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Is partial privatization of universities a solution for higher education? A successive monopolies model.

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Abstract

This paper studies a model of vertical successive monopolies where students/workers buy qualification from an university then “sell” skilled labor to a monopolist who itself sells its final product to consumers, linking this way for the first time the education sector to the labor and output markets. The question is whether a public university should be partially or fully privatized. The partially privatized university fixes the tuition fees in order to maximize a weighted sum of profits and social welfare. A larger share of the private sector means lower training costs but, at given training costs, higher margins and lower final output levels. We prove that partial privatization of the university is optimal when public inefficiency is not too severe and that the State keeps in this case a large majority of university’s shares. When the inefficiency parameter increases above some critical level, one switches discontinuously to full privatization. We show that these results are robust to the introduction of a feasibility constraint requiring university profits to be non-negative following privatization.

Keywords: Education, labor market, successive monopolies, vertical differentiation, partial-privatized university, State regulation.

JEL Classification: D42, I28, J4, L13.

1 Introduction

Over the last few decades, a substantial expansion of private higher education has been recorded all over the world. Data from the 2010 PROPHE’s statistics indicate that private higher education holds 33.1% of total higher education enrollment¹. More

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¹<http://www.albany.edu/dept/eaps/prophe/>

specifically, Asia leads with 36%, USA follows with 29.4% and Europe registers the lowest percentage with only 16%. The expansion of private higher education has been seen as a necessity to cope with “more students and less money” (Thornton 2012: 13), i.e. the overwhelming increase of the demand for higher education and the incapacity or the unwillingness of public higher education to absorb such a demand. The general idea that the public management is “wasteful, inefficient and unproductive” (Walker 1984: 30) is behind the observed waves of privatization of the public sector in general and higher education institutions in particular, along with an increasing competition for the use of declining public resources.

More recently, the reverse trend has also been observed (Kwieck, 2017, Levy, 2013). According to Kwieck (2017: 260), “in post-communist Europe, [...] the dynamics have clearly been changing toward more publicness and less privateness in the last decade”, which has been called by the author “de-privatization” of higher education.

Privatization and de-privatization have to be understood in dynamic terms, in terms of less or more implication of the state in the sector and of “increased [or decreased] reliance on market mechanisms to govern higher education (McLendon and Mokher 2009: 25-26)”. In fact, we are speaking in both cases of a degree in privatization and a tendency to go in one way or in the opposite one, thus to increase or decrease, in other words, to choose the degree of privatization. Indeed, according to Levy (2013), universities can partly privatize, as other public enterprises, as a way to improve their management. In this paper, we aim at determining the optimal degree of partial privatization of a public university, explicitly relating the quality of training to the quality of the final output, thus considering the effect of education on the downstream firm through the educated workers, in a successive monopolies model.

Education, as an important part of human capital, is a global public good. Indeed education and higher education have been quite extensively shown to have positive effects in terms of productivity, economic growth, health, civic participation and non-market benefits (marriage, fertility...) ². Because of the existence of strong spillover effects the provision by the private sector would not be optimal. In the same frame of mind, “the privatization agenda inevitably raises the questions of equitable access, intergenerational social mobility, and the individualistic nature of modern societies” (Kwieck, 2017: 261). We do not claim to account for all these effects in our analysis. We rather focus on the link between higher education and the real economy through educated workers. But this alone accounts simply at the same time for the two roles identified by Farrell et al. (2006: 9), “the accumulation of human capital (that is, educated and trained men and women) on the one hand, and the accumulation and application of knowledge to the production process, on the other”, as highly educated workers are at the same time one of the outputs of higher education and “the primary source of application of global academic knowledge to the domestic economy.” (Farrell, 2006: 13). And this alone may question the provision of education by a private owner. While “many academic leaders assert that a proper higher education is supposed to be removed, or at least substantially insulated, from commercialization

²For a survey, see Farrell et al. (2006).

and market forces"³, partial privatization may be a pragmatic solution to improve the management of education institutions, ease the pressure on public resources and stick more closely to the market needs without losing sight of general interest.

At this stage, it seems important to define more precisely the terms we will be using throughout the paper. Privatization of a public university does not necessarily mean the transfer of its legal ownership to a private owner. This has almost never been observed, contrasting with other public enterprises such as airlines or water and electricity suppliers (Levy, 2013). We mean rather, as Levy (2013: 36) put it, that "the public universities in question seek to improve their management such that they are more like their private counterparts." Being like a private university would mean seeking more efficiency until the university's resources are devoted to "the most profitable income-generating activity open to it." (Williams 1996: 52). In short, a partially privatized public university heeds more attention to its profit. This may occur for several reasons and may take different forms (Levy, 2013). First, as in East Asia, governments reduce the financial budget of public higher education, compelling indirectly public universities to seek other sources to finance their activities. Second, as in Romania, public universities are subject to an entrepreneurial partnership with foreign universities, which encourages labeled public universities to improve management and administration activities hence improving efficiency. The third model of partial privatization adopted in post communist Russia allows students who cannot access the restrictive public quota (free or low tuition fees) to enter the same universities while paying for their enrollment. Public universities are encouraged or even constrained to give more room to diverse members of the society in governance boards, among which the potential employers, i.e. the firms, who participate increasingly in strategic decisions (Godonoga, 2017) introducing their ways of seeing things, in a way their philosophy and their practices. On the other side, a private university may be made "more public", in the sense that it may be compelled to take into account the general interest, even if it remains legally entirely privately owned. Indeed governments may directly or indirectly influence the private provision of higher education through regulatory mechanisms or general standards and procedures (Godonoga, 2017). What matters is not the legal owner of the university, but rather how the decisions are taken, thus who partakes in the decision and for which mission thus which objective to reach. Hence legally private universities may be partly public in that they are forced to integrate at least partially criteria linked to general interest and legally public universities may be partially private in that they integrate profit maximization into their management procedures. In this paper, a partially privatized university simply maximizes a weighted sum of social welfare and profit. At the extremes we have purely public universities and purely private ones.

More specifically, when we consider the effect of education on the downstream firms, essentially through quality, there appears something very similar to the now familiar "double marginalization" effect in Industrial Organization, when different firms exert their market power at successive levels in the vertical supply chain. In the latter case, the upstream firms do not account for the effect of their pricing

³Johnstone, (2003: 356)

decisions on the downstream ones, so that aggregate profits are not maximized, and both firms do not consider the impact of their decisions on consumers' utility. In this paper, the university is the upstream firm. When it is State owned, it can set low tuition fees, thereby alleviating the negative impact of successive monopolies on welfare. But State ownership has some inefficiencies of its own. This paper investigates the circumstances under which partial vs full privatization of universities is socially optimal, taking into account the existing increasing relation between the final product's and the education's quality through the labor market.

Another question to be emphasized regarding education is labor market, insofar as, today's students are tomorrow's workers. Several authors (De Fraja, 2001; Romero and Del Rey, 2004; Olivera, 2006) highlight the link between education and labor market only by considering wages in the function of students' utility. But they do not consider wages as endogenous variables. In our model we consider that salaries are endogenously determined through the equilibrium between supply and demand on the labor market. We moreover emphasize the link between education's quality and the quality of commercialized goods through workers' quality. This is in line with the findings of the OECD Survey of Adult Skills "that educational attainment is positively related to skill proficiency." (Sarrico, 2017: 17). To the best of our knowledge, we are the first to model explicitly the link between education and the final product market through workers/students. This amounts to consider higher education and more generally training activities as an integral part of the economy and opens the way to assess the effects of education on the real economy.

Specifically, we consider a model of successive monopolies through which one university "sells" qualification to students/workers who "sell" skilled labor to a manufacturer who finally sells its product to consumers. Workers are differentiated by their cost of learning/working which is itself increasing in the skill level. On the product market, there is a vertical preference for quality. The product's quality is assumed to increase with the qualification of workers. We allow private and public sectors to hold shares in the university. The unit cost at the university is assumed to be increasing in the proportion of shares held by the State. In the first step of the game, the State fixes the proportion of shares it holds in the university. In the second step, the university fixes tuition fees in order to maximize a sum of social surplus and university profits weighted respectively by the public and private shares in the university. In the third step, the firm fixes its price so as to maximize its profit. The wage balances demand and supply on the labor market.

The results on the degree of privatization at equilibrium turn out to depend discontinuously on the "inefficiency parameter" which measures how much the unit cost increases with the proportion of public ownership of university shares. When the inefficiency parameter is below a critical level, partial privatization appears at equilibrium, where the State keeps a very large majority of University's shares⁴ and the appeal to the private sector is very limited. Above the threshold, full privatization emerges.

In most cases however, partial privatization may be simply not feasible because the

⁴More than 80%.

partially privatized university would make losses, so that no private investor would accept to buy shares at a non-negative price. To hold, this equilibrium should be sustained through the State's commitment to cover the potential university's losses. If this is not politically feasible, one has to introduce the constraint that the university should not make losses after privatization. Under this constraint, we prove that partial privatization in which the private sector owns one third of the university, obtains at equilibrium for small values of the inefficiency parameter, the university making zero profits, while full privatization obtains for large values.

Related literature:

Most authors who deal with vertical successive monopolies under linear wholesale prices show that the laissez-faire equilibrium is not socially optimal (Zeuthen, 1933; Lerner, 1933; McKenzie, 1951; Stigler, 1951; Machlup and Tabor, 1960). Indeed, cumulative mark-ups from one producer to another might increase considerably the price charged to consumers and reduce quantities. One way to overcome double marginalization is public regulation through State's ownership. For example, an upstream public firm chooses its price at its marginal cost (as if the buyer produces itself the upstream product) or a downstream public firm sells its product at its marginal value (as if the firm produces itself the upstream product). In both situations, market regulation absorbs the cumulative markups effect (Stigler, 1951). However, using a spatial model, Heywood and Pal (2004) rule out the problem of double marginalization by assuming that the demand for the final product is completely inelastic. The authors show that, due to the strategic interaction between upstream and downstream firms, public regulation may well increase downstream firms' profits and decrease welfare with respect to a model with no public intervention. Hence, the issue of public regulation in the context of successive monopolies is still controversial and remains of interest.

Furthermore, most articles which study State regulation and privatization in vertically differentiated markets, introduce general models of competition between public and private firms (Grilo, 1994; Nashijima, 2008). Rare are authors who study these issues in a specified market, for example health (Barbot and Brandao, 2005) or education (Romero and Del Rey, 2004). More specifically, Romero and Del Rey (2004) focused only on competition between private and public universities and did not deal with mixed ownership. Otherwise, to the best of our knowledge, Ishibashi and Kaneko (2008) are the only authors to have analyzed the possibility of partial privatization within the context of vertical differentiation. The authors showed that within a mixed duopoly and under price and quality competition, partial privatization obtains at equilibrium, however, they did not deal with the education issue. Hence, partial privatization of education in vertically differentiated market remains under-explored in the literature.

Public institutions are generally considered as less efficient than private ones, and privatization is usually adopted in order to offset public inefficiency. Indeed, Tuckman

(1984) argues that State ownership generates additional costs due to inefficient production's management, poor production's capacities or conflict of interests between the State and the managers. To the best of our knowledge, only Oliveira (2006) highlights this point by considering a positive parameter which captures the degree of inefficiency in the cost function of public universities. However, the author supposes the same level of inefficiency for either public universities or partially public universities. In the present paper, we consider that the degree of inefficiency is weighted by the share held by the State in the university.

Finally, labor market is timidly addressed in the theoretical models in economics of education. Indeed, several authors introduce future compensation for students/workers (De Fraja, 2001; Romero and Del Rey, 2004; Olivera, 2006) in the function of individual capacities and salaries are considered as exogenous variables. In this paper, we consider that salaries are determined by balancing supply and demand on the labor market, assuming an increasing relation between the education's quality and the product's one. The supply for labor is given by the number of students/workers having accepted to study and work and the demand for labor is given by the demand for the final output on the market. That the product's quality increases with the qualification of workers may be related to the abundant literature on the effect of R&D on productivity, such as Griliches (1979, 1998), Jaffe et al. (1993), Jaffe and Trajtenberg (1996), Mohnen (1996), Blomstrom and Kokko (1998), and Cincera and van Pottelsberghe (2001). In a way, we confirm the pioneering idea of Griliches that the technical change identified as the engine of growth by the earlier works of Abramovitz (1956) and Solow (1957) is an endogenous result of the economic activity (Farrell et al., 2006). Indeed the number of the students/workers trained by the university and their qualification, which both may account for productivity, are endogenously determined in our model. Our hypothesis on the link between the qualification and the product's quality can also be related to the conclusions of the OECD Survey of Adult Skills (Farrell et al., 2006). Indeed the Survey finds that the adults who have tertiary education attainment have a higher proficiency in information processing skills, probably resulting in higher products' quality, than those who have not attained upper secondary education.

The remainder of the paper is organized as follows. Section 2 introduces the model. In Section 3, we solve the game. In Section 4, we discuss our results. Section 5 concludes. All proofs are given in Appendix.

2 The model

We consider one university which supplies higher education. It provides qualification e to students at tuition fees t . Graduate students "sell" skilled labor to one private firm perceiving a unit salary ω . The firm offers its final product at price p . The market's structure is depicted in Figure 1.

The workers. It is natural to suppose that the qualification provided by a worker increasingly conditions the produced quality of the final output. For simplicity sake, we suppose that the product's quality equals the qualification, hence allowing to denote in the same manner both variables. Denote by e the worker's qualification/effort training and at the same time the product's quality. As in De Fraja (1999), the utility of a worker/student is given by:

$$U_\alpha = \omega - t - \alpha e,$$

where α characterizes the sensitiveness of each student/worker to qualification and is uniformly distributed over $[0, \bar{\alpha}]$ with a density normalized to one. Indeed, a higher qualification and product's quality needs more effort and time, thus is (all things being equal) not desirable from the workers' viewpoint. Parameter $\bar{\alpha}$ is assumed to be sufficiently high so that it is never constraining. A type α -worker goes to the university in order to acquire a qualification and to work if this provides him/her a larger utility than staying at home⁵.

The consumers. There is a continuum of consumers uniformly distributed on $[0, \bar{\theta}]$ with a density normalized to 1. The utility of a consumer buying one unit of product e at price p is given, as in Mussa and Rosen (1978), by:

$$V(\theta) = \begin{cases} \theta e - p & \text{if he/she buys one unit of product;} \\ 0 & \text{if he/she buys nothing.} \end{cases}$$

Each consumer is assumed to buy one unit of output if it procures him/her a positive utility. Otherwise, he/she buys nothing.

We assume that one unit of output requires one unit of labor. Thus, the demand for labor equals the total product demand.

The university. We denote by $\beta \in [0, 1]$ the share held by the State in the university. The extreme values $\beta = 0$ and $\beta = 1$ correspond respectively to a fully privatized and a public university.

Assuming that public universities are less efficient than private ones, we introduce a parameter k which captures the degree of inefficiency in the university's cost function. However, insofar as partially public universities are not as inefficient as fully public ones, we consider that the degree of inefficiency is weighted by the State-shares held in the university. We thus assume that the managerial effort of private shareholders reduces costs. Hence the higher is the degree of privatization, the more important is the managerial effort, the lower are costs. Formally, supposing that the

⁵An alternative interpretation is that workers with no qualification produce a numeraire good under constant returns to scale.

unit training cost equals zero under pure private management, the unit training cost is given by:

$$C(e) = \beta ke,$$

where parameter k measures the degree of inefficiency of public management.

The university maximizes a sum of the social welfare (SW) and the profit of the institution (Π^U) weighted respectively by the public and private shares in the university:

$$G = \beta SW + (1 - \beta)\Pi^U.$$

The game. Decisions take place in a three-step game:

- The State chooses the quality of training (which equals the product's quality) e in $[0, \bar{q}]$, then its share in the university $\beta \in [0, 1]$ so as to maximize the social welfare SW .
- The university determines the tuition fees t so as to maximize the weighted sum G .
- The firm chooses p so as to maximize its profit Π^F .

Wages adjust balancing the demand and supply on the labor market.

The fact that the quality training be decided by the state seems the most natural hypothesis, as the state generally imposes the specifications to be met by universities, be they private or public. In the terms used by Godonoga (2017), our approach may be qualified as a "supply-push" one. Other alternatives are available. Remaining in the "supply-push" approach, the university may be supposed to be the one who decides the training quality. But it would be a "demand-pull" model to suppose that the quality is decided by the firm.

We distinguish two cases. The commitment case where the State commits to cover the university's deficit when such a deficit appears, allowing the university to make losses at equilibrium. Second, the no-commitment case where we assume that the State does not cover the potential deficit of the university, solving the game under a constraint of non-negativity of the university's profit. In our analysis, we compare our results with a benchmark, the social optimum case defined and calculated just below.

In all the considered cases, wages adjust so that the supply and demand equalize on the labor market. Worker α decides to work when $U_\alpha \geq 0$, equivalent to $\alpha \leq \frac{\omega - t}{e}$. Thus, given the hypothesis on the density of workers, labor supply is $\frac{\omega - t}{e}$. On the demand side, Consumer θ purchases the product if $V(\theta) \geq 0$, equivalent to $\theta \geq \frac{p}{e}$. Hence, the demand for the product is $Q = \bar{\theta} - \frac{p}{e}$.

The equilibrium wage is such that:

$$\omega - t = \bar{\theta}e - p.$$

In all the considered cases (social optimum, commitment and no-commitment cases), given e, p, t and the parameters, the wage is given by the expression:

$$\omega = \bar{\theta}e - p + t. \quad (1)$$

The social optimum

At the social optimum, the State fixes simultaneously the price p , the tuition fees t and the share to hold in the university (β), salaries adjusting on the labor market. We prove that at the optimum, ω and the tuition fees t are undetermined and the State chooses the price p so as to cancel the aggregate profit ($\Pi^U + \Pi^F = 0$). The choice of the values of ω and t has no impact on the optimal level of product's quantity (then employment), profits and the social welfare. We summarize in Result 1 the outcome at the social optimum.

Result 1 (The social optimum). *At the social optimum, the share held by the State in the university, quality of training, tuition fees, price, salary and quantity are given by:*

$$\beta^{opt} = 0, \quad e^{opt} = \bar{q}, \quad \omega^{opt} - t^{opt} = \frac{1}{2}\bar{\theta}\bar{q}, \quad p^{opt} = \frac{1}{2}\bar{\theta}\bar{q}, \quad Q^{opt} = \frac{1}{2}\bar{\theta}.$$

Profits and social surplus are as follows:

$$\Pi^{U^{opt}} + \Pi^{F^{opt}} = 0, \quad SW^{opt} = \frac{1}{4}\bar{\theta}^2\bar{q}.$$

3 Equilibrium in the commitment case

In this section, we provide equilibrium for the commitment case solving the game by backward-induction. The labor-clearing wage, given in Equation 1 obtains as a function of e, p and t . This expression is inserted in the firm's profit which is maximized w.r.t price p , providing the price and the wage as a function of e, t and β .

Inserting these expressions in the university's profit and maximizing it w.r.t the tuition fees t , we obtain the equilibrium of the second step provided in Lemma 1.

Lemma 1. *For a given value of the State share in the university (β), and given training quality e , at the equilibrium of the second step, the university fixes the tuition fees as follows:*

$$t(\beta, e) = \frac{e(2\bar{\theta} + \beta(2k - 3\bar{\theta}))}{(4 - 3\beta)}. \quad (2)$$

The output price, the salary and the output quantity are thus given by: $p = \frac{e(7\bar{\theta}-6\bar{\theta}\beta+\beta k)}{2(4-3\beta)}$, $\omega = \frac{e(5\bar{\theta}-6\bar{\theta}\beta+3k\beta)}{2(4-3\beta)}$, $Q = \frac{(\bar{\theta}-\beta k)}{2(4-3\beta)}$ for $\beta < \frac{\bar{\theta}}{k}$ and 0 otherwise.

Note that this may imply that the university gives grants to students, namely that we may have $t < 0$. Moreover, when $t(\beta, e) < \beta k e$, the university fixes a level of tuition fees under its marginal cost, hence making losses and needing financing.

The choice of the State at equilibrium in terms of training quality and public share is given in Proposition 1.

Proposition 1 (The commitment case). *At the subgame perfect equilibrium, the State chooses $e^* = \bar{q}$ and its share β^* in the university as follows (denoting by $\kappa = \frac{k}{\bar{\theta}}$):*

- (i) *If $\kappa = 0$ then $\beta^* = 1$ i.e. the university is completely public,*
- (ii) *if $0 < \kappa < \frac{3}{28}(9 - 4\sqrt{2}) \equiv \kappa_0$, then privatization is partial with $\beta^* = \hat{\beta}(\kappa) = \frac{1}{6\kappa}(12\kappa - 3 + \sqrt{9 - 36\kappa + 32\kappa^2})$,*
- (iii) *if $\kappa \geq \frac{3}{28}(9 - 4\sqrt{2})$, then we have full privatization, i.e. $\beta^* = 0$.*

As depicted in Figure 2 the State's share in the university at equilibrium (β^*) depends discontinuously on the inefficiency parameter (κ). Note that when the university is partially privatized, β^* is decreasing for values of $\kappa \in [0, \kappa_0[$ tending towards $\beta_0 = \beta(\kappa_0) \simeq 0.818$. Hence, under partial privatization the State holds always a large majority in the university with more than 80% of shares.

The discontinuity of the optimal value of β^* results from the fact that SW , the function to be maximized, is double-peaked, with a local maximum at 0 and another one at $\hat{\beta}(\kappa)$. The global maximum is the one among the two local maxima with the highest value of SW . The comparison between both depends on κ . This is why β^* jumps down from $\hat{\beta}(\kappa)$ to zero, when κ goes beyond some threshold.

Corollary 1 provides the equilibrium outcome in terms of relevant variables: price, tuition fees, salary, exchanged quantity of the product, profits and social welfare.

Corollary 1. *At the subgame perfect equilibrium the prices, salary, quantity, profits and social welfare are given, for each case identified in Proposition 1, as follows:*

i) *When $\kappa = 0$ (public university):*

$$p = \frac{1}{2}\bar{\theta}\bar{q}, \quad t = -\bar{\theta}\bar{q}, \quad \omega = -\frac{1}{2}\bar{\theta}\bar{q}, \quad Q = \frac{1}{2}\bar{\theta}.$$

$$\Pi^U = -\frac{1}{2}\bar{\theta}^2\bar{q}, \quad \Pi^F = \frac{1}{2}\bar{\theta}^2\bar{q}, \quad SW^C = \frac{1}{4}\bar{\theta}^2\bar{q}.$$

ii) *When $0 < \kappa < \kappa_0$ (partially private university):*

$$p = \frac{\bar{q}\bar{\theta}(7-6\hat{\beta}(\kappa)+\kappa\hat{\beta}(\kappa))}{2(4-3\hat{\beta}(\kappa))}, \quad t = \frac{\bar{q}\bar{\theta}(2+\hat{\beta}(\kappa)(2\kappa-3))}{(4-3\hat{\beta}(\kappa))}, \quad \omega = \frac{\bar{q}\bar{\theta}(5-6\hat{\beta}(\kappa)+3\kappa\hat{\beta}(\kappa))}{2(4-3\hat{\beta}(\kappa))}, \quad Q = \frac{\bar{\theta}(1-\kappa\hat{\beta}(\kappa))}{2(4-3\hat{\beta}(\kappa))}.$$

$$\Pi^U = \frac{\bar{q}\bar{\theta}^2(2-2\kappa\hat{\beta}(\kappa)-3\hat{\beta}(\kappa)+3\kappa\hat{\beta}(\kappa)^2)(1-\kappa\hat{\beta}(\kappa))}{2(4-3\hat{\beta}(\kappa))^2}, \quad \Pi^F = \frac{\bar{q}\bar{\theta}^2(1-\kappa\hat{\beta}(\kappa))^2}{2(4-3\hat{\beta}(\kappa))^2}, \quad SW^C = \frac{\bar{q}\bar{\theta}^2(1-\kappa\hat{\beta}(\kappa))^2(7-6\hat{\beta}(\kappa))}{4(4-3\hat{\beta}(\kappa))^2}.$$

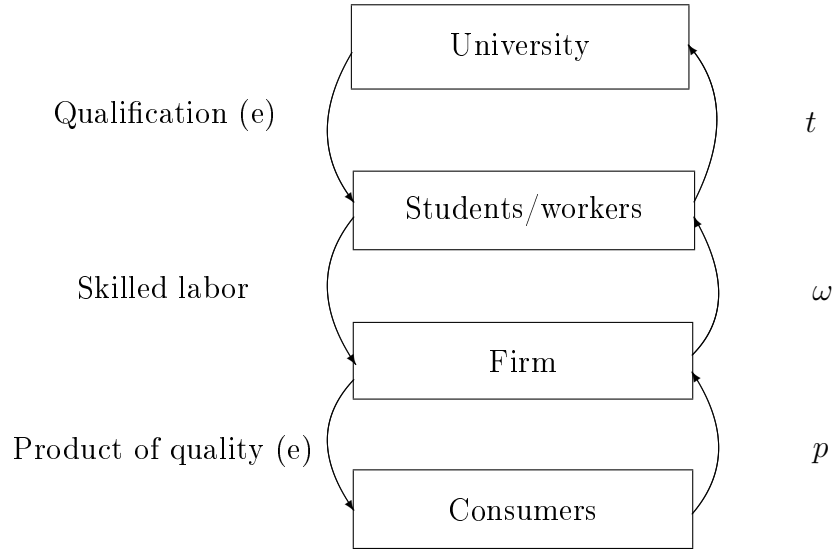


Figure 1: The market structure

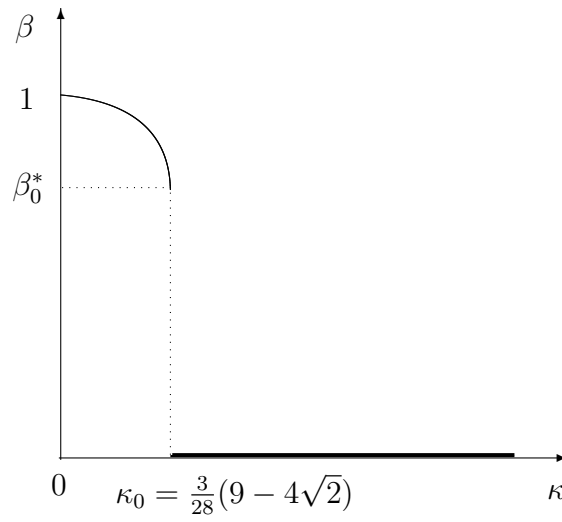


Figure 2: The State's share in the university, β^* , at equilibrium in the commitment case.

iii) When $\kappa \geq \kappa_0$ (fully private university):

$$p = \frac{7}{8}\bar{\theta}\bar{q}, \quad t = \frac{1}{2}\bar{\theta}\bar{q}, \quad \omega = \frac{5}{8}\bar{\theta}\bar{q}, \quad Q = \frac{1}{8}\bar{\theta}.$$

$$\Pi^U = \frac{1}{16}\bar{\theta}^2\bar{q}, \quad \Pi^F = \frac{1}{32}\bar{\theta}^2\bar{q}, \quad SW^C = \frac{7}{64}\bar{\theta}^2\bar{q}.$$

Figures 3(a) and 3(b) provide the social welfare and the university's profit at equilibrium for all values of κ . It has been obtained numerically for $\kappa \in]0, \kappa_0]$.

When the State is fully efficient (case (i), $\kappa = 0$) the university is fully State owned and tuition fees (t) are fixed below the university's marginal cost ($t < 0$). This underpricing policy is adopted in order to eliminate market's inefficiencies due to the firm's pricing above its marginal cost ($p > w$). Indeed, a decrease in tuition fees generates a decrease in equilibrium wages ($\frac{\partial \omega}{\partial t} > 0$), which reduces the double marginalization effect. Moreover, the tuition fees are fixed at a level so as to cancel the aggregate profit ($\Pi^F + \Pi^U = 0$), as if the firm produced at a price equal to the *social* marginal cost. Such a mechanism ensures the same level of welfare as the socially optimal one. Hence, as in Stigler (1951) we conclude that in the full efficiency case one way to overcome double marginalization is public regulation through State ownership of the upstream firm. Note that the firm and the university should be State financed, insofar as we assume that a negative level of tuition fees supposes that the university gives grants to students ($t < 0$) and a negative level of salaries implies that the government has to finance the firm in order to enhance employment ($w < 0$).

When partial privatization obtains (case ii), the level of welfare is always under the optimum's level as illustrated in Figure 3(a). An increase in the degree of privatization increases tuition fees increasing the double marginalization effect and the market's inefficiency thus decreasing social welfare.

Note that partial privatization appears at equilibrium even if the university makes losses as obtained in Figure 3(b). This should be explained by the fact that partial privatization has two contradictory effects. On the one hand, a decrease in β decreases inefficiency due to State ownership ($C(e) = \beta ke$), thus reducing losses. On the other hand, it increases the output price, which increases the market's inefficiency (double marginalization). In order to absorb the market's inefficiencies, the social planner tolerates losses even if the university is partially privatized. Our results are similar to those of Ghosh et al. (2013) who consider a model of competition between a public domestic firm and a foreign private one and prove that even if partial privatization emerges at equilibrium, the public firm's price is below marginal cost due to adverse price effect of privatization: an increase in privatization level decreases domestic firm's losses and increases the foreign price.

1) Oui cette figure devrait être dans le même style que les autres, d'autant qu'elle a été effectivement obtenue pour une large partie de manière numérique.

2) Pourquoi est-ce qu'elle est placée en plein milieu du texte?

3) Les figures 1 et 2 apparaissent aussi de manière pas très heureuse. J'ai vu qu'elles figurent bien là où elles devraient dans le programme Tex. Je ne sais pas

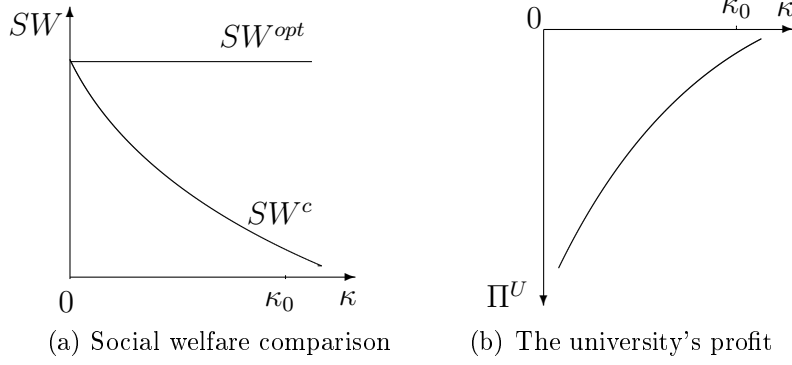


Figure 3: Social Welfare and University's profit at equilibrium in the commitment case.

si on peut faire quelque chose pour les forcer à apparaître à des emplacements plus pertinents (pas la peine de faire trop d'efforts à ce stade, ça peut s'arranger tout seul après). Remarque à garder jusqu'à ce que ça s'arrange.

Naturally, for high values of inefficiencies (case iii), the university is fully privatized. Since there is no State ownership, the university imposes a high level of tuition fees, which increases cumulative markups. In this situation which corresponds to successive private monopolies, both the university and the firm make profits and welfare is not socially optimal ($SW < SW^{opt}$).

In cases (i) and (ii) where the public share in the university is positive, the university makes a negative profit. And for privatization to be feasible, the private sector must have some incentive to buy shares in the university. This is why we need the assumption that the State be able to commit to cover *ex post* the university deficit when such a deficit appears. When this is not possible, we have to take into account a constraint of non-negativity of the university's profit. This is the object of the following section.

It may appear surprising not to have a discontinuity of SW^C , while β^* is discontinuous. Mathematically this happens because, as explained earlier, the function SW to be maximized, is double-peaked with 0 and another positive value of β as local maxima. The optimal value is equal to the latter for $\kappa < \kappa_0$ and shifts down to 0 when $\kappa > \kappa_0$. At $\kappa = \kappa_0$, the values of SW at the two local maxima are precisely equal, meaning that the optimal value of SW , which is SW^C is continuous.

4 Equilibrium in the no-commitment case

In this section, we assume that the State does not commit to cover the losses the partially privatized university may make. A constraint of non-negativity is introduced on the university's profit. Proposition 2 provides the equilibrium in this case.

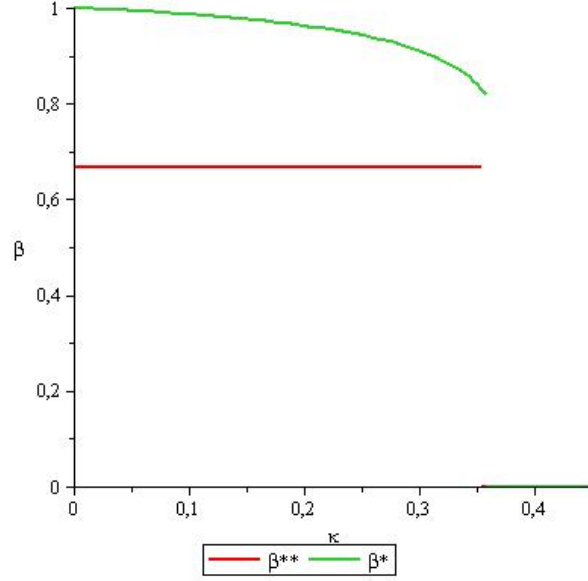


Figure 4: The state's share at equilibrium in the commitment (β^*) and no-commitment (β^{**}) cases

Proposition 2 (The no-commitment case). *Under the constraint of non-negativity of the university's profit, at the subgame perfect equilibrium, the State chooses the training quality $e^{**} = \bar{q}$ and its share β^{**} as follows:*

- (iv) $\beta^{**} = \frac{2}{3}$, if $0 \leq \kappa < \frac{6-\sqrt{21}}{4}$ (i.e. partial privatization),
- (v) $\beta^{**} = 0$ if $\kappa \geq \frac{6-\sqrt{21}}{4} \equiv \kappa_1$ (i.e. full privatization).

In the no-commitment case the university switches from partial privatization regime to full privatization one at $\kappa = \kappa_1 \simeq 0.3543$. Recall that from Proposition 1 in the commitment case the university switches to full privatization at $\kappa_0 \simeq 0.3582 > \kappa_1$. Hence, the no-commitment and commitment solutions respectively β^{**} and β^* meet from $\kappa = \kappa_0$ as depicted in Figure 4. In other words, from that value of $\kappa = \kappa_0$ the constraint on the university's profit is no longer active, and the state chooses anyway to privatize completely. Note that the values of κ_0 and κ_1 are very close, even seeming to be equal on Figure 4.

As the State does not commit to cover the university's losses, partial privatization is chosen for low values of the inefficiency parameter, but with a lower value of the state's share in the university in order to overcome the state's inefficiency. As the university is not allowed to make losses, the State chooses partial privatization even in the full efficiency case where it is as efficient as a private owner.

In Corollary 2, we provide the equilibrium outcome when the university is partially privatized. The equilibrium outcome for case (v) is the same as in case (iii) given in

Corollary 1 .

Corollary 2. *For $\kappa < \kappa_1$ (case iv), at equilibrium in the no commitment case, the university is partially privatized and prices, salary, quantity, profits and social welfare of equilibrium are given as follows:*

$$p = \frac{\bar{\theta}\bar{q}}{12}(9 + 2\kappa), \quad t = \frac{2}{3}\bar{\theta}\kappa\bar{q}, \quad \omega = \frac{\bar{\theta}\bar{q}}{12}(3 + 2\kappa), \quad Q = \frac{\bar{\theta}}{12}(3 - 2\kappa).$$

$$\Pi^U = 0, \quad \Pi^F = \frac{\bar{\theta}^2\bar{q}}{72}(3 - 2\kappa)^2, \quad SW^{NC} = \frac{\bar{\theta}^2\bar{q}}{48}(3 - 2\kappa)^2.$$

In the partial privatization case, tuition fees equal the university's marginal cost yielding to zero profit for the university. Here, under the assumption of non-negativity of the university's profit, the State absