgrading interventions, and the report on the state of the gas distribution network.

The criteria for evaluating the DPs shall cover the following aspects: adequacy of the analysis of the network and facilities, evaluation of the extension and upgrading interventions, evaluation of the interventions to maintain the efficiency of the network and facilities, and technological innovation implemented in an accelerated or additional manner to that provided for in the regulation, subject to the demonstration of the credibility of the offer in distribution facilities already operated by the distributor. The latter aspect is important in light of sector development; for example, green gas is a promising renewable energy carrier compatible with the existing gas networks (Singlitico et al., 2019).

The DCs and interventions contained in the guidelines must enable the operator's economic and financial equilibrium and be justified by an analysis of the benefits to consumers compared to the costs to be incurred. No wonder, financial equilibrium is a prominent topic in public services (Meidutē & Paliulis, 2011).

They may be differentiated, if necessary, with respect to the degree of methanization achieved in the municipality, age of the plant, territorial expansion, and territorial characteristics, particularly orographic prevalence and population density.

The DCs may include the minimum density of new redelivery points per kilometer of the network in new areas, which makes distribution plant development mandatory; the volume of natural gas distributed per kilometer of the network, which makes distribution plant upgrading mandatory; interventions for safety and modernization of distribution facilities; and the weighted average remaining life of the facility, below which, if the leakage rate per kilometer of the network also exceeds the threshold value, the replacement of certain sections of the natural gas distribution network is mandatory.

The Regulatory Authority aims to encourage infrastructure growth capable of delivering benefits above costs and therefore seeks to identify a simplified approach for CBA and provides an initial threshold below which the CA is not required to develop the CBA.

DCs are defined on the basis of a simplified CBA. If the CA identifies less than 10 or 25 meters per redelivery point as the parameter in the case of municipalities falling in deprived areas, the CBA is unnecessary. Instead, interventions that do not fall under the DCs must undergo a CBA, which, if it provides positive results, is included in the Guidelines, while if the CBA is negative, the intervention is not included in the Scope Programmatic Guidelines. The next paragraph contains the methodology for applying DCs to extension interventions.

3. Methodology

Research design

This article focuses on the part of the natural gas supply chain that is inert to distribution. Natural gas distribution is regulated under a concession issued through open bidding by CAs. The gas is distributed through an integrated system of infrastructures, including withdrawal substations, pressure reduction plants, distribution networks, and redelivery points, which allow natural gas to be transported from the transmission network to end customers.

The values of DCs were simulated on the basis of the elements summarized below: database created with public data and referring to the gas distribution sector, identification of parameters under analysis, and identification of a multiplicative factor derived from the above parameters to be applied to the starting value of 10 or 25 meters per redelivery point.

The basic elements described above enable the acquisition of important evidence, such as objectivity of source data and greater linkage with plant data present in the territorial scopes or individual municipalities, avoiding the risk that a single value of DCs may be excessively rewarding or penalizing, and the possible creation of groups based on evidence related to the territories.

To analyze, we prepared a database that contained essential data according to the parameters listed in Ministerial Decree 226/11 to which we added other parameters deemed suitable, also retrieved from official sources, such as natural gas volumes per redelivery point and climate zones. The data used for our model can be found on the Ministry of Ecological Transition website, which publishes (for each territorial scope) key information such as the number of customers served, volume of natural gas distributed, length in kilometers of the existing network, altitude, and population.

The calculations and computations were based on the latest data available for the gas sector: 172 territorial scopes considering the aggregations that have occurred from the initial 177, 21.518 million redelivery points, 252 thousand kilometers of gas distribution network, and 58.4 million inhabitants.

Variables and parameters

We examined the variables reported in Table 1 from the characterization data of municipalities and territorial scopes published by the Ministry of Ecological Transition.

Degree of methanization (P1): The degree of methanization of the territorial scope is calculated through the ratio of the number of inhabitants to the redelivery points. It indicates the degree of coverage of natural gas distribution in the various municipalities belonging to the area. Considering that the average of this parameter with reference to all territorial scopes is 2.96, a fair share of the values under consideration, for approximately 45% of them, can be seen to be concentrated around the national average, testifying to the fact that natural gas distribution has covered most of the Italian territory, compared, however, to a remaining 10% of territorial scopes where there are high values of the ratio and therefore a low degree of methanization; the latter include mainly the territorial scopes of Southern Italy and those in which the percentage of mountainous municipalities is prevalent. Additionally, this consideration makes it possible to justify, as a result of the findings of the processed models, the granting of a higher value of meters per redelivery point used as a minimum condition for extension interventions.

Network density versus land area (P2): This parameter is the spatial expansion, calculated as the ratio between the area in square kilometers and the kilometers of the existing network within it. This parameter has a high degree of variability, as areas within the municipality may be undeveloped or inhabited, which can shift the value significantly from that for the urbanized areas of the municipality alone. This ratio shows the degree of the ubiquity of the natural gas distribution network with respect to the territory: where the ratio approaches 1, it indicates a high expansion of the network, while a high value translates, conversely, into a lower coverage of the territory. About the previous observation, it is reiterated that urbanized areas may have municipalities with high network expansion. The average over the total area is 1.28, and from the graph, a dense concentration of values can be seen between 0.3 and 1.5 in terms of the ratio of the area over kilometers of network and a total number of redelivery points ranging from 50,000 to 150,000. At the same time, it can also be seen how our country has strong variability in terms of territorial expansion; in fact, the coefficient of variation has a value of 91.82%, indicating the heterogeneity of values and their strong dispersion on different levels, because the figure is closely related to the orographic characteristics of the various territorial areas.

