Regulating with market information

Francisco Contreras Bustos\textsuperscript{1} and Rafael Costa Lima\textsuperscript{1}

\textsuperscript{1}Department of Economics, Universidade Federal de Pernambuco, Brazil

March 15, 2019

Abstract
Governments often provide goods and services by hiring private firms which operate in a market. Yet, traditional theory of regulation treats the regulated firm as if it served exclusively the regulator. In reality, the regulated firm usually operates in a market. This market operation may provide information for the regulator. In this paper we study how the regulator can use market information to save the information rents and reduce allocative distortions. We use the model to discuss a voucher program to undergraduate education in Brazil.

\textbf{Keywords}: Regulation, Asymmetric information, Cost of public funds, Federal financial aids, Tax waiver, Private higher education institutions.
\textbf{JEL}: L43, L51, G38.

1 Introduction
Regulation theory models frequently view the problem of regulating a firm as one plagued with information asymmetries. The regulator wishes to execute a project, or have goods produced, but does not know the firm’s production cost. The solution consists of incentive compatible contracts, that induce the firm to reveal her cost through her choices. The optimal solution is not efficient. Distortions arise when compared to situations without information asymmetries.

This approach implicitly assumes that the regulator does have another channel to learn the firm’s cost. That should be the case when the project (or good) is tailor made for the regulator. Or when there’s no competing firm on the market. When such firms exist, the regulator benefits from using information from the competing firm’s contract on the contract, on what is called yardstick competition [Shleifer 1985].

For some classes of goods and services, however, the regulated firm already services some consumers on the market. For example, in Brazil, the government contracts private higher education institutions to offer free undergraduate education for poor students. The program is called PROUNI (which should stand for the translation of “University for all”). Not all students are eligible for the government scholarship, so there is a market demand for these institutions. As result, the same firm serves consumers in the market while contracting a basically identical service with the government. The firm’s market operation provides the regulator with additional information about the firm’s costs, since it can be easily tracked (by
tax records, for example). But should the regulator use this information? If so, how exactly? In this paper we wish to provide a first take on these questions.

We develop a model where a monopolist already operates in the market and is hired by regulator to provide the same service offered in the market. Assuming two firm efficiency cases to represent the asymmetry of information, a linear cost function in the amount of service offered and private and social demands known by the regulator and the firm, the paper extends the standard regulatory models by including the monopolist’s own profit in the market within the incentive compatibility constraints, having an additional tool to induce the firm to choose the contract designed for her. Comparing our results with those of the standard models, we show that market information has an impact on fiscal savings through the reduction of informational rents by improving the government’s bargaining power, achieving an optimal regulatory policy that improves the consumer net surplus. In addition, comparing with the case without regulation we obtain the same results of improvement in allocation efficiency as the models that do not incorporate market information.

As a theoretical application of our model, we will analyze the Brazilian government program PROUNI mentioned above.

### 1.1 Related literature

The paper is related to two lines of research. The first one studies how to regulate a monopolist under different assumptions of uncertainty. The second line of research is related to our theoretical application to the PROUNI and studies the role of grants and subsidized loans in determining the price of postsecondary education.

Asymmetry in regulation has already been studied. Baron and Myerson [1982] study how to regulate a monopolistic firm when the regulator doesn’t know the costs. Their optimal price regulatory policy is induced to be above marginal cost for all cost realizations other than the lowest. These higher cost realizations help reduce the firm’s incentive to exaggerate costs by reducing inefficiently production levels and then decreasing firm’s cost advantage. Our results are in line with theirs, by imposing inefficiency in the output of the firm with the highest cost in order to reduce the informational rent of the most efficient.

Laffont and Tirole [1986] incorporate moral hazard in their model, unlike ours where we only assume adverse selection. Contrary to the case of cost unobservability, they find an effort distortion for a given output that is more than offset from a welfare point of view by the lower price distortion, demonstrating the trade-off between inducing revelation and inducing effort (they have a partial sharing of cost). Our approach adds market information in the analysis, therefore we are not worried about inducing effort by not incorporating moral hazard, but we do have similar results by distorting the output of the less efficient firm.

Lewis and Sappington [1988] analyze the case when the regulator is imperfectly informed about both the firm’s cost and demand functions. As the results from the last models, the optimal regulated price will be higher, the higher are the firm’s costs and the greater is demand, and this distorts efficient production level to reduce the firm’s rents. For the smallest demand and cost realization, the output will be supplied at the efficient level. But the firm can exaggerate costs and understate demand at the same time. In this case, the regulator may find optimal to set a price below realized marginal cost. In our model we will assume that the government perfectly knows the demand for the service, therefore we will not have to worry about cases where prices have to be set below the marginal cost.
In general, our results will be in accordance with the literature, having the standard trade-off between allocative efficiency and informational rent extraction. But our model in comparison with the standard models of regulation will also have a greater economic efficiency for the government and greater welfare for the students benefited with the scholarships.

