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Abstract

Using the "budget-based scheme" approach developed by Kirby *et.al*. (1991) and Reichelstein (1992), this paper establishes the optimal policy function in order to control "hidden actions" from managers of Public Water Utilities (PWU) regarding investments that deviate from the Optimized Business Plan (OBP), with the purpose of inducing managers to reduce deviation from the execution of not programmed investments in the OBP and from programmed investments that were not executed. We find a high percentage of investment (47%) that deviates from its OBP. However between 16% and 35% of executed investment that it deviates from its programmation, can be controlled by the PWU manager with a compensation payment schemes.

List of Acronyms

ATUSA	:	Tumbes Water S.A. (Anonymous Society)
IDB	:	Inter-American Development Bank
IMB	:	Institutional Modified Budget
JBIK	:	Japan Bank for International Cooperation
KfW	:	Kreditanstalt für Wiederaufbau (KfW),
MEF	:	Ministry of Economy and Finance (MEF).
MVCS	:	Ministry of Housing, Construction and Sanitation (MVCS)
OBP	:	Optimized Business Plan
OIB	:	Opening Institutional Budget
PWU	:	Public Water Utilities
SEDAPAL	:	Drinking Water Service & Sewage to Lima
SUNASS	:	National Superintendence of Sanitation - SUNASS
WB	:	World Bank

I. Introduction

A major portion of the investment executed by the Public Water Utilities (PWU) in Peru is not planned through its Optimized Business Plan (OBP). These investment amounts that deviate from the planned investment are not monitored by the regulator (National Supervision of Sanitation-SUNASS) due to the high costs involved. Many projects executed by municipalities and transferred to the PWU for operation are not monitored by the utility. This creates incentives to Board and to managers for seeking to control the PWU budget and implement projects without adequate supervision. As a consequence, managers could allocate the budget in a discretional way, without adequate planning, and increase the likelihood for the utility to work inefficiently.

Chahuara and Lucich (2011) show that PWU that do not follow the regulation through the OBP are technically less efficient. The OBP establishes tariff structures and performance targets associated with the investment program for a five years period. The OBP evaluates the relevance, efficiency and effectiveness of the projects with the goal to determine through efficient costs, the tariff level associate to the quality of the sanitation services.

The regulatory framework does not prevent the PWU to execute investments that have not been programmed in the OBP in the extent they can achieve the performance goals established in tariff plans and execute some percentage of their income into investment. The penalty could be established ex post, only when the PWU has not reached the performance goal of the service quality established by SUNASS in the tariff study, but refers exclusively to non-compliance targets and it do not refer to the inefficiencies that these projects executed outside the OBP could generate.

The present study aims to know the measure in which the investment executed by the PWU is not included in the OBP or is deflected from its programming, and also know in which way and how much of these deviations can be minimized by using an incentive scheme.

To achieve these goals, this paper proposes an analytical framework to explain the moral hazard present in the investment decisions by managers of PWU that are not observed by the regulator (the hidden actions), and one incentive scheme as a solution based on the contract theory as a function of proper planning of investments that induce managers to reduce the share of investment that has not been programmed into the OBP.

The main contribution of this paper is the usage of the "budget-based scheme" approach and the application of the methodology proposed by Kirby *et. al.* (1991) and Reichelstein (1992) to build a menu of compensation payments for minimize the deviations in the execution of the investment program from a Business Plan or OBP (investment-based scheme).

The incentive scheme should induce to managers of the PWU to reveal their true knowledge about their investment planning capacity, that is, to reveal their "type", which will allow them to minimize the deviations in the execution of the investment program previously defined. Also, unlike Kirby *et al.* (1991) and Reichelstein (1992), the main problem that the Principal has to face in our work is the maximization of sanitation services.

After this introduction, we will describe the institutional framework of the PWU, highlighting the agency problem. In the third section we will review the literature about contracts and incentives for public management. In the fourth section, we will develop the analytical framework for an optimal policy to control hidden actions. In the fifth and sixth section we will estimate the portion of not scheduled investment that can be reduced and the amount of money needed. Finally in section seven conclusions will be presented.

II. The agency problem in water public utilities in Peru

2.1 Stakeholders

In Peru, provincial municipalities are owners of the Public Water Utilities (PWU), except for SEDAPAL, which is a public company operating in Lima, and ATUSA which is a private concession in Tumbes. However, the Board of Proprietors composed by provincial mayors and the regional government do exert influence on the Directory of PWU. The rest of the directory members, between 30% or 40%, represent the civil society. In turn, the Board appoints and delegates the management of the PWU in the CEO, who in some way, by signing contracts of exploitation with the Ministry of Housing, Construction and Sanitation (MVCS) should be protected from the political interference of the Board of Proprietors.

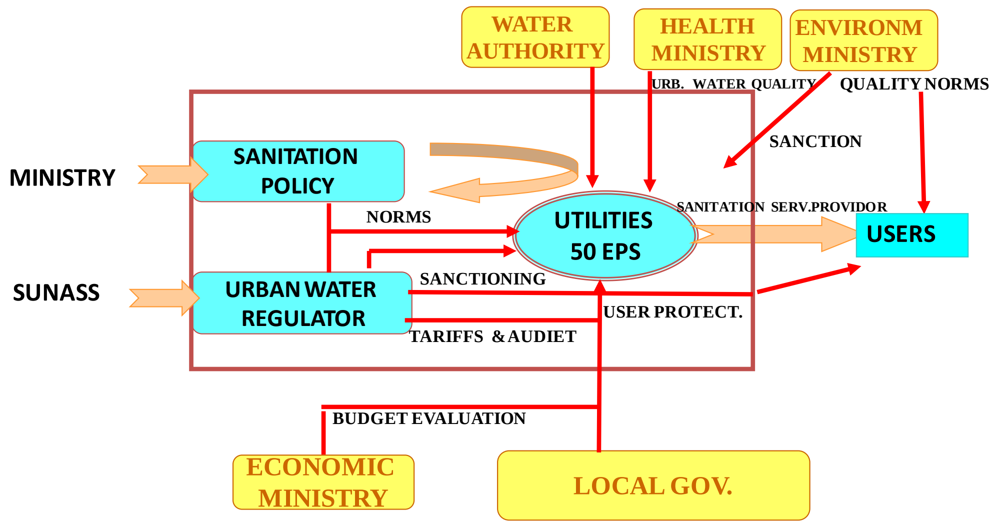
As the PWU are municipal companies, the approval of its annual budget and the scale of its staff remuneration depend on the Ministry of Economy and Finance (MEF). The control exercised by the MEF is decisive for the economic and financial management of the PWU. However, in the approval of its budget, the MEF considers the projected income of the PWU established by the regulator in its tariff study.

Since 2005, tariffs are approved by the National Superintendence of Sanitation - SUNASS (before 2005, the law stipulated that tariffs should be approved by the mayors or their representatives). The tariff levels are set to recover the economic efficient costs for providing the service (payback the credit and cover the operation and maintenance costs of infrastructure). The tariff increment is approved whether the PWU reach the management goals and the quality of services provided by the regulator based on the investment program.

The OBP is the main regulatory tool for setting tariffs for 5 years period. Through the OBP the tariff structure, the investment program and the performance goals can be linked. The PWU suggests the OBP to SUNASS for preparing the tariff study.