Housing Dispersion (P3): The rationale for the inclusion of this indicator is to enhance the situations in which the population density is low, to recognize to these territorial scopes a higher ratio of network meters to the redelivery points for extension interventions, trying to favor or otherwise ease the natural gas distribution of the most deprived areas, meaning those mountainous areas characterized by lower population density. Conversely, in cases with a low ratio of surface area to inhabitants and, therefore a high population density, the intent is to differentiate the base reference value of 10 meters per redelivery point set by the Authority, keeping this value as the lower threshold of the DCs and modulating it to a more congruous level according to the specific territorial realities. The placement of the values for the various territorial scopes was also observed for population density. An average of 6.20 was found, and a high concentration, approximately 80% of the territorial scopes, of values was around the average.

Intensity of network use (P4): This parameter measures the cubic meters of natural gas delivered per redelivery point and is, therefore, a technical variable designed to consider the intensity of utilization of the distribution network.

Degree-days counter (P5): This parameter considers the environmental aspect, particularly the benefits of using natural gas over other conventional fuels in areas of our country where there is a greater need for heat, through recognizing a higher threshold meter per redelivery point for such cases. The parameter used is the degree-day counter, the sum extended to all days in a conventional annual heating period of only the daily positive differences between the conventionally set temperature of 20°C and the daily average outdoor temperature. A low value indicates a short heating period with daily average temperatures close to the conventionally set temperature, while a high value denotes prolonged heating periods and daily average temperatures well below conventional. This parameter is useful because six climate bands have been identified, based on this parameter, allowing different minimum land areas to be placed within these bands to assess the reworking of the threshold for DC.

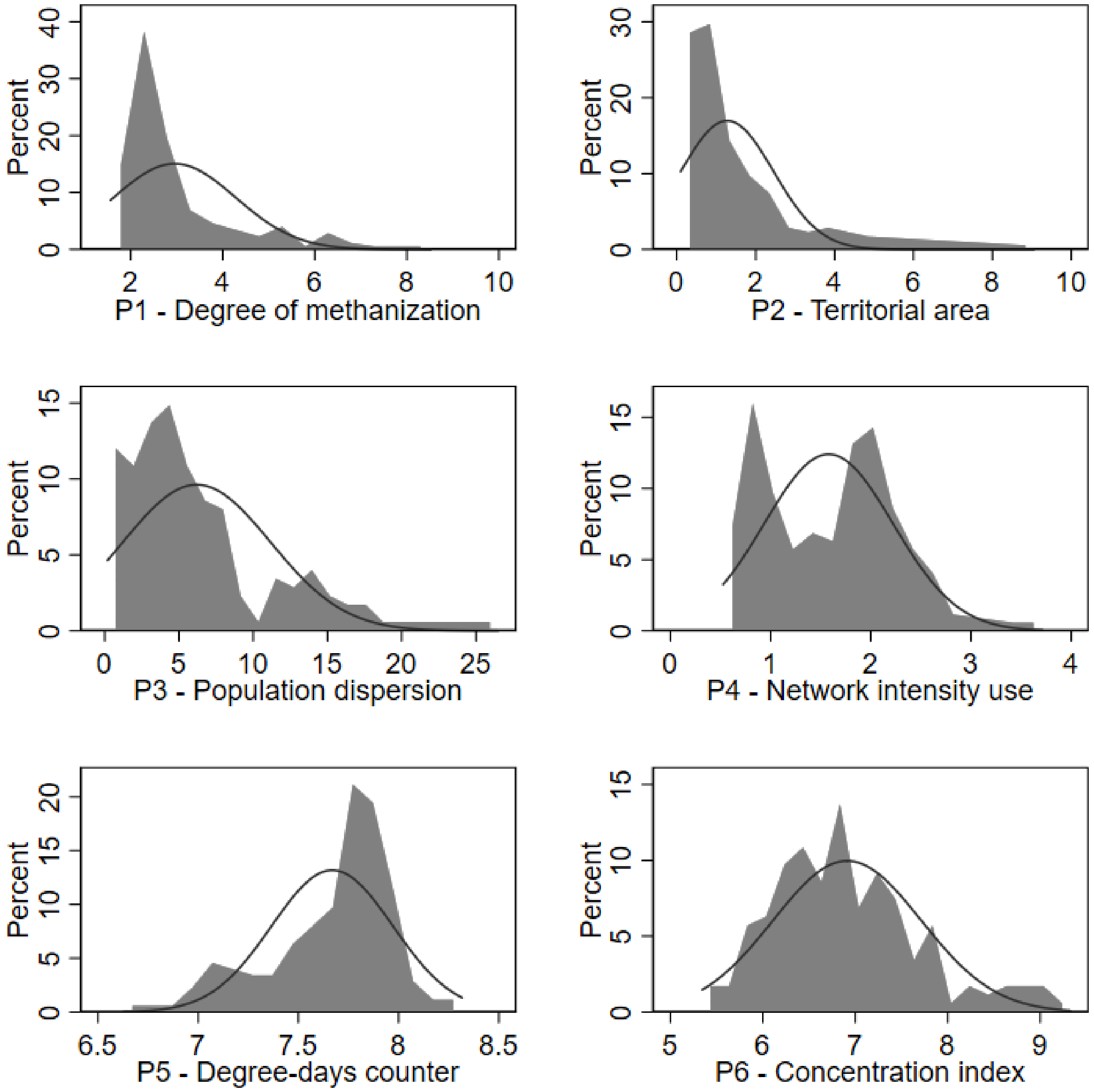
Urban concentration (P6): This parameter represents the degree of concentration of the population of municipalities within the territorial scope. It is important because it allows us to consider the specific weight of large urban centers that differ in both morphological and socioeconomic variables from others. Table 1 shows some key statistics of the variables considered. It should be noted that the information in the table refers to the values of the territorial scopes and therefore contains an arithmetic mean obtained from the information of the municipalities forming the territorial scopes.

Table 1- Description of parameters

Zone	Statistics	P1	P2	P3	P4	P5	P6
B	Mean	4.470	0.191	0.242	0.588	6.621	9.210
C	Mean	4.867	1.392	3.787	0.761	7.096	7.000
	St. dev	1.678	0.821	2.462	0.120	0.103	0.799
D	Mean	3.200	1.702	6.613	1.130	7.517	6.965
	St. dev	1.288	1.213	4.443	0.417	0.123	0.724
E	Mean	2.368	0.972	6.053	1.905	7.840	6.912
	St. dev	0.608	1.120	5.315	0.442	0.099	0.821
F	Mean	3.123	2.234	11.461	2.198	8.014	6.314
	St. dev	1.293	1.249	3.786	0.780	0.184	0.335
Total	Mean	2.956	1.277	6.196	1.580	7.669	6.912
	St. dev	1.325	1.176	4.976	0.643	0.303	0.801

Regarding the different possible calculation methodologies that can be adopted, which can always be modulated by acting on the coefficients, a procedure more successful in intercepting and significantly differentiating territorial scopes with different characteristics is considered more suitable to reflect local characteristics than one that tends instead to flatten the values to an average level. Figure 1 contains histograms of the coefficients identified for the definition of DCs.

Figure 1. Distribution of parameters



Note: data in logarithms. Histograms refer to distribution of parameters in the territorial scopes.

The above parameters were then reviewed and compared for their variability and potential impact on DCs. The scatter plot below relates the parameters to each other, highlighting their main correlations. Figure 2 shows the distribution of the parameters.

Figure 2. Scatter matrix between parameters.

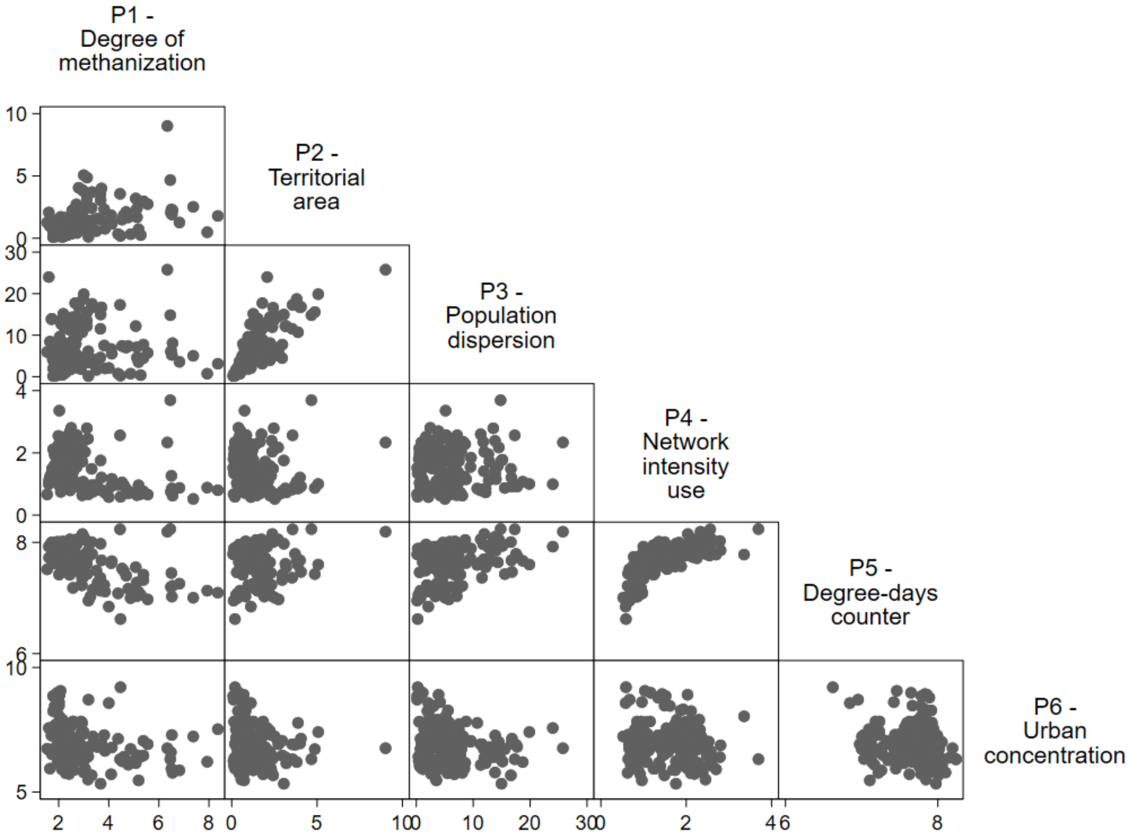


Figure 3 shows the climate zones into which Italy is divided. Regarding the territorial scopes, 56% fall within climate zone E, while 24% fall within climate zone D, which when viewed together account for almost all the territorial scopes; the remainder are divided into 13% within climate zone C, 6% within climate zone F, with only 1% of spatial application area in climate zone B. None of the territorial scopes fall within climate zone A.

Figure 3. Climate zones.

Note: in red is zone A: 0%, orange is B: 1%, yellow is C: 13 %, light blue is D: 24 %, blue is E: 56%, and dark blue is F: 6 %

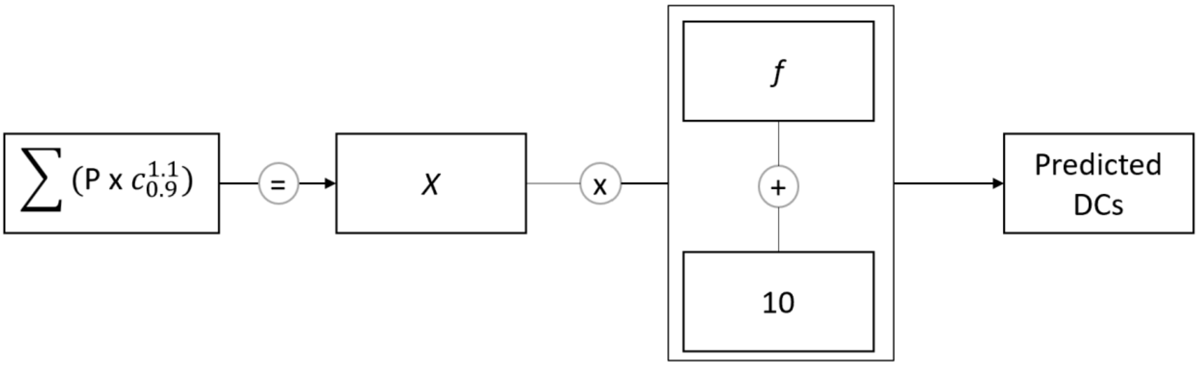
The following section contains estimates of DCs according to the analysis conducted using the identified parameters.

There has been some discussion on the appropriateness of introducing an indicator that would enhance interventions to support energy transition and new technologies such as bidirectional grids, storage systems, leakage reduction, and power-to-gas. Although the topic is significant, it has not been further explored.

Model setup

Based on the parameters, the proposed reworking of the DCs for network extension work starts from 10 meters per redelivery point. The approach depicted in Figure 4 is to identify a set of variables *v* from which to derive coefficients *c* depending on the value of the variables; specifically, coefficients are set to 0.9 if the value is lower than the first decile, 1 if the value lies between the first and ninth deciles, and 1.1 if the value exceeds the ninth decile. These c coefficients are then multiplied with each other, generating the factor X, which is then applied to the DCs. Consequently, as X is the product of the c coefficients, to compute the predicted DCs, a recalculation of the DCs is proposed according to the following Figure 4.

Figure 4. Simulation approach



The application model uses the current ratio of meters over redelivery points as the minimum threshold. Thus, it also provides for the possibility of establishing thresholds for DCs, in some cases theoretically lower than 10 meters per redelivery point for certain territorial scopes.

4. Results

The elaborations demonstrate the possibility of identifying differentiated suitable DCs according to the spatial characteristics of territories. In the elaboration, metropolitan area and capitals were distinguished from those of the remaining municipalities to capture differentiations based on the degree of methanization achieved and the population density of the reality considered. Figure 5 contains the kernel density of the observed DCs against the predicted ones. Clearly, predicted values seem to distribute more uniformly along the range of redelivery points depicting a more realistic situation compared to the actual threshold.

Figure 5. Kernel density of observed and predicted DCs.

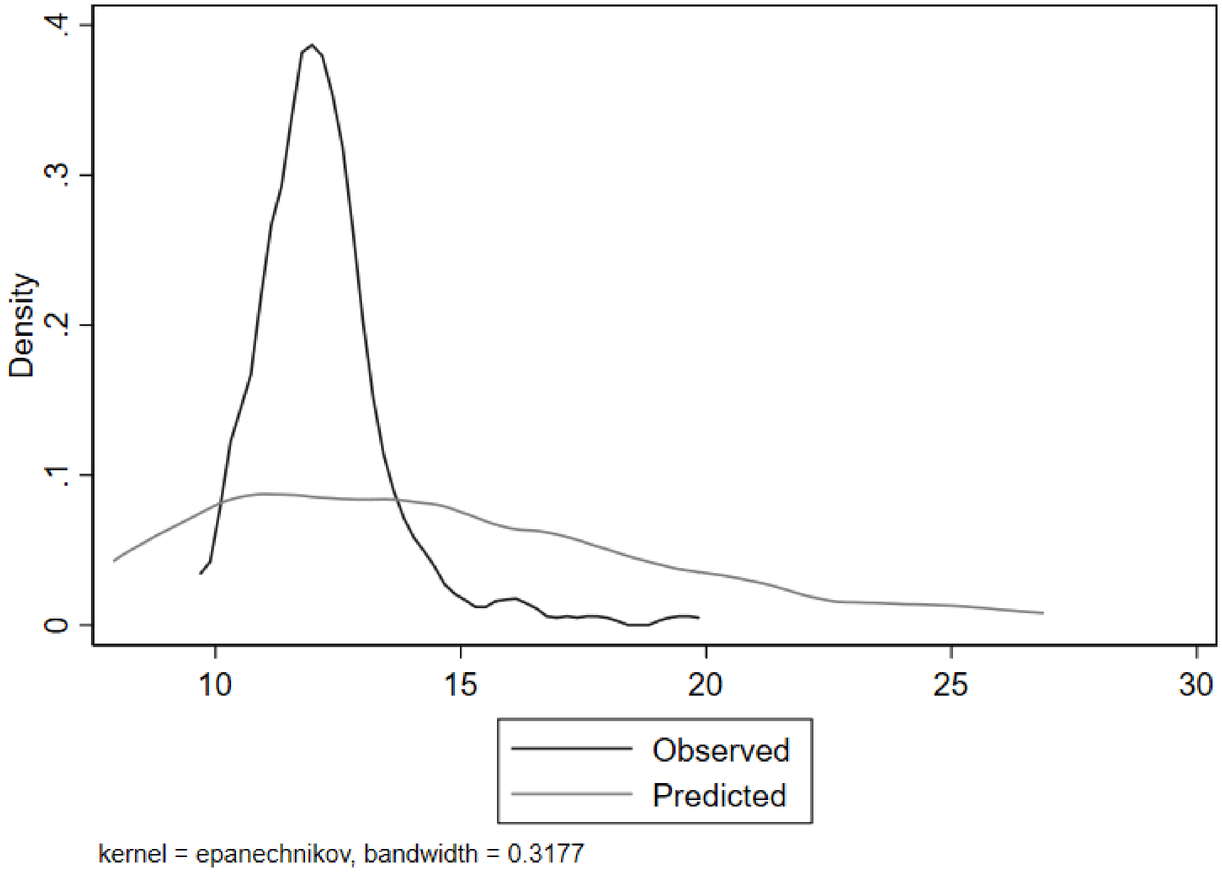
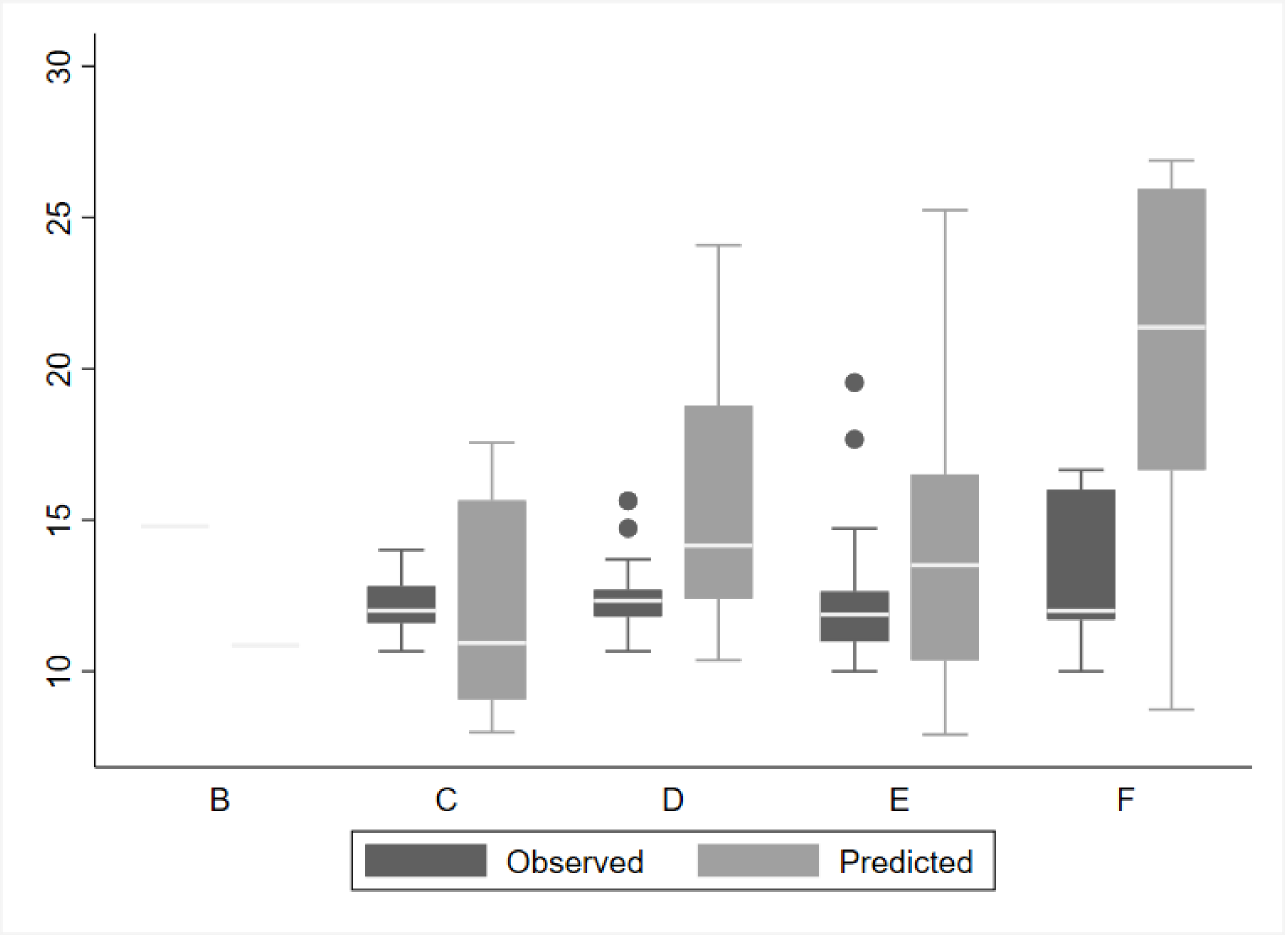


Figure 6 compares the observed and the predicted DCs and a noticeable improvement emerges. Indeed, the predicted DCs seem to better reflect the morphological characteristics of different territories so that the DCs are more tailored to the territories.

Figure 6. Comparative distribution of DCs



The next section contains the implications for policy from applying CBA analysis for interventions that exceed DCs.

Table 2 shows the regression analysis results aimed at comparing the drivers of DCs and confirms that the approach proposed in this paper allows for streamlined decision-making.

Table 2. Regression analysis

VARIABLES	(1) a observed	(2) b predicted
P1	0.0335***	0.0531***
	(0.00709)	(0.0171)
P2	0.00519	0.0423*
	(0.0105)	(0.0253)
P3	0.00524**	0.0317***
	(0.00239)	(0.00575)
P4	-0.0440***	-0.0492
	(0.0154)	(0.0372)

P5	0.168***	0.420***
	(0.0404)	(0.0974)
P6	0.0871***	0.124***
	(0.00816)	(0.0196)
Constant	0.533*	-1.784**
	(0.317)	(0.764)
Observations	175	175
R-squared	0.508	0.651

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Some particularly relevant aspects emerge from Table 2, which confirm the hypothesis underlying the research question of this paper. First, the effect of housing density per redelivery point is confirmed in both models. Second, the influence of the density of the natural gas distribution network with respect to the area is also observed to increase, and this finding, which goes in the same direction as the above, is important in that this variable, which is related to the extension of the network to serve the scattered users in the area, must be considered. Third, the impact of population dispersion increases significantly, confirming that in less densely populated areas, the threshold of DCs must be higher. Fourth, as expected, the variable referring to the intensity of network use, which is a quantitative variable, loses significance while retaining the negative sign. Finally, the relevance of the variables referring to temperature and urban concentration is demonstrated.

5. Discussion and implications for CBA

The results of the analyses show that through the proposed approach, decision-making and evaluation of DPs could be streamlined and simplified by clearly and objectively identifying which proposals need CBA and which objectively fall within the DCs, taking into account spatial characteristics that significantly affect them. This approach is important as policymakers need to minimize spending in evaluation processes (Vine et al., 2013). It is a matter of adopting a multistep, multicriteria approach to benefit assessment (Saarikoski et al., 2016) given the necessity of decision-analytic techniques as support for policymakers (Gamper & Turcanu, 2007).

It is desirable to design and develop a shared CBA format available to CAs, which is set up in such a way as to ensure the subsequent stage of bid preparation by the bidders and, consequently, the successful bidder so that a model can be set up to be usable by CAs in different territories.

This article proposes insights to support simplification that touches on the critical points of tenders for natural gas distribution service and at the same time brings a benefit for their fulfillment when there are inherent limitations to the procedure itself.

A prominent simplification relates to CBA, in which the attempt at simplification is directed at reducing its scope: on the one hand, investments and their recoverability are validated on the economic-financial level, and on the other hand, these investments are made with the logic of ensuring greater efficiency and effectiveness with respect to the centrality of environmental policy.

Specifically, the simplification approach is directly linked to the CA. On the one hand, a financial analysis of the eligible investments that derive from the minimum development criteria with respect to which the same must comply with a series of conditions to guarantee the operator's economic-financial balance. On the other hand, a second line of analysis aimed at identifying the overall convenience for the company of the implementation of an intervention. The latter examination consists of three different stages (ARERA, 2019), of which we report the essential features:

- In the first stage, the impacts on consumers included within the scope of the concession are assessed based on market prices. The stage that can be carried out through a cost-effectiveness analysis consists of identifying the solution that minimizes the cost and at the same time is convenient for the consumer and presents the prerequisites for connecting the subject to the network being developed.
- In the second stage, the impacts for consumers included within the tariff framework are analyzed, purifying market prices of all potentially distorting elements, such as taxes, excise taxes, subsidies, and concessions, because they represent a transfer of money between different parties and not a real economic cost or benefit for society; this is kept in mind for both the natural gas distribution option and in the counterfactual option. This ensures that any fiscal asymmetries between the different solutions under analysis do not affect the results or rather that the preferable solution does not turn out to be so only because of the effect of subsidies borne by consumers outside the scope of the concession;
- In the third stage, an analysis of social and environmental impacts is conducted considering the externalities generated by the alternatives under consideration.

Regarding the first stage, in which a cost-effectiveness analysis is carried out on the consumer within the territorial scope, it is possible to integrate—by the CA—within a single investment analysis the financial rationality of the operator and the efficiency for the consumer.

Turning instead to the second phase, the CA possesses information only about some things that happen within the entire area. There is in this case, for that entity, a problem of decision coordination, as the CA would have to evaluate the effects on the area while holding firm on the development behavior of all other entities, not knowing the simultaneous decisions of the other territorial scopes falling within the tariff area.

With reference to the last stage of the analysis, set according to counterfactual evaluations, the starting hypothesis (H0) is to be compared with the solution that includes natural gas (H1) and alternative solutions that may depend on individual behavior choices but also on policy choices that are neither predictable nor related to CA availability. Thus, a risk of a false negative is created, i.e., a case in which the hypothesis (H1) is rejected with the possibility that if it is not within the availability of the CA to provide direction or govern that hypothesis assessed as better than gas, it will not be implemented at all.

More generally, there is, however, a methodological risk when within a macro tariff area there is a simultaneity of uncoordinated assumptions among them, such as energy policy choices that may be greater than the geographic perimeter of the single minimum territorial area not falling within the governance of the CA's decisions, let alone the latter being used to refute the advisability of developing or not developing the gas network.

A simplifying line can be undertaken within the entrustment of tasks to the subject CA, in which the information set that allows it to carry out these assessments is closely linked with effective governance of decisions related to the CA itself. Such simplification can be useful in removing an excess of evaluation that is likely to be declined according to well-defined theoretical objectives, but which, due to a significant information asymmetry, leads only to the costs of implementing a process and often barriers to the development of tenders.

6. Conclusions

From the analyses in this paper, despite the complexity of the legal and regulatory framework, we identify three objectives to be achieved to facilitate the conduct of competitive bidding: simplification, clarity, and flexibility.

Regarding the verification of the residual industrial value and the net invested capital value for regulatory purposes, the information that CAs are required to submit to the authority could be simplified to standardize it as much as possible and facilitate the authority's verification task; additionally, it would be advisable to expand the number of self-certifications by CAs because this would reduce the amount of verification by the authority.

In the intersection between the logic of tendering and the logic behind regulation, certain problematic nodes need to be considered that, by generating clarity among all the actors involved, create the indispensable conditions for the conduct of tenders. First, a shared, transparent, and replicable CBA methodology must guarantee the degree of certainty of the system. This is a central node to have sufficient predictability of the tariff recognition of investments and the allocation of scores in the bidding process. Additionally, the separation of technical and economic bids must be clearly defined, particularly the eligibility criteria for works that the tariff cannot finance. Depending, in fact, on whether one or the other interpretative direction is chosen, the consequences on the care of the public interest, on the one hand, and on the market, on the other, are very significant. Particularly, the risk of offering ample space to bids for interventions not recognizable in the tariff encourages unnecessary or unsustainable investments while favoring market players with greater financial means.

The regulatory framework of natural gas distribution service tenders should be enriched with new perspectives on increasing the flexibility of procedures and enhancing the discretion of CAs, which should be able to choose the procedures for contracting and not just the tender.

One could, for example, allow competitive dialog or innovative forms of public-private partnership. This would activate learning mechanisms and openness to innovative technical solutions, typical in complex contracts, without sacrificing the actual competition stage once a certain solution has been chosen.

Then, it would be necessary to allow the rules to be updated to constantly adjust the service to the needs that may arise and are not adequately foreseeable by CAs when preparing tender documents. This possibility should be anchored in the basic principle of ensuring the economic-financial balance of the successful bidder and balanced with the constraint of not distorting the bidding mechanism, thus encouraging evasive behavior.

References

Adedokun, O. A., Ibironke, O. T., & Babatunde, S. O. (2013). Assessment of competitive tendering methods of procuring educational building projects in Nigeria. *Journal of Facilities Management*, *11*(1), 81–94. https://doi.org/10.1108/14725961311301484

ARERA. (2018). *Provisions for consulting the ten-year development plans of the natural gas transport network and approving the minimum requirements for the preparation of the plans* *and for the cost-benefit analysis of the interventions (468/2018/R/gas)*.

ARERA. (2019). *Criteria for the tariff regulation of gas distribution and metering services in the fifth regulatory period (DCO 410/2019/R7gas)*.

Beccarello, M., & Di Foggia, G. (2022a). Economic Impact of Energy Efficiency Policies: A Scenario Analysis. *International Journal of Economics and Finance*, *14*(12), 1–11. https://doi.org/10.5539/ijef.v14n12p1

Beccarello, M., & Di Foggia, G. (2022b). Introducing a system operator in the waste management industry by adapting lessons from the energy sector. *Frontiers in Sustainability*, *3*, 984721. https://doi.org/10.3389/frsus.2022.984721

Bergendorff, H., Larsson, T., & Näslund, R. (1983). The monopoly v competition debate. *Telecommunications Policy*, *7*(4), 297–308. https://doi.org/10.1016/0308-5961(83)90084-8

Dorigoni, S., & Portatadino, S. (2009). Natural gas distribution in Italy: When competition does not help the market. *Utilities Policy*, *17*(3), 245–257. https://doi.org/10.1016/j.jup.2009.03.001

European Commission. (2022). Services of general economic interest. In *EUR-lex*. European Union. https://eur-lex.europa.eu/EN/legal-content/glossary/services-of-general-economic-interest.html

FiedZiuk, N. (2013). Putting services of general economic interest up for tender: reflections on applicable EU rules. *Common Market Law Review*, *50*, 87–114.

Gamper, C. D., & Turcanu, C. (2007). On the governmental use of multi-criteria analysis. *Ecological Economics*, *62*(2), 298–307. https://doi.org/10.1016/j.ecolecon.2007.01.010

Goncharuk, A. G. (2008). Performance benchmarking in gas distribution industry. *Benchmarking: An International Journal*, *15*(5), 548–559. https://doi.org/10.1108/14635770810903141

Gullì, F. (2016). Investments projects in natural gas distribution in Italy : a model of social cost-benefit analysis. *Economics and Policy of Energy and Environment*, *3*, 5–134. https://doi.org/10.3280/EFE2016-003001

Joskow, P. L. (2007). Regulation of Natural Monopoly. In A. M. Polinsky & S. B. T.-H. of L. and E. Shavell (Eds.), *Handbook of Law and Ecoonomics* (Vol. 2, pp. 1227–1348). Elsevier. https://doi.org/https://doi.org/10.1016/S1574-0730(07)02016-6

Meidutē, I., & Paliulis, N. K. (2011). Feasibility study of public-private partnership. *International Journal of Strategic Property Management*, *15*(3), 257–274.

https://doi.org/10.3846/1648715X.2011.617860

Mikolajková, M., Haikarainen, C., Saxén, H., & Pettersson, F. (2017). Optimization of a natural gas distribution network with potential future extensions. *Energy*, *125*, 848–859. https://doi.org/10.1016/j.energy.2016.11.090

Muthuraman, K., Aouam, T., & Rardin, R. (2008). Regulation of Natural Gas Distribution Using Policy Benchmarks. *Operations Research*, *56*(5), 1131–1145. https://doi.org/10.1287/opre.1070.0507

Pollitt, T. J. and M. (2005). Electricity Market Reform in the European Union: Review of Progress toward Liberalization & Integration. In *The Energy Journal: Vol. Volume 26* (Issue SI, pp. 11–42). https://doi.org/10.5547/ISSN0195-6574-EJ-Vol26-NoSI-2

Saarikoski, H., Mustajoki, J., Barton, D. N., Geneletti, D., Langemeyer, J., Gomez-Baggethun, E., Marttunen, M., Antunes, P., Keune, H., & Santos, R. (2016). Multi-Criteria Decision Analysis and Cost-Benefit Analysis: Comparing alternative frameworks for integrated valuation of ecosystem services. *Ecosystem Services*, *22*, 238–249. https://doi.org/10.1016/j.ecoser.2016.10.014

Singlitico, A., Goggins, J., & Monaghan, R. F. D. (2019). The role of life cycle assessment in the sustainable transition to a decarbonised gas network through green gas production. *Renewable and Sustainable Energy Reviews*, *99*, 16–28. https://doi.org/10.1016/j.rser.2018.09.040

Thörnqvist, C., & Woolfson, C. (2012). When tender turns tough: posted workers and the tendering regime in the Swedish construction industry. *Construction Management and Economics*, *30*(7), 525–533. https://doi.org/10.1080/01446193.2011.640338

Tol, R. S. J. (2012). A cost-benefit analysis of the EU 20/20/2020 package. *Energy Policy*, *49*, 288–295. https://doi.org/10.1016/j.enpol.2012.06.018

Tovar, B., Ramos-Real, F. J., & de Almeida, E. L. F. (2015). Efficiency and performance in gas distribution. Evidence from Brazil. *Applied Economics*, *47*(50), 5390–5406. https://doi.org/10.1080/00036846.2015.1047093

Vine, E., Hall, N., Keating, K. M., Kushler, M., & Prahl, R. (2013). Emerging evaluation issues: Persistence, behavior, rebound, and policy. *Energy Efficiency*, *6*(2), 329–339. https://doi.org/10.1007/s12053-012-9174-6