Our paper is also connected with the literature that studies the Bennett hypothesis, name given by William Bennett’s article that raised that federal loans gives “cover” for colleges to raise their prices \cite{Bennett1987}. The results are different. Using data between 1978 and 1985 from the Department of Education’s Integrated Postsecondary Education Data System (IPEDS), \cite{McPherson1991} found that increases in government aid are accompanied by increases in institutional grants in private universities, but with an increase at public universities’ tuition. With a panel from 1989 to 1996, \cite{Singeli2007} find little evidence of Bennett’s hypothesis for state tuition for public universities. However, for private universities, increases in Pell grants seem to be matched almost one-by-one by increases in tuition. \cite{Rizzo2004} find evidence in in-state but not in out-of-state tuition, using a restricted sample of 91 public flagship state universities between 1979 and 1998. \cite{Turner2014} using a combined regression discontinuity/regression kink approach finds that the impact of Pell grant program comes from a change on institutional aid to capture the federal aid. \cite{Cellini2014} using data from the states of Florida, Michigan and Wisconsin, they find that institutions that are chosen by Title IV charge tuition for sub-baccalaureate (mainly certificate) programs that is about 78% higher than that charged by comparable programs in nonparticipating institutions, lending some credence to the Bennett hypothesis of federal aid capture.

Regarding subsidized loans, \cite{Lucca2018} with a difference-in-differences design find that institutions in the US that were more exposed to student credit expansion experienced disproportionate tuition increases. For Brazil, \cite{Duarte2016} with difference-in-differences approach tested the greater availability of loans for the reduction of the interest rate of the Student Financing Fund (FIES, for Fundo de Financiamento Estudantil), finding an increase in tuition. Also, with a structural demand model, they find that relaxing the credit restriction reduces the price elasticity of demand, concluding that in part the mechanism that explains the increase in tuition in Brazil is the increase in insensitivity about prices. All this evidence helps to justify why to regulate the costs of universities and their relationship with government aid to students. Also based on this evidence we will take Bennett hypothesis as true, without testing it on the model.

The paper proceeds as follows. In Section 2 we present the model, the situation under complete information and the no discrimination scenario. Section 3 shows the standard regulation model and our extension with the market information. Section 4 analyzes the optimal policy and the PROUNI. Section 5 concludes.

## 2 The model

Consider the standard framework presented in \cite{Laffont1993, Laffont2002} or \cite{Baron1982}. There is a monopolist in the private higher education market. For simplicity, we only assume two possible cases, where the monopolist can be efficient or inefficient in their marginal costs, denoted by $\underline{c}$ and $\overline{c}$ respectively, with $\underline{c} < \overline{c}$. The government (or regulator) hires the monopolist to provide higher education to people with low
income, but he (the government) can’t identify the type of the monopolist (if he is efficient or inefficient).

To keep the problem mathematically tractable, we shall assume that the firm’s cost is linear in $q^s$ of the form:

$$C^s = cq^s + \alpha$$

(1)

where $c \in \{c, \overline{c}\}$ is the constant marginal cost that is unknown to the regulator. $q^s \in \{q^s, \overline{q^s}\}$ is the number of scholarship students that the monopolist has in his institution and $\alpha$ is the fixed cost that we will assume the same for the two types and known by the regulator. Hereafter in all the expressions, the superscript $s$ will denote scholarship students or $ns$ for non-scholarship students and the subscript will denote $p$ for private or $s$ for social.

The marginal and total costs are reported by the firm to the regulator, and the costs are reimbursed by the government. To accept the relationship with the government, the firm must be compensated by a transfer $t \in \{t, \overline{t}\}$ that pays the total cost. Then, the utility of the firm by the scholarship students is:

$$U^s = t - (cq^s + \alpha)$$

(2)

To participate in the contract, it must be fulfilled that the monopoly utility must be greater than his reservation utility, which we will assume equal to zero.

By the demand side, we will assume that exist a private demand for education by low-income students $q^s_p$ and a social demand that will be greater than the private demand by the externalities, given by a parameter $\gamma$ in the social demand $q^s_s$. Also, we have a demand for private education from non-scholarship students $q^{ns}_p$ having the same slope that the other two demands. All the demands will be known to both the regulator and the firm.

$$q^s_p = a - bp$$

(3)

$$q^s_s = a + \gamma - bp$$

(4)

$$q^{ns}_p = a' - bp$$

(5)

Here $a$, $a'$, $\gamma$ and $b$ are positive known constants with $a' > a$. $p$ is the college tuition paid by students. We must also impose that $q^s_p \geq 0$, $q^s_s \geq 0$ and $q^{ns}_p \geq 0$.

Therefore, the gross private and social surplus of scholarship students are:

$$S^s_p = A - \frac{1}{2} \frac{(a - q^s)^2}{b} + m$$

(6)

$$S^s_s = A - \frac{1}{2} \frac{(a + \gamma - q^s)^2}{b} + R$$

(7)

where $A$, $m$ and $R$ are positive constants indicating some preference for other things that are not studies and preferences for money.

### 2.1 Complete information

This section gives the first-best of the regulatory policy, that will be one of our benchmarks. The second one is the standard regulation approach that will be presented in subsection 3.1.

Let $\lambda > 0$ be the shadow cost of public funds. Under complete information the regulator maximizes the net surplus of scholarship students added to the firm’s profit in the scholarship
students segment which is \( U^s = 0 \) because the participation constraint is binding, so that:

\[
A = \frac{1}{2} \frac{(a + \gamma - q^s)^2}{b} + R - (1 + \lambda)(cq^s + \alpha) \tag{8}
\]

We are concerned only with the welfare of low-income students because there is already a non-scholarship sector that ensures the functioning of the market and the monopolist’s profit. Therefore we do not include the firm’s utility in the analysis of the optimal regulation policy.

From the first-order conditions with respect to \( q^s \), we get the optimal level of scholarship students for the regulator, then the transfer to the private higher education institution and the net surplus:

\[
q^s_* = a + \gamma - (1 + \lambda)bc \tag{9}
\]

\[
t^* = c[a + \gamma - (1 + \lambda)bc] + \alpha \tag{10}
\]

\[
S^s_* = A - \frac{1}{2b} [(1 + \lambda)bc]^2 + R - (1 + \lambda) [cq^s(c) + \alpha] \tag{11}
\]

If the monopolist does not accept the contract with the government, he will just attend the demand of non-scholarship students, with the typical monopolist’s problem presented in appendix A.1.

### 2.2 No discrimination

This subsection illustrates the situation where the monopolist cannot discriminate and the government believes in the declared information. The government asks the service or good price to the monopolist \( \tilde{p} \), and given this, the regulator does his maximization problem with the transfer \( t = \tilde{p}q^s + \alpha \):

\[
\max_{q^s} A = \frac{1}{2} \frac{(a + \gamma - q^s)^2}{b} + R - (1 + \lambda)(\tilde{p}q^s + \alpha)
\]

The solution of this program is:

\[
\frac{a + \gamma - q^s}{b} - (1 + \lambda)\tilde{p} = 0 \implies q^s(\tilde{p}) = a + \gamma - (1 + \lambda)b\tilde{p} \tag{12}
\]

But the monopolist is not naive. After the maximization of government, the monopolist behaves as a Stackelberg leader, having a case of third-degree price discrimination:

\[
\max_{\tilde{p}} (a' - b\tilde{p})(\tilde{p} - c) + [a + \gamma - (1 + \lambda)b\tilde{p}][\tilde{p} - c]
\]

This problem yields:

\[
\tilde{p} = \frac{a' + a + \gamma}{2(2 + \lambda)b} + \frac{c}{2} \tag{13}
\]

\[
\tilde{q}^s = \frac{(3 + \lambda)(a + \gamma) - (1 + \lambda)[a' + (2 + \lambda)bc]}{2(2 + \lambda)} \tag{14}
\]

\[
\tilde{t} = \tilde{p}[a + \gamma - (1 + \lambda)b\tilde{p}] + \alpha \tag{15}
\]

Under monopoly and considering the social demand, the firm can charge the price \( p^M_s = \frac{a + \gamma + bc}{2b} \). From this last result together with \( p^M = \frac{a' + bc}{2b} \) we can conclude that \( \frac{a' + a + \gamma}{2b} > c \).
which would also help to find that $\tilde{p} > c$ if the externality is large enough. As we will see next, $\gamma$ has to respect certain conditions.

The condition for $\tilde{p} > p^M$ is:

$$\implies \gamma > (1 + \lambda)a' - a \quad (16)$$

which shows the situation when the government pays more than the price the monopolist charges in the market. Implicitly this condition implies that there is a social benefit for the service that is above the private benefit, allowing the firm to charge a higher price.

By the monopoly side, his utility will be greater than zero if $U^s > 0$, implying that:

$$\implies \gamma > \frac{(1 + \lambda)}{(3 + \lambda)} [a' + 3(2 + \lambda)bc] - a \quad (17)$$

which is the condition for the monopolist to earn profits in the scholarship segment.

For the condition that the number of scholarship students ($q(\tilde{p})$ and $q(c)$) are greater than zero, we obtain:

$$\implies \gamma > \frac{(1 + \lambda)}{(7 + 3\lambda)} [a' + 3(2 + \lambda)bc] - a \quad (18)$$

As we can see from (16), (17) and (18), the constraint (16) requires a larger $\gamma$. Then having a price higher than the monopoly price will generate a positive utility for the monopolist (so an additional cost to the government given that under complete information the regulator does not leave utility to the firm) and a positive amount of scholarship students.

Finally, the net surplus is:

$$S^*_s = A - \frac{1}{2b}[(1 + \lambda)b\tilde{p}]^2 + R - (1 + \lambda) [\tilde{p}(a + \gamma - (1 + \lambda)b\tilde{p}) + \alpha] \quad (19)$$

3 Regulating with the market information

We first analyze the standard case of regulation. Then, we will compare this results with our contribution to the literature, where we are going to use the market information from the same monopolist to regulate him.

3.1 Regulating without market information

For simplicity, we assume that the marginal cost can take two possible values, $c$ and $\bar{c}$, with $c < \bar{c}$. The regulator only knows that with probability $v$ the monopolist is efficient. Following Laffont and Tirole [1993], the regulator will offer two contracts $\{(q, l), (\bar{q}, \bar{l})\}$, conditional on the monopolist’s type. According to the revelation principle, the contract must be a restricted regulation policy that requires the firm reports her marginal cost and not incentivize the firm to lie.
Thus, the problem of the government is:

\[
\max_{t, q} E \left[ S^*_s(q^t) - (1 + \lambda) t_i + t_i - (c_i q_i + \alpha) \right]
\]

s.t. \( t - (c q + \alpha) \geq \overline{t} - (c \overline{q} + \alpha) \)
\( \overline{t} - (c \overline{q} + \alpha) \geq \overline{t} - (c \overline{q} + \alpha) \)
\( t - (c q + \alpha) \geq 0 \)
\( \overline{t} - (c \overline{q} + \alpha) \geq 0 \)

where the first two constraints are those of incentive compatibility (IC) and the last two are the participation constraints (PC). As always in the literature, the type that wants to lie is going to have her IC binding and the other type her PC binding\(^1\). Therefore, the regulator problem will be as follows:

\[
\max_{t, q} E \left[ S^b_s(q^b) - (1 + \lambda) t + t - (c q + \alpha) \right]
\]

s.t. \( t = c q + \alpha + \eta(\overline{r} - \underline{r}) \)
\( \overline{t} = c \overline{q} + \alpha \)

where the third term on the right side of the transfer for the efficient type corresponds to her informational rent, which is a function of the number of scholarship students that the inefficient institution has.

From the first-order condition of the last problem together with with the truthful revelation we obtain:

\[
q = a + \gamma - (1 + \lambda) b c
\]  \(20\)
\[
\overline{q} = a + \gamma - (1 + \lambda) b c - \frac{v}{1 - v} b (\overline{r} - \underline{r})
\]  \(21\)

Thus the transfers for every contract according to the cost reported by the monopolist are:

\[
\underline{t} = c q + \alpha + (\overline{r} - \underline{r}) \overline{q}
\]  \(22\)
\[
\overline{t} = c \overline{q} + \alpha
\]  \(23\)

As we can see comparing the number of scholarship students under complete information \[9\] with the case if the monopolist is efficient \[20\], there isn’t a difference. But in order to reduce the informational rent of the efficient type in \[22\], the regulator will have to reduce the number of scholarship students \[21\] that the inefficient monopolist have under asymmetric information. Besides, we can perceive that \( \underline{t} < t^* < \overline{t} \).

Then, the net surplus is:

\[
E(S^*_s) = A - \frac{1}{2 b} \left\{ v [(1 + \lambda) b c]^2 + (1 - v) \left[ (1 + \lambda) b \overline{r} + \lambda \frac{v}{1 - v} b (\overline{r} - \underline{r}) \right]^2 \right\} + R
\]

\[
- (1 + \lambda) \left\{ v [c \overline{q} + \overline{q} (\overline{r} - \underline{r})] + (1 - v) c \overline{q} + \alpha \right\}
\]  \(24\)

\(^1\)Demonstrated in appendix A.2.
3.2 Regulating with market information

The environment is like in subsection 3.1 but now we will make use of the market information about the same monopolist, from the non-scholarship segment he serves. For this, we look at the monopolist’s profit without the relationship with the government, and we condition it to his type to include it in the IC constraints. In this way the constraints are:

\[
\begin{align*}
    t - (cq + \alpha) + \pi^M &\geq t - (cq + \alpha) + \tilde{\pi}^M \\
    \bar{t} - (c\bar{q} + \alpha) + \pi^M &\geq \bar{t} - (c\bar{q} + \alpha) + \tilde{\pi}^M \\
    \underline{t} - (cq + \alpha) + \tilde{\pi}^M &\geq 0 \\
    \bar{t} - (c\bar{q} + \alpha) + \pi^M &\geq 0
\end{align*}
\]

where \(\tilde{\pi}^M\) and \(\tilde{\pi}^M\) are the monopolist’s profit if he chooses the higher contract or the lower when he is efficient and inefficient respectively. Both expressions are smaller than if he spoke the truth, having no incentive to lie. This is, \(\pi^M > \tilde{\pi}^M\) and \(\pi^M > \tilde{\pi}^M\).

The regulator’s optimization problem is:

\[
\begin{align*}
    \max_{t, \bar{t}, \underline{t}} & E \left[ S_b(q^b) - (1 + \lambda)t + t - (cq + \alpha) \right] \\
    \text{s.a.} & \quad t - (cq + \alpha) + \pi^M \geq t - (cq + \alpha) + \tilde{\pi}^M \\
                 & \quad \bar{t} - (c\bar{q} + \alpha) + \pi^M \geq \bar{t} - (c\bar{q} + \alpha) + \tilde{\pi}^M \\
                 & \quad \underline{t} - (cq + \alpha) + \tilde{\pi}^M \geq 0 \\
                 & \quad \bar{t} - (c\bar{q} + \alpha) + \pi^M \geq 0
\end{align*}
\]

As in the last subsection, the IC of the efficient type and the PC of the inefficient type are binding at the optimum\(^3\). In this way after the first-order condition, we get the optimal contract:

\[
\begin{align*}
    \underline{q} &= a + \gamma - (1 + \lambda)b\bar{c} \quad (25) \\
    \bar{q} &= a + \gamma - (1 + \lambda)b\bar{c} - \lambda \frac{v}{1 - v} b(\bar{c} - \underline{c}) \quad (26) \\
    \underline{t} &= cq + \alpha + (\pi - \underline{\pi})\bar{q} - \pi^M - \frac{b(\bar{c} - \underline{c})^2}{4} \quad (27) \\
    \bar{t} &= c\bar{q} + \alpha - \pi^M \quad (28)
\end{align*}
\]

Comparing the results that we obtain using the market information with the classic case of regulation presented in subsection 3.1, we can do some comments. First of all, the use of market information in this approach doesn’t have an impact on the allocations of scholarship students, having the same output for the efficient and inefficient monopolistic firm in the two approaches. Secondly, comparing the transfer that the regulator would give to the monopoly firm, in our approach we find a pair of contracts where the government would be saving resources by paying smaller transfers than when the market information is not taken care of.

Also, according to the approach presented in this subsection and under complete information the transfer will be:

\[
    t^{**} = c[a + \gamma - (1 + \lambda)bc] + \alpha - \pi^M \quad (29)
\]

\(^2\)The difference for both cases is the same: \(\pi^M - \tilde{\pi}^M = \pi^M - \tilde{\pi}^M = \frac{b(\bar{c} - \underline{c})^2}{4}\)

\(^3\)See demonstration in appendix A.3.
Lastly, the net surplus is:

$$E(S_s^*) = A - \frac{1}{2b} \left\{ v \left[ (1 + \lambda)b\bar{c} + (1 - v) \left[ (1 + \lambda)b\bar{c} + \lambda \frac{v}{1 - v} b(\bar{c} - \underline{c}) \right] \right]^2 + R \right\} - (1 + \lambda) \left\{ v \left[ \bar{c} + \bar{q}(\bar{c} - \underline{c}) - \frac{b(\bar{c} - \underline{c})}{4} \right] + (1 - v)\bar{c}q + \alpha - \pi M \right\}$$

(30)

4 Discussion

In this section, we will discuss our model results and the application to PROUNI. To evaluate the impact of the use of market information, we will compare the net surplus of consumers in the different situations presented in the previous sections, as well as the optimal number of scholarship students and the transfer paid by the regulator conditional to the monopoly firm’s type. Taking into account this we will recommend the optimal strategy that the government can use to regulate the firm.

4.1 Analysis of the optimal regulatory policy

First of all, it is important to highlight that the impact on the net surplus will depend on the externality $\gamma$ that we assume in the social demand of the scholarship students. If it fulfills the constraint (16), it will imply that the price paid by the government in the no discrimination scenario is greater than the price under monopoly and then greater than the prior beliefs that the regulator has.

Comparing (24) with (30), the net surplus of the standard case of regulation with the result of our approach using market information available in the non-scholarship segment, we can get an improvement in the welfare of the scholarship students, achieving a enhancement of:

$$\Delta(S_s^*) = (1 + \lambda) \left\{ v \frac{b(\bar{c} - \underline{c})^2}{4} + \pi M \right\}$$

(31)

The result comes directly from the compatibility of incentives used in the subsection 3.2, where the firm in our approach in addition to reveal its type correctly to the government, she will not be able to lie in the market because if she doesn’t do that she will get less profit, which gives two incentives to the firm not to lie.

If now we compare (19) with (24), the net surplus without regulation with the net surplus of the standard case of regulation, the results will depend on externalities $\gamma$, as we see in the next expression:

$$\Delta(S_s^*) = \frac{1}{2b} \left\{ [(1 + \lambda)b\bar{p}]^2 - v [(1 + \lambda)b\bar{c}]^2 - (1 - v) \left[ (1 + \lambda)b\bar{c} + \lambda \frac{v}{1 - v} b(\bar{c} - \underline{c}) \right]^2 \right\} + (1 + \lambda) \left\{ \bar{p} [a + \gamma - (1 + \lambda)b\bar{p}] - v[\bar{c} + \bar{q}(\bar{c} - \underline{c})] - (1 - v)\bar{c}q \right\}$$

(32)

Therefore, the welfare of students will be improved if the externality from the studies to the people of low income is larger enough. This will imply that the price paid by the regulator in subsection 2.2 will be greater than the subjective prior beliefs of costs that the government has. If this condition is met, we will have that our regulatory policy will have an additional improvement for the students, because as we see in (31) our approach is better than the case without market information.
Such a result demonstrate an important implication that comes from the information that the government has when he takes his optimal decision. Until now, the government has only used his prior subjective beliefs of the marginal costs and no other information is included in their maximization problem. When we include useful information such as the market, this allows the government to diminish the information asymmetry with respect to the monopoly. Diminishing the asymmetry now the government can extract more rent from the firm, improving the consumers’ net surplus.

4.2 The PROUNI

This program offers full or partial scholarships in private institutions to low-income students according to per capita family income. In exchange for these scholarships, the institutions participating in the program are exempt from certain taxes according to their institutional status.

Table 1: Aliquots and base of calculation of federal taxes by institutional status

<table>
<thead>
<tr>
<th>Tributes</th>
<th>For-profit</th>
<th>Non-profit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>wo PROUNI</td>
<td>w PROUNI</td>
</tr>
<tr>
<td>IRPJ</td>
<td>25% x profit</td>
<td>-</td>
</tr>
<tr>
<td>CSLL</td>
<td>9% x profit</td>
<td>-</td>
</tr>
<tr>
<td>COFINS</td>
<td>7.6% x revenue</td>
<td>-</td>
</tr>
<tr>
<td>PIS</td>
<td>1.65% x revenue</td>
<td>1% x leaf</td>
</tr>
<tr>
<td>INSS</td>
<td>20% x leaf</td>
<td>20% x profit</td>
</tr>
</tbody>
</table>

Source: Carvalho and Lopreato [2005]. “w” for with and “wo” for without.

For-profit institutions are the most benefited by being exempt from practically all taxes, in addition to representing 57% of the number of program’s scholarships until the second semester of 2014 according to data from PROUNI’s own site[^1] (26% belongs to entities of social attendance and the rest to non-profit not beneficial institutions).

The government faces misrepresentation of information from both students and educational institutions. Curiously, in Brazil, the government is paying a fee that is higher than the median fee charged in the private sector. This fact is in accordance with the Bennett hypothesis cited in the related literature, but as we mentioned above our model did not aim to test it. Besides that, tax expenditures increased considerably between 2014 and 2016, and enormous growth is estimated for 2019 reaching 0.71% of GDP.

This excess cost that the government faces in the goods or services motivates the application of this model to the case of PROUNI.

Analyzing the optimal number of scholarship students for the regulator, our approach and the standard case of regulation presented in subsection 3.1 have the same results. Thus, our strategy didn’t have an improvement in allocative efficiency. We obtain the standard results where the optimal amount of scholarship students of the contract offered for the efficient monopoly will be the same that under complete information, but to limit the informational rent of the efficient monopoly the government has to decrease the number of scholarship students offered for the inefficient monopoly. But seeing our results with the nondiscrimination subsection, comparing (25) and (26) with (14), we get an increase in the number of scholarship students because the assumption given by (16), and then an improvement in the net surplus.

Table 2: Distribution of estimated tax expenditures of PROUNI, by type of tax (valued in US$ million at constant prices based on Aug 2018)

<table>
<thead>
<tr>
<th>Year</th>
<th>IRPJ</th>
<th>CSLL</th>
<th>COFINS</th>
<th>PIS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>43.02%</td>
<td>15.39%</td>
<td>34.14%</td>
<td>7.45%</td>
<td>234.04</td>
</tr>
<tr>
<td>2012</td>
<td>37.28%</td>
<td>17.23%</td>
<td>37.39%</td>
<td>8.10%</td>
<td>307.98</td>
</tr>
<tr>
<td>2013</td>
<td>42.09%</td>
<td>14.55%</td>
<td>35.64%</td>
<td>7.72%</td>
<td>292.28</td>
</tr>
<tr>
<td>2014</td>
<td>34.82%</td>
<td>10.41%</td>
<td>45.01%</td>
<td>9.75%</td>
<td>215.71</td>
</tr>
<tr>
<td>2015</td>
<td>40.72%</td>
<td>12.89%</td>
<td>38.12%</td>
<td>8.26%</td>
<td>320.11</td>
</tr>
<tr>
<td>2016</td>
<td>46.07%</td>
<td>16.42%</td>
<td>30.82%</td>
<td>6.68%</td>
<td>373.68</td>
</tr>
<tr>
<td>2017</td>
<td>46.07%</td>
<td>16.42%</td>
<td>30.82%</td>
<td>6.68%</td>
<td>353.52</td>
</tr>
<tr>
<td>2018</td>
<td>46.07%</td>
<td>16.42%</td>
<td>30.82%</td>
<td>6.68%</td>
<td>353.49</td>
</tr>
<tr>
<td>2019</td>
<td>54.27%</td>
<td>19.98%</td>
<td>21.17%</td>
<td>4.59%</td>
<td>534.50</td>
</tr>
</tbody>
</table>

Source: Prepared with data from the SFR.

Another important result that we offer with our policy recommendations is the improvement in economic efficiency of this program. If we compare our optimal contract with subsection 3.1, the transfer for both monopoly types in our results are less than the transfer from the standard approach, comparing (22) with (27) and (23) with (28).

Then with our optimal policy, the government would achieve an improvement in allocative and economic efficiency in the PROUNI.

5 Conclusion

The present paper looks for many industries where a regulated firm serves the same product or service for the market and for the government. It analyzes the relationship between the market information available to the regulator and how he performs the regulatory policies. In our knowledge, a theoretical model that adds the firm’s own market information was not yet studied in the literature. As well, a specific application in the private higher education market was not studied either.

Knowing that our model is quite simple when considering only adverse selection and a regulated firm that is a monopoly, it adds important insights in comparison with the standard regulation models. First, we find the same result with respect to the output who must have the contract for the inefficient type. When the government wants to mitigate the informational rent of the efficient type, as it is positively related to $q$, the government will distort the inefficient output from the first-best allocation to control this rent. As a consequence this will imply having tuition above the marginal cost. Secondly, with the added market information the government gets to reduce the transfer offered for both types and even more important, he gets to extract more informational rent than in the standard regulation case, having a greater saving in the fiscal coffers. Third, with this additional information the regulator will also have an improvement in the welfare of the scholarship students under the assumption of a high externality for higher education, a premise that is in line with the enormous increase in the demand for financial aid for higher education.

Taking into account the overcharging the government is paying, when the regulator begins to look for the information available in the market to carry out his regulatory policies, specifically the monopolist’s profit, what is being generated is a decrease in the information asymmetry that the government faces with respect to the costs of the firm, achieving greater negotiation

5This is demonstrated in Appendix A.3.
power when dealing the trade-off between allocative efficiency and informational rent with the firm.

As we did many assumptions regarding the model’s environment, many questions remain for future research. First is to see the impact of the results when more firms are operating in the market. Related to this point, another question is to see how to incorporate in the analysis the information of other companies participating in the market. Finally, an unanswered question is to look at how the model reacts to situations where the monopolist can discriminate prices.

References


A Maximization problems

A.1 Monopolist’s problem in the non-scholarship segment

In this case, the monopolist only meets the demand of non-scholarship students \( q^M \), having the following problem and solutions:

\[
\max_{q^M} \left( \frac{a'-q^M}{b} \right) q^M - (cq^M + \alpha) \quad \Rightarrow \quad q^M = \frac{a' - bc}{2} \\
\Rightarrow \quad p^M = \frac{a' + bc}{2b} \\
\Rightarrow \quad \pi^M = \frac{(a' - bc)^2}{4b}
\]

A.2 Regulating without market information

From the constraints defined in the problem of subsection 3.1, considering the CI together with the PC, we obtain that the PC is not binding:

\[
\bar{t} - (cq + \alpha) \geq \bar{t} - (\bar{c}q + \alpha) > \bar{t} - (\bar{c}q + \alpha) \geq 0
\]

We can dismiss CI because it is met in the optimal:

\[
\bar{t} - (\bar{c}q + \alpha) \geq \bar{t} - (\bar{c}q + \alpha) \pm q
\]

\[
0 \geq (\bar{c} - \bar{c})(\bar{q} - q)
\]

where the first term of the right side is positive and the second negative, respecting the inequality. This then leads to having bound the incentive compatibility constraint of the efficient type and the participation constraint of the inefficient type. This implies having the following problem:

\[
\max_{q^M} \quad v \left\{ S^b(q^b) - (1 + \lambda) \left[ cq + \alpha + \bar{c}(\bar{c} - q) \right] + \bar{q}(\bar{c} - q) \right\} + (1 - v) \left\{ S^b(q^b) - (1 + \lambda)(\bar{c}q + \alpha) \right\}
\]

obtaining the results \( \text{[20]} \) and \( \text{[21]} \) from the first-order conditions.

A.3 Regulating with market information

Similar to the appendix A.2 and considering the restrictions of subsection 3.2, taking into account the CI together with the PC, we obtain that the PC is not binding:

\[
\bar{t} - (cq + \alpha) + \pi^M \geq \bar{t} - (\bar{c}q + \alpha) + \tilde{\pi}^M > \bar{t} - (\bar{c}q + \alpha) + \pi^M \geq 0
\]
because \( \pi^M > \tilde{\pi}^M > \pi^M > \tilde{\pi}^M \). These inequalities are also useful because it allows demonstrating that informational rent is lower than in the standard case of regulation. From CI:

\[
\mathcal{L} - (c\bar{q} + \alpha) + \pi^M \geq \mathcal{L} - (c\bar{q} + \alpha) + \tilde{\pi}^M \pm cq \pm \pi^M
\]

\[\Rightarrow \mathcal{L} \geq c\bar{q} + \alpha + \bar{q}(\bar{c} - \bar{c}) - \tilde{\pi}^M - \pi^M + \tilde{\pi}^M
\]

where the net result of the last three terms on the right side is negative, demonstrating an important insight that proves the decrease in informational rent.

We can dismiss CI because it is met in the optimal:

\[
\mathcal{L} - (c\bar{q} + \alpha) + \pi^M \geq \mathcal{L} - (c\bar{q} + \alpha) + \tilde{\pi}^M \pm cq \pm \pi^M
\]

\[0 \geq (\bar{c} - \bar{c})(\bar{q} - \bar{q}) - \tilde{\pi}^M - \pi^M + \tilde{\pi}^M
\]

which is true based on the inequalities of the monopolies' profits and the results in the optimal. This implies having the following problem:

\[
\Rightarrow \max_{\bar{q}, \bar{\pi}} \quad \left\{ S_b^b(q^b) - (1 + \lambda) \left[ c\bar{q} + \alpha + \bar{q}(\bar{c} - \bar{c}) - \frac{b(\bar{c} - \bar{c})^2}{4} - \pi^M \right] + \bar{\pi}(\bar{c} - \bar{c}) \right\}
\]

\[+ (1 - v) \left\{ S_e^e(q^e) - (1 + \lambda)(\bar{c}^e + \alpha - \pi^M) \right\}
\]

obtaining the results \((25)\) and \((26)\) from the first-order conditions.