The funds required by the PWU to execute the necessary investments to improve sanitation services, beyond the internally generated resources and the concessional loans from international technical cooperation (Japan Bank for International Cooperation (JBIK), Kreditanstalt für Wiederaufbau (KfW), Inter-American Development Bank (IDB), World Bank (WB), etc.), depend on the central government, largely through the MVCS, which grants and funds directly to the PWU or indirectly through regional or municipal governments, which in turn can carry out the projects and subsequently transfer them to the PWU for operation and maintenance.

Graph 1
Urban Sanitation Sector in Perú - Stakeholders



Adaptation – WET NET: GIRH

The local authority (Mayors) through the Corporate Board of the PWU can induce the orientation of the central government transfers to the execution of investment projects. Although the central government can transfer resources directly to the PWU (since it is an executive unit and has the capacity to formulate and execute sanitation projects), tax aspects and others issues can induce to the corporate boards to decide to transfer the donations directly to their municipalities.

Finally, International technical cooperation participates through concessional loans with low interest rates, but the approval depends on the MEF. This institution also analyze the technical feasibility of the projects with funds by the central government.

2.2 Incentives

The regulatory framework for PWU does not provide explicit incentives to tackle agency problems in the management of the PWU, but rather assumes that existing policy instruments such as the Exploitation Contract, the Account Manual and the Corporate Governance Code, would ensure the delegation of management to maximize the public interest and neutralize the political interference of the Board or the Shareholders in technical decisions, discouraging managers interest on budget control.

Public management of the PWU, except for the limited participation of workers in the utilities, has no explicit incentives to improve the delivery of services. In the context of perfect delegation of the management, the incentives of the regulatory framework are focus in obtain tariffs increases if the PWU reaches the performance goals of the quality service and it obtains surpluses for cost reduction.

In this sense, there are two incentive for the PWU in the regulatory framework in order to generate the surpluses needed to invest in infrastructure in an ideal way and to maximize the quality of the service (considering that this purpose is subject to the credit restriction in the sector): obtaining a benefit through “efficiency gains” between tariff revisions and, increasing the tariff if the PWU reaches the performance goals.

III. Literature Review

Economic literature shows that there has been intensive studies for the regulation for private management of public services through incentive schemes based on the theory of contracts to address agency problems (Laffont & Tirole,1993) since the eighties; however incentive schemes has been little used to address the agency problem in the management of public enterprises, specially under the "public enterprise" approach developed by Rees (1984) which considers that the positive goal of a public company may be related to different aspects of maximizing aggregate welfare of society, such as the company's production, income and quality of service or delivery, which is precisely the purpose for public management of municipal-owned businesses.

The agency problem in the management of public utilities that arises when the owner, authorities or their representatives (boards of directors, directory, etc.) do not have the same interests that manager or when this has no mechanisms to counteract the political influence of these actors on technical decisions, is reinforced by the difficulties to assess the results and performance of public administration and measure the size and efficiency required of the bureaucracy, and also by the absence of competition that encourages innovation and cost reduction. “The controllers get much of its profits of the control through inefficiencies that increase the real costs” (Bustos & Galetovic: 2002), creating governance problems in the company, avoiding accountability, discouraging efficiency, and establishing conditions for the manager do not follow the Principal (which can be the mayor, the central government or the regulator), but may follow his own interests or those derived from the collusion. For these reasons the agency problem in public administration has a negative effect on economic efficiency of public management companies (Weimer & Vining: 1998; Araral, 2008).

In the case of decisions associated with the assign of internally generated resources by PWU, if managers attempt to control more budget without proper accountability and outside the regulatory scheme (without following the OBP), the managers could make inefficient investment decisions. Chahuara & Lucich (2011) show that PWU do not follow the OBP are less efficient technically. Also, the low salaries encourage managers to take more risks on their actions when the Principal does not observe it.

To encourage efficiency in the private management of public services, it is common to observe the existence of incentive schemes that seek to share efficiency gains between users and the operator resulting from lower operating costs (Vogelsang, 2002).

From the work of Laffont & Tirole (1986) we can understand that these incentive schemes allow the control of the "*trade off*" between how acceptable the cost should be transferred to the user and how much risk should the operator take, which also allow a rigorous approach to the information asymmetry between the regulator and the operator. The relevant aspect of these schemes is to establish a standard value which is the benchmark that must be overcome, and the portion of these efficiency gains to be shared among participants. Although is common in these schemes to establish standard costs, there are many situations in which what is rewarded are the quality of service indicators.

To encourage the formulation of efficient budgets and evaluate their performance, contractual schemes as Fixed Price, Cost Plus or combinations thereof Cost-Plus-Fixed-Fee, Cost-Plus-Incentive-Fee, Fixed Price Cost Reimbursement (see Table 1), have been used in the design of contracts between government and suppliers of goods and services or executors of projects These schemes have granted compensation for managers good performance in terms of achieving certain results, such as reducing costs, streamlining procurement and better prices for the provision of these services (Reichelstein: 1992).

These schemes have led not only to improve the cost-based acquisitions (Cost-based procurement) but also the self regulation of public services. Table 1 provides its features.

Table 1
Government Contracts

Type of contract	*Characteristics*	*Limitations*
Cost Plus	Adjust tariff when the costs vary for maintain a rate of return fixed.	Problem of cost padding
Fixed Price	Remain fixed tariff and take profits by efficiency gains. This contract share the risk between agent and principal.	Its election depends on a) low uncertainty about technology, project components and cost, for avoiding information rent, and b) aversion to cost padding to users.
Cost-Plus-Fixed-Fee	Fixed fee may be adjusted.	Permit renegotiation and strategy behavior.
Cost-Plus-Incentive-Fee	Parties can negotiate a cost target *T*, and firm´s profit increases proportionally with cost underruns relative to the cost target, form incentive scheme: $a + b\ (T\text{-}x)$	Problem to select cost target *T*, it generates lowest cost-share parameter *b.*
	$a + b(E - x)$	Weitzman (1976) propose T by E.
Fixed Price Cost Reimbursement	Simple Menu: Cost-Plus + Fixed Price (Rogerson, 2003)	Few use.

Source: own

The use of combined scheme has overcome the problems of Fixed Price or Cost Plus. Nevertheless the difficulties to renegotiate and to determine a "target cost" (which can lead to financial problems to the operators or unwanted benefits) have not allowed these combined schemes to be efficient when the regulator has no ability or certainty to fix the values.

To gain efficiency in the budget management is necessary to avoid the review of the contract parameters and their expectations, and hence the agents opportunistic behavior. An alternative to achieve this is the use of mechanisms that induce agents to report their own performance or the expected value of their action, being, among these, the most efficient mechanism that induces agents to tell the truth.

Ijiri *et al.* (1968) replaces the cost set by the regulator (target cost) in the Cost-Plus-Incentive-Fee contracts with an officer's report and compares it to what happens. The use of reports in the contracts with asymmetric information has been developed by the literature since the work of Weitzman (1976) by supposing that only the manager knows the function distribution for the actual outcome (Kirby *et al.*, 1991). Reichelstein & Osband (1984) compare the officer's report with what he expects to happen, and Kirby *et al*. (1991) adds the hidden action to what the agent expects to occur, where compensation is given in terms of minimizing bias, that is, plan accordingly.
The evolution from "the report" to "what the agent expected to happen", with and without hidden actions, takes place in the incentive contracts, where the agent chooses a “target cost” from a proposed menu. This election represents

his expected cost, and then evaluates the difference between the observed cost and the reported cost.

From the mechanisms that lead to "tell the truth" in a context of hidden actions, the "budget-based scheme" proposed by Kirby *et al*. (1991) is an efficient scheme. This mechanism induces agents to "tell the truth", rewarding any deviation between what is reported and what actually happens. In these schemes, the optimal linear contracts are those which enable the operator to choose the "*cost share parameter" "b"*.

Rogerson (2007) states that the optimal linear contract would take place when the "types" of firms according to their technology, capacity planning, etc., can be differentiated from the choice of contract made by the operator, being possible to represent even the deflection or slack as a best result. This will allow the principal to identify the types, through the principle of revelation and adjust the rates according to the levels of efficiency that may be required.

3.1 Reporting incentives

The budget-based scheme, belonging to the category of lineal contracts menu, is an incentive scheme that will address the problem of the presence of moral hazard in the agency. This scheme has been developed by Kirby *et al*. (1991) and applied by Reichelstein (1992) in the German Defense Department´s government contracts, to assess the work of the administration cost centre in which the retribution to the operator has two components: a "target profit" and a "bonus" [or penalty] if the operator obtains lower [higher] cost in regards to the cost reported to this centre.

The particularities of this incentive scheme are two: i) both the "target profit" ***a(E)*** and the "*cost share*" ***b(E)*** are functions of the "target cost" ***E***, that is reported by the operator and which properties will induce to report unbiased values, and ii) the deviation between the cost observed ***x*** and the "target cost" ***E*** is rewarded or penalized by the "cost share" ***b(E)*** (Reichelstein, 1992).

The scheme works as follows: to start the project, the operator submits its cost report ***E***, on which the principal will pay an incentive fee (target profit) ***a(E)*** and a incentive profit ***b(E)*** which is proportional to the budgeted variance ***(E-x),*** *that is* ***b(E)(E-x).***

Thus, if the operator intends to report higher costs than what he is expected to get, that is ***E > z,*** with the intention of obtaining a higher retribution through the bonus, the value of the "parameters" ***a(.)*** and ***b(.)*** will diminish, and therefore also the total compensation value. However, if the reported cost by the operator is equal to the cost that the agent expects to get, that is, ***E = z***, maximum retribution can be obtained, so the operator should always report **E** when he expects to happen ***z***. This implies that ***a(z) ≥ a(E) + b(E)*(E-z)***, so that the retribution expected equals ***a(z)*** if the true value ***z*** is reported. Therefore, this report is unbiased (Reichelstein, 1992).

Thus the operator has an incentive to reveal the truth about their own assessment of the project cost. Also, as the principal offers a contract menu, the agent's cost report involves choosing a particular incentive function from that menu, which also will reveal their type.

In the context of government contracts, this kind of scheme which induces the operator into optimal planning, would allow the Principal to receive unbiased information that would be useful in the budget planning process. In this sense, from the perspective of cost control, the budget-based scheme is an optimal mechanism of incentives that induce the operator to provide unbiased budget estimations of the expected costs (Reichelstein, 1992).

3.2 Performance incentives

In the context of "hidden actions", it is expected that the agent incurs in higher cost than those would take place in a context without "moral hazard", adding as a consequence of it, a slack or deviation "α" to the "minimum expected cost" μ, when obtaining other benefits ***B***(α) as a result of his "hidden actions" α. Thus, the agent expected cost ***z***, within the context of moral hazard is the sum of α and μ.

Whenever slack represents the efficiency of the operator, where $\alpha = 0$ is a situation of maximum efficiency, the principal will be willing to offer a higher rent to the operator in exchange to reduce deficiency levels in his operations.

In order to accomplish this, the principal will implement an incentive scheme [budget based scheme] through an "*optimal contracts menu*", that allow him to control the amount of slack as a consequence of the definition of an optimal policy in function $\alpha(\mu)$ of the minimum expected cost μ.

This policy is represented by a sequence of different levels of slack for the entire trajectory of μ, which permits to optimize the objective of the Principal´s problem (in Kirby is cost minimizing), that depends, among other things, on the maximization of expected benefits by the operators.

Thus, it is considered that an optimal contract is a revelation mechanism through which the manager reports its cost parameter ***E*** (or ũ) and the Principal establishes (according to this report) the manager retribution ***G(.)*** and the expected cost ***z***(.) that optimizes the objective function (Kirby *et al*., 1991).

Also, the Budget-based scheme leads to a separation of types. In this way, a relatively high cost level μ (which reflects a high type) that would be associated with a lower "cost share parameter" ***b(.)*** generates less incentives for the operator to reduce slack, in relation to the benefits of hidden activities ***B (.).***

The scheme shows that it is preferable for the Principal to allow the operator (who is better informed) to choose from a menu the cost-share parameter ***b(.)***.

The incentive scheme proposed by Kirby *et al.* (1991) has not been used in the literature to minimize the deviations which may arise in the execution of an investment program, that is the deviation between programmed projects and executed projects, considering that agents have incentives to execute projects that differ with originally programmed projects.

In this sense, our proposal constitute an application of budget-based schemes to regulate the agents behavior when not follow the investment program proposed by the regulator of water services and sanitation in the Peruvian urban area, according to the theoretical developments and applications of Kirby *et al*. (1991) and Reichelstein (1992).

IV. Analytical framework

4.1 Problem Description

Under the assumption of perfect delegation, the PWU as a municipal enterprise has the goal to maximize the provision of sanitation services subject to its spending capacity and to its budget, approved by the MEF. This institution also approves the additional budget, wages and salaries of the PWU´s workers, although the PWU´s income is obtained from the sale of sanitation services.

In order to maximize this goal, the PWU requests the MEF each year to expand its budget in order to improve the service based on the revenue projections made by SUNASS in its tariff study.

However, while the manager has incentives in not following the OBP because of the private benefits he obtains by the budget allocation of not planned projects, and the inadequate supervision of the budget allocation, the agency problem arises between the regulator and the PWU for the compliance of regulations regarding the investment program of the OBP. In this situation, although the regulator may not observe the manager´s hidden actions (represented by the slack), he knows the distribution function of the minimum expected value when not following the OBP.

In this context, we consider the existence of one portion of the investment that deviates from its schedule in the OBP, given by z, which affects the productivity of factors and therefore the production level of sanitation, by altering the nature or composition of the investment program contained in the OBP. The portion z is separated into: the minimum expected value when the OBP "μ" has not been followed (which is explained by factors beyond the control of the agent) and hidden actions properly α that are deviations with respect to “μ”.

Given this situation, the Principal introduces an incentive scheme (using the budget-based scheme) to reclaim or repay the manager ***G(.)*** whether he reduces the investment portion of the unscheduled OBP under his control α.

For the incentive scheme to be effective, the mechanism should allow the Principal to control the slack (or unscheduled deviated investments that can be controlled), so is possible to establish an appropriate trade-off between the income that the agent is allowed to get through of ***B(.)*** and the reward (or incentives) that is given to induce the agent to improve the quality of the PWU provision as a result of the slack reduction.

With the aim to control the slack, the principal should solve the agency problem by inducing agents to "tell the truth" (*E* = *z*), revealing their type and setting the optimal policy of “hidden actions” as function of the minimum expected value of investment not included in the OBP, considering that the function distribution is known by the Principal. Thus, the parameters of the incentive scheme will be based on the value of optimal policy.

4.2 The model

The proposed model describes the problem faced by the Regulator, when maximizing the sanitation services ***q(.)*** subject to the budget constraint, the incentive-compatibility constraint (***IC***) and the agent participation constraint (***RP***), when the Regulator-Principal incorporates an incentive scheme ***H(.)*** that induces the agent to tell the truth. The Principal provides compensation to the PWU as a whole ***H(.)***, and other compensation to the agent ***G(.)*** from the information reported by the agent.

The model is solved as if the principal decides in a centralized way how many resources ***R*** are allocated and how much deviation ***z*** from the OBP should be allowed to maximize the service, considering that the PWU has a bigger budget and the agent will assign a portion of the resources in unscheduled projects in the OBP (where a portion α could be avoided), to the extent that the private marginal benefit obtained by these actions exceeds the compensation granted by the Principal.

So, the Principal problem is presented by:

$$\underset{R,z(.)}{Max} \quad \int_{\underline{\mu}}^{\overline{\mu}} q(R, z(\mu))n(\mu)d\mu$$

Subject to:

$$\begin{cases} H(.) + pq(.) - wR - G(.) = 0 \\ H(.) = a(E) + b(E) * [E - z(\mu)]; \quad G(.) = \gamma H(.) \\ U(\mu,\mu) \geq U(\tilde{\mu},\mu) \quad IC \quad \forall \mu, \tilde{\mu} \quad \varepsilon [\underline{u}, \bar{u}] \\ U(\mu,\mu) \geq T \quad RP \quad \forall \mu \\ U(\tilde{\mu},\mu) = G(.) + B(z(\tilde{\mu}) - \mu) \end{cases}$$

Where:

q(.): billed volume sanitation services (m3).

R: production factors (capital and labor). This framework no varies on the optimum policy.

Z(μ): proportion of not programmed investment. In a more general specification z is *z*(μ,*e*), where *e* is the effort for the planning improvement.

p: price per billed volume (S/./m3).

w: prices of production factors.

H(.): PWU retribution.

a(E): *target profit (depends on report E by PWU).*

b(E): *cost-share parametre (depend on the E report by the PWU).*

E: *investment proportion report.*

G(.): agent retribution, it is a portion γ of H(.)

U(.): agent welfare (utility) function.

$U(\tilde{\mu},\mu)$: agent welfare when he reports $\tilde{\mu}$ (or *E*) and the true value is μ.

T: minimum value for participation.

B(.): agent private benefit function.

Revenues from the sanitation services and net credit transfers allow the PWU to formulate the budget each year, considering the "current spending" and the "capital spending", which will generate an increase in the demand for capital and labor resources. On the “capital spending planning” the agent decides whether to follow the schedule set in the OBP(OIB/IMB) or not to follow it. While it is true that increasing the amount of investment has a positive impact on production and spending, the variation in the composition of investments, by introducing new projects and by stopping the execution of others would impact negatively on production. So $q_R > 0$, $q_{RR} < 0$; $q_z < 0$, $q_{zz} > 0$.

If the manager does not follow the OBP, it is assumed that allocates "controlled resources" to unscheduled projects in the OBP, and receives a private benefit rate ***B(.)*** as function of the portion of the amount of projects assigned this way "α".

To estimate the "private benefit rate" that one manager would accept for his "hidden actions" we should consider the obtained reward by a representative private agent in the management of projects for the same amount of money, being discounted through the adjustment factor "s_i", a set of capabilities that the public official has failed to gain, net of the risk of hidden actions itself[1]. Thus the total profit for the "hidden actions" is defined as $BP = B(s_{i.}\ \alpha).M.$ It is expected that if "α" increases, ***B(.)*** also increases but at decreasing rates.

In this situation, the Principal implements a scheme of incentives through compensation payments to the agent. This incentive policy determines an optimal deviation level, as a result of the maximization process described above, with the condition that ***a(E)*** is a convex and decreasing function, and that ***b(E) = ´a(E).***

It is assumed for simplicity that the manager's compensation ***G(.),*** is equal to a portion γ of the transfer of resources ***H(.)*** to the PWU, that is, γ***H(.)***. The amount of compensation to the manager not only depends on these variables but also to the magnitude or amount of the transfer, defined by the Principal, who in turn should consider the ability to execute projects in the locality.

Thus, given the allocation of the amount of transfers, the parameter γ will achieve the fit between ***G´(.)*** and ***B´(.)***, in the optimization process of the Principal´s problem that determines the optimal deviation "α" .

By simplifying the model, replacing ***G(.)*** in ***H(.),*** and ***H(.)*** in the budget constraint, the Lagrangian is as follows:

$$L = \int_{\mu}^{\bar{\mu}} q(R, z(\mu)) + \lambda\big[G(.)(1-\gamma)/\gamma + pq\big(R, z(\mu)\big) - wR\big]\eta(\mu)d\mu$$

Since $U(\tilde{\mu}, \mu) = G(\tilde{\mu}) + B(z(\tilde{\mu}) - \mu)$, be $U´(\mu) = -B´(z(\tilde{\mu}) - \mu)$

[1] Shleifer & Vishny (1994), consider the public manager get from politician, as a private benefit, a portion ("α") of the transfer net of unproductive expenditure promoted by politician, paying a fee for participating in this action.

and $\overline{U}(\mu) = \int_{\mu}^{\overline{\mu}} B'(z(t) - t)dt + T$, solving for ***G(.)*** and replacing in the above equation, the Lagrangian takes the following expression:

$$L = \int_{\mu}^{\overline{\mu}} \left\{ q(.) + \lambda \left[pq(.) - wR + \delta \left(\int_{\mu}^{\overline{\mu}} B'(z(t) - t)dt + T - B(z(\tilde{\mu}) - \mu) \right) \right] \right\} n(\mu)d\mu$$

The problem is solved to establish the first order condition for ***z***, from which it determines the value of the slack (the first order condition for *K* and *L*, where *R* is decomposed the results are not affected.) Differentiating the Lagrangian with respect to ***z***, we obtain:

$$q_z\theta - \phi B'(z(\mu) - \mu) + \phi \frac{N(\mu)}{n(\mu)} B''(z(\mu) - \mu) = 0$$

Setting:

$$B(\alpha) = \begin{cases} \left(s_1 * \alpha - s_2 * \dfrac{\alpha^2}{2} \right) & if \quad \alpha \leq \alpha^* \\ (s_1 - s_2 * \alpha^*) * \alpha + s_2 * \dfrac{\alpha^{*2}}{2}) & if \quad \alpha \leq \alpha^* \end{cases}$$

Being: $s_1 - s_2 * \alpha^* > 0$

Replacing ***B'(.)*** and ***B''(.)***, and making algebraic simplifications, the optimal policy function for "*hidden actions*" is as follows:

$$\alpha(\mu) = \begin{cases} 0 & for\; \mu \leq \mu_* \\ \dfrac{s_1 - \Phi q_z}{s_2} + \dfrac{N(\mu)}{n(\mu)} & for\; \mu_* \leq \mu \leq \mu^* \\ \alpha^* & for\; \mu^* \leq \mu \end{cases}$$

where: $\Phi = \theta / \phi$; $\phi = \delta\lambda$; $\theta = 1 + \lambda p$; $\delta = (1 - \gamma) / \gamma$

It is important to note that the "policy function" depends on the distribution function of μ, and their parameters (***p, γ, λ)*** are part of the solution to the first order condition that maximizes the welfare of the agent ***a'= b = B'(α)***[2], through which the expected compensation demanded by the "hidden actions" is established, so that if the deviation increases, the compensation should also increase.

[2] The agent should choose the "*slack*" that allows him to maximize his well-being *U(.) given by B(α) + G(E).* The Principal will induce managers to "tell the truth" through *G(E)= a(μ+α),* given by *z=E*. Under this considerations, the first order condition sets: *b(μ + α) = B´(α),* given by *b(E) = -a´(E),* when function a(.) is convex and decreasing. Where *E = ũ ,* the maximum welfare is given when *U(μ, μ) > U(μ, ũ) = G(ũ)+B(z(ũ)- μ),* where ũ it is his report and μ the true value. So, whatever the value of α chosen by the operator, he will always generate an unbiased estimator, that is *ũ =μ.*.

Finally, the function ***b(.)*** measures the rate of risk assumed by the agent in the contract to achieve the reported value, that is, ***E = x***, since ***E = z***. This function is derived from the equilibrium condition of the agent maximization problem.

$$\underbrace{Max}_{\alpha}\,[G(\mu+\alpha(\mu))+B(\alpha(\mu))]$$

$$a'(\mu+\alpha(\mu))\gamma+B'(\alpha(\mu))$$

$$b(E)=-a'(E)$$

$$b(\mu+\alpha(\mu))\gamma=B'(\alpha(\mu))$$

Replace the function of ***α(μ)*** in ***B´(.)*** yields:

$$b(E)=\begin{cases} s_1 & for\ E_0\le E\le z_1 \\ s_1-s_2\left[\dfrac{E-z_1}{r+2}\right] & for\ z_1\le E\le z_2 \\ s_1-s_2\tau(E) & for\ z_3\le E\le z_4 \\ s_1-s_2\alpha^* & for\ z_4\le E\le \bar{E} \end{cases}$$

In Table 2, we can appreciate the model values.

V. Non- Programmed investment under agent control

Methodologically, the model it is solved with the estimation of the optimal policy function ***α(μ)***, fulfilling with the boundary conditions established in the previous section. Having estimated ***α(μ)*** we obtain the functions ***B(.)*** *y* ***b(.)*** from the agent maximization condition: ***b(E)*** = ***B´(α).*** With the risk ratio estimated ***b(E)*** the matrix compensation payments can be built.

To estimate the portion of the investment that deviates from the OBP programming and that can be controlled by the PWU´s manager; we assign values to the parameters related to the optimal policy function and calibrate the model with the reality, complying with certain boundary conditions. The model can be used to simulate different possible scenarios, relating both to the portion of the investment that deviates from the OBP and that could be avoided, as well as building a menu or a matrix of compensation payments to reduce it.

5.1 Analysis of primary information

Through the application of the "Budget and Expenditure Survey of the PWU", we have collected information that allowed us to parameterize the function of policy ***α(μ)*** and characterize the function of distribution of ***μ***.

The gathered information allowed us to have a good approximation of the levels of deviation between the different types of expenditure incurred and its programming or planning. In respect we can be stated that:

- On average, 47% of the investment portfolio for the regulatory period has changed because some executed projects were not included in the OBP, or because others projects included in the OBP, were not executed.
- The level of implementation of not included projects in the OBP, for the PWU that filled the questionnaire, is approximately 50%, showing a large dispersion among the data.
- The portion of planned projects financed with own resources that have not been executed or it won´t be executed, are relatively less.
- By adding these two variables: projects not included in OBP and amounts of own resources don´t executed (the latter weighted by the share of equity investment with respect to the total investment), we obtain a variable that measures the deviation of resources to other activities not scheduled in the OBP, referring not only to investment but also to current expenditure. We use it as a proxy variable of the deviation of the expenditure with respect to the programmed. Thus, on average, between 40% and 50% of the funds would be used in a non programmed form, either because they were not included in the OBP or because they are not executed.

This reasoning is consistent with the results of the following questions: How much investment could have been executed if problems associated with third parties had not happened? (delays in the bidding process, delays in disbursements for the execution of works, among the main problems), and also with the result of the question: In which measure the investment programmed in the OBP has been used to prepare the Opening Institutional Budget (OIB)?. If the external problems would have not occurred, a 66% of the projects could have been executed, and the 33% not executed will remain under the responsibility of their own PWU. The 56% of the PWU use the OBP for making their OIB opening budget.

From analysis of the OIB and the OBP can be noted:

- The level of investment project execution exceeds the investment programming in the OIB (Opening Institutional Budget), both in regard to own resources as other funding sources. This incidence is greater when it comes to third-party resources that from own resources. The inclusion of new projects is evident.
- The link of the level of execution of investment projects included in the OBP, with the projects execution of the OIB, reveals that the OIB is not linked to the OBP at least a half. By having a larger deviation, we assume that the OIB is used to achieve the financing of the MEF.

- By contrast, the level of investment execution is around 60% regarding to the programmed in the IMB (Institutional modified budget); without consider outsiders this value reaches 78%. This indicates that along with changes in the OIB, many projects have been rejected.
- However, the execution of current expenditure on both the IMB and the OIB is almost 100%, which shows the difficulties in planning investments

5.2 Definition of the variable z

The analysis of data collected through the "Budget and Expenditure Survey of the PWU," establishes that it is necessary to define the variable ***z***, referring to the portion of the investment that has changed with respect to the schedule, which includes executed investment that was not programmed in the OBP or that being a programmed investment was not executed for different reasons.

The value of the variable z is multiple, operationally it will allow to:

a) Have an index that measures the magnitude and the portion of the executed investment that was not programmed in the OBP or that being a programmed investment, was not executed. This could help to implement new regulatory instruments or sanitation policy, such as the criteria for the distribution of the central government transfers, so as to encourage the EPS to improve the planning of their investments.
b) Estimate its impact on the PWU technical efficiency.
c) Construct the matrix of compensation payments which provides compensation for agents if they decrease the value of "z".

5.3 Estimation of the parameter values

The basic information required for model parameterization is given by the distribution function $n(\boldsymbol{\mu})$, the knowledge about the opportunity cost or private benefit function of the manger, and initial values for model parameters: $\boldsymbol{\lambda}$***, p,*** $\boldsymbol{q_z}$,$\boldsymbol{\gamma}$***, M.***

The initial values of these parameters that describe the current situation are shown in the Table 2; however the calibration will consider the behavior of the random variable μ and ranges of possible variation.

As shown in Table 2, it is necessary to indicate that econometric estimates have been made to complete the estimation of model parameters, using as a source of information the "Budget and Expenditure Survey of the PWU" from 2011. Both for the elasticity of the budget (λ) and for the variable that captures the impact of changes in the proportion of investment that deviates from the OBP on production (q_z), two estimations have been made, one through stochastic frontier analysis (SFA), and the other through linear regression for a Cobb-Douglas production function under the following specification: $Q = AL^{\kappa}K^{\nu}(KZ)^{\upsilon}$, considering capital as the relative length network and labor as the number of workers, and including the variable *m*: *KZ* is defined as "*the proportion of investment that deviates from the OBP, multiplied by the capital factor*", the same could be interpreted as a proxy for technical efficiency, so that $\frac{\partial LnQ}{\partial m} = \upsilon$ measures the elasticity of ***m*** factor on production. In this case it is important to consider the variable ***z*** can be included in the model from a proxy variable to represent it as a portion of ***K***. For the analysis of borders environmental variables have also been included, such as PWU size, population density, geographic region, pressure, etc. (using the database of the Chahuara & Lucich, 2011). The negative sign of the estimations show that the increasing of this proportion will affect the PWU´s production. This result is consistent with that obtained by Chahuara & Lucich (2011), about companies that do not follow the OBP are less technically efficient.

Table 2

Range of values of the model parameters

Parameter	Value (UM)	Base Information	Range
λ	Elasticity of billed volume sanitation under budget changes (%)	Econometric estimation taken of the database from the questionnaire: "*Budget an Expenditure of EPS*".	[0.01 - 0.09]
p	Average price of sanitation service (soles / m3)	Direct observation.	[1 - 1.6]
q_z	Incidence of change of the proportion of non programmed investment on the production (sanitation services).	Econometric estimation taken of the database from the questionnaire: "*Budget an Expenditure of EPS*".	[-50,000 - -10,000]
γ	Participation of manager retribution with respect to the total transfer.	Direct observation calibrated with the agent opportunity cost.	[0,001 - 0,01]
M	Private manager income with similar sells.	Direct observation from the agent opportunity cost.	200,000 → 400,000
$\theta, \delta, \phi, \Phi$	$\Phi = \theta / \phi$; $\phi = \delta\lambda$; $\theta = 1 + \lambda p$; $\delta = (1 - \gamma) / \gamma$		

Source: own

Table 3 shows the values of the parameters of the model equations. There are: the policy function $\alpha(\mu)$, the distribution function of μ, the private benefit function $B(\alpha)$ and the estimated risk rate function ***b(E)***. The range of variation of the parameters values are shown in Table 2. In no case, except for the negative sign of "the proportion of unplanned investment on production" q_z, the variation in the value of the parameters shows a significant impact on the results. Thus, the sensitivity of $\alpha(\mu)$ to the variation of γ is minimal (1 to 2 percentage points), and also with respect to the variation of λ. Only when it is very small (0.03 to 0.001), $\alpha(\mu)$ increases by 30%.

Table 3
Model functions

Function	Parameters	**Values**		**Parameters**	**Values**
$B(\alpha)=$ $s_1\alpha - (s_2/2)\alpha^2$ If $\alpha < \alpha^*$	$v_1 = s_1$	0.85			
$(s_1 - s_2\alpha^*)\alpha + (s_2/2)\alpha^{*2}$ If $\alpha > \alpha^*$	$v_2 = s_1 - s_2\alpha^*$	0.02			
condition: $v_2 < b < v_1$	s_2	0.03		**y**	61.484
$h(\mu)=$ $[1/(r+1)](\mu - \underline{\mu})$ If $\mu \leq m$	C	0,002		$\underline{\mu}$	5
$[1/(r+1)]\{2[(m-\underline{\mu})^{r+1}/(\bar{\mu}-\mu)^r]-(\bar{\mu}-\mu)\}$ If $\mu > m$	r	0,5		$\bar{\mu}$	100
condition: $\underline{\mu} < \mu < \bar{\mu}$ where $h(\mu)=N(\mu)/n(\mu)$	m	52.5		α^*	25
$\alpha(\mu)=$ 0 If $\mu \leq \mu_*$	M	360,000		μ_*	12
$(s_1M - q_z\Phi)/s_2M + h(\mu)$ If $\mu_* \leq \mu \leq \mu^*$	q_z	15,000		μ^*	54
α^* If $\mu^* \leq \mu$	λ	0.03		δ	-99
	p	1.00		ϕ	-2.97
where $\mu^* = \underline{\mu}+(r+1)[(1-s_1)/s_2]$;	γ	0.01		θ	1.03
$b(E)=$ s_1 For $E_0 \leq E \leq z_1$	$b(E_0<E<z_1)$	0.85		Φ	-0.35
$s_1 - s_2[(E-z_1)/(r+2)]$ For $z_1 \leq E \leq z_2$	$b(z_1<E<z_2)$	0.40		z_1	12
$s_1 - s_2\tau(E)$ For $z_2 \leq E \leq z_3$	$b(z_2<E<z_3)$	0.21		z_2	80
$s_1 - s_2\alpha^*$ For $z_3 \leq E \leq \bar{E}$	$b(z_3<E<\bar{E})$	0.02		z_3	86
	$\tau(z_3)=\alpha^*$	25		$\tau(z_2)$	27

Where: $z_1 = \underline{\mu} + (r+1)[(1-s_1)/s_2]$; $z_2 = m+(m-z_1)/(r+1)$; $z_3 = y + \alpha^*$; $\tau(z_2)=(z_2-z_1)/(r+2)$; $\tau(z_3) = \alpha^*$;

y is solved numerically knowing the value of α^* *for* $\alpha^* = [1/(r+1)]\{2[(\bar{\mu}-m)^{r+1}/(\bar{\mu}-y)^r]-(\bar{\mu}-y)-(z1-u)\}$

$\boldsymbol{\mu^*}$ is solved numerically knowing the value of α^* *for* $\alpha^* = [1/(r+1)]\{2[(m-\underline{\mu})^{r+1}/(\bar{\mu}-\mu^*)^r]-(\bar{\mu}-\mu^*)-(\mu_*-\underline{\mu})\}$

Source: own

Regarding the implication of the negative sign of the relationship established between production and "the portion of the investment that deviates from the OBP", it is necessary to indicate that this deviation will have an amplifying effect on the "optimal slack", since the deviation not only distracts the manager´s attention for private gain but also generates a negative impact on production. The Principal should further increase the agent's participation rate (*γ)* to increase production and encourage the agent to reduce the "slack" (*b=B´*); the "slack "generates less production and more incentives for further increase[3].

We should point out that when simulating a situation without incentives or without the compensatory payoff matrix, we assume a value for γ close to zero.

If the sanitation policy establishes that transfers are not granted, the PWU have to generate their own resources to incentive or compensate their managers, meaning that δ = 1, the slack will tend to zero (significantly reduced because the amplifying effect is lost in the numerator)

The model estimations are robusts in terms of changes in the value of the parameters, not affecting the results in the range of variability, which is economically feasible, except for the change on the sign of the impact of ***z*** on the production levels.

5.4 Expected value of hidden actions

With the parameterized model and the knowledge of the distribution function of $\boldsymbol{\mu}$, we estimate the expected value of the investment amount that deviates from the OBP as a result of the hidden actions of the managers $E[\alpha(\mu)]$, and we build a compensation payments menu with the intention to propose the agents to reduce this deviation or "*slack*".

The estimate of "*slack*" reveals the amount of executed investment that was not programmed in the OBP or that being a programmed investment was not executed. This investment can be avoided with an adequate planning and a system of incentives or retributions.

To estimate the mean value of the *slack*, we define the distribution function of $\boldsymbol{\mu}$***;*** and then, assuming certain distribution functions for $\boldsymbol{\mu}$ "we simulate the model" that predicts the mean of the portion of executed investment that was not programmed in the OBP or that being a programmed investment was not executed.

Whereas the investment information, obtained through the questionnaire "*Budget and Expenditure of PWU" is referring to the "total executed investment*

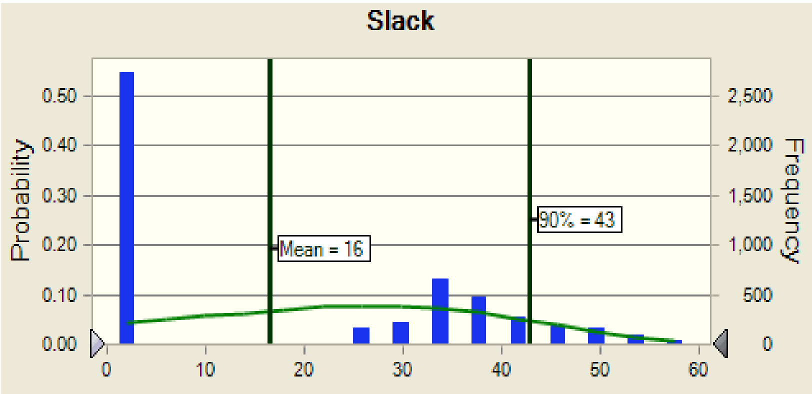
[3] A more slack due to less effort generates greater diversion of investment and lower production. But extending the model including the factor $\boldsymbol{q_z z_e}$ does not change the results obtained in this study.

that was not programmed in the OBP or that being a programmed investment was not executed", and not to its minimum level that it is inevitable; we have agreed to estimate the values and distribution function of "μ" from only matching values between the ***"z-values observed***" and the ***"z-values estimated***" as a result to estimate the value of "*slack*" for different values of μ.

The distribution function of μ is exponential with mean of 13.84 which is about half the mean value obtained with ***z***, which is the mean value of the unscheduled investment from the OBP or not executed programmed investment[4].

According to the result of simulation, the expected value of the "*slack*" for all PWU is 16.5%. This means that it is expected that the percentage of unplanned investment in the OBP (the average deviation of investment with respect to the OBP) by controllable causes by the PWU is 16%. Graph 2 shows that 90% of the time the deviation is less than 43%, with 30% of the time under 8%, and 40% under 15%, which makes that the average of 16.5 % is not far from the central value.

Graph 2
***Slack* distribution**



Source: own

However, it is important to note that by obtaining a coefficient of variation of 1.46, we have proposed another function distribution for "μ" for PWU with "**z** values" above 7%, and then also other expected value of the "slack".

The results show some important changes that might suggest us to work with two menus of contracts. This would let us differentiate the PWU by type, giving

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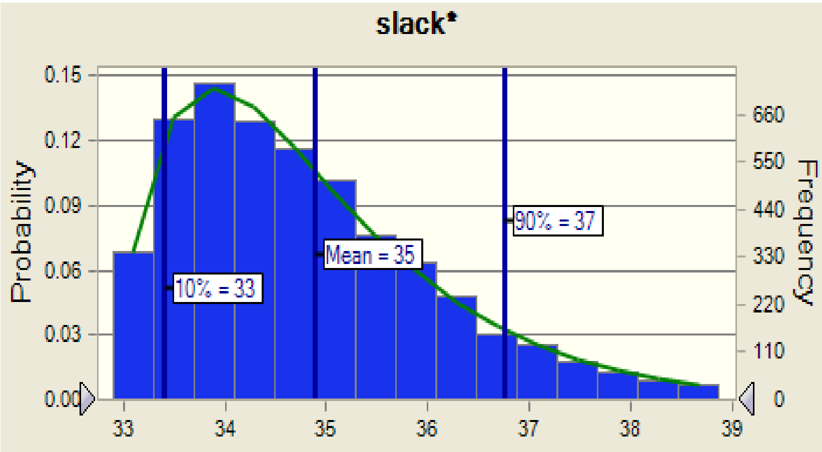
[4] The fact that the collected data let us to fit the values of z and μ to an exponential distribution implies that the probability that the expected value of "*slack*" (as a result of the model) is less than the arithmetic average is high. Thus although the arithmetic average of μ is 13.8% (and the "slack" is 20%), the expected value of $\alpha(\mu)$ for all of the EPS is 16%.

them incentives to compete, especially considering that many PWU may have underestimated the data recorded in the survey.

Considering PWU with ***z-values*** reported above 7%, with an adjusted average of 40% (which has been adjusted to achieve the minimum amount of data for modeling with values of the sample itself), the estimation of the expected value of "*slack*" is at 35%. This means that for a segment of the PWU, the percentage of unplanned investment in the OBP that can be controlled by their managers is 35%. It is important to note here that the distribution function for μ in this segment of PWU changes, going from exponential to a gamma distribution, that is closer to normal. This situation shows that for this group of PWU, the portion of the deviation is more focused and likely to show a pattern of behavior that should be studied if the schemes differ.

Graph 3
Slack* **distribution**



Source: own

VI. Constructing the matrix compensation

The matrix compensation payments can achieve the following objectives:

a) Determine the value of the compensatory payment required to reduce the slack in different amounts, and
b) Disclose from the PWU information regarding their "type" (in relation with their ability to management planning, political capture and risk taking) and regarding the percentage of unplanned investment that the PWU can control or reduce. We can reach this result, either by choosing some combination from the menu or even not choosing any. In this regard it is important to ask the question in two stages. "The answer" or inclusive the "no answer" generates information regarding the characteristics of the management of the PWU, enabling differentiated regulatory policy measures.

The compensatory payoff matrix shown in Table 4 has been constructed taking the following parameters values: cost-share b_i and rank of the reported-information E, which have been collected from the parameterized model presented in the previous section.

Based on these values the matrix has been completed using the following equation $a(E_{t-1})=a(E_t)+½[b(E_{t-1})+b(E_t)]*[E_t-E_{t-1}]$ proposed by Reichelstein (1992) allowing to satisfy the condition $b(E)=-a´(E)$, and the following assumptions about the main diagonal: the first component is "*a(E)* maximum" which is the maximum compensation, the remaining components of the diagonal were calculated by extrapolating the implementation of the "rate of return" *b(E)* as the value of risk (Coughlan & Gates, 2009) (see Table 4). The final component is zero, and we have assumed 100 000 *nuevos soles* as the maximum value of *a(.)*.

Table 4:
Matrix of compensation payments (in thousands of *nuevos soles*)

Inves.Dev. Estimated	Investment deviation observed (%)				Cost Share b (%)
E	**11**	**79**	**86**	**90**	**b**
11	100	44	-20	-47	**85**
79	58	47	-18	-45	**40**
86	55	45	25	-2	**21**
90	55	44	24	0	**2**

Source: own

The compensation payment is calculated as follows. Suppose the PWU is committed to deviate in 86% and actually obtains a deviation of 79%, then receives a payment of 45 + 0.21 (86-79) = 46.5 thousand *nuevos soles*.

The flexibility of the matrix also allows the following: ***a)*** the choice of the expected value of the deviation ***z*****,** that the PWU are committed to achieve ***b)*** the estimation of the reduction of the expected value of the deviation ***z*** based on the estimation of the slack and the expected benefit, ***c)*** the re-calculation of the expected benefit ***a(.)***, as a result of a better calibration after an election by the agents, ***d)*** the re-calculation of the maximum value ***a(.)***, considering information regarding to the disposition of EPS managers to take risk, and finally ***e)*** the breakdown of the ranges given the characteristics of the process choice and the function distribution of the variable μ, other than those that have been treated by the **r-symmetric** value. For the present case, when μ has exponential distribution, it is required an adaptation of the implicit distribution function from the theoretical model which assumed **r-symmetric**, and therefore of the ranges so that the values are contained in the particular election process.

From the basic matrix, the augmented matrix is generated considering more value for ***E*** and ***x*** (see Table 5). To determine the amount of money corresponding to the slack reduction, we focus on (***E, x***) = (25, 25) with a current compensation of 44 thousand *nuevos soles* (actual manager remuneration) and so we subtract 16.5% that corresponds to the slack or expected value of hidden actions calculated in the section 5.4, earning a compensation corresponding to 100 thousand *nuevos soles*. This means that if the compensation is 100 thousand *nuevos soles,* managers undertake to reduce the deviation of the investment made with respect to its programming (that is ***z***), up to 11%.

Table 5
Matrix of compensation payments (in thousands of *nuevos soles*)

Invest.Dev. Estimated	Investment deviation observed (%)								Cost Share b (%)
E	**11**	**25**	**40**	**55**	**65**	**79**	**86**	**90**	**b**
11	100	41	27	14	(2)	(17)	(35)	(50)	**85**
25	89	44	30	16	-	(15)	(32)	(47)	**75**
40	78	33	41	27	11	(3)	(21)	(36)	**70**
55	68	23	31	38	22	7	(10)	(25)	**65**
65	62	17	25	32	32	18	0	(15)	**55**
79	55	10	18	26	26	24	6	(9)	**40**
86	53	8	16	23	24	21	12	(2)	**21**
90	53	8	16	23	23	21	12	0	**2**

Source: own

The main limitation in the design of the matrix of compensation payments is the maximum value estimated ***a(.)****MAX*. However, this value is associated to the opportunity cost faced by managers when deciding on the execution of investments, either by political pressure or by the execution of works related to interest groups. In this sense, any amount paid as compensation above their current pay is necessary; however, for purposes of implementation, this must be bounded.

A practical solution that could be implemented before using the matrix of compensation payments is to estimate the willingness to accept a compensation (WTA), asking managers (through the construction of a hypothetical scenario) about how much money they would be “willing to accept as bonus for reduce the slack", in order to reveal the behavior that the managers would have on whether or not to reduce the portion of "controlled investment" that deviated from OBP, which would allow to estimate the amount of money by which managers should be willing to reduce the portion of "controlled investment" that deviate from OBP. The optimal mechanism is one that achieves to pay at least the private benefit.

VII. Conclusions

The present work using the "*Budget-based scheme*" approach developed by Kirby et.al (1991) and Reichelstein (1992), establishes the optimal policy function to control the "*hidden actions*" of managers from Public Water Utilities

(PWU), regarding execution of investments deviated from the Optimized Business Plan (OBP), by regulating the “*trade off*” between reducing information rents and providing more incentives, so as to induce managers to reduce the slack or the executed investment not programmed in the OBP or that being a programmed investment, it was not executed, but under their control.

A necessary condition for the existence of the optimal policy function is that the execution of investments that deviate from the OBP*,* includes not only the portion of executed investment not programmed in the OBP but also the portion of the programmed investment that was not executed, so that the policy not only prevents the admission of other projects but also improves the use and planning of internally generated resources already committed.

The analysis of information collected through the "Budget and expenditure survey of the PWU" applied to the PWU, reveals that there is a high percentage of investment (47%) that deviates from its schedule in the OBP, however, most of the PWU reported that this was due to uncontrolled situations for them.

Using the optimal policy function to control the "*hidden actions*", we have estimated in 16.5% the expected value of the "portion of the executed investment not programmed in the OBP or not executed programmed investment" which is controlled by the manager of the PWU and that can be reduced from the total investment portion that deviates from the OBP. Nevertheless, considering only enterprises that report z-values above of 7%, the estimation of expected value of slack (or portion of the executed investment that deviate from OBP) that managers can reduce, is 35%.

The menu of compensation payments designed to reduce the effects of "hidden actions", and constructed from the estimated values of the parameters of the policy function, establishes the conditions to reduce the estimated investment portion that deviates from the OBP which is under the agent’s control. After estimating the opportunity cost faced by the manager to follow the OBP, is feasible to reduce by 16.5 percentage points the total investment portion that deviates from the OBP. The compensation payment must be at least the double in regards to current remuneration, considering the current salaries of the managers of the PWU.

Whereas the reduction of the portion of executed investment that deviate from the OBP in 16.5% could generate at least 100 000 nuevos soles of annual increase in production that is equivalent to retribution required by managers for reach this reduction, then the compensation payment scheme is efficient.

If there are other non-monetary factors that may be present in the private benefit function, especially those identified by Shleifer & Vishny (1994) in their work *Politicians and firms*, it is recommended to adjust the expected benefit of the matrix according to a contingent valuation study on hidden actions before implementing the menu of compensatory payments.

The used methodology allows us, from the observed data collected, to achieve the best prediction about the probability distribution of what we actually can control and reduce in regards to the total investment portion that deviates from the OBP, and build an array of compensation payments that can respond to these behaviors and features.

Also, the methodology allows the agents to choose the parameters of the menu on which they will be evaluated (considering that they have more information), and also induces them to reveal their "type", not only in relation to their planning capacity (higher or lower) but also in relation to risk taking.

Beyond the numerical results obtained, the work reaches to the application of a methodology that improves the planning investment of the PWU, which can be used in the design of sectoral and regulatory policy instruments. For example, the methodology could be useful to approve the investment budget, authorize the use of funds for investment or allocate the sectoral transfers among the set of the PWU that demonstrate greater compliance.

Although this study could sophisticate their estimates even more, we consider the standardization of the criteria for constructing the matrix of compensation payments more relevant, in order that agents can make an efficient election from the incentives menu and avoid claims or strategic behaviors when they set the contract, especially when this model is used to estimate the willingness to accept compensation to reduce the diversion of investments with respect to the OBP.

Finally, although through the use of the presented methodology we can identify and quantify the impact of hidden actions, and even analyze their effect on the production levels, what we should know and what is actually relevant for future research is the efficiency of this tool. Therefore we should know if the implementation cost may be covered with the improvement in the quality of provision.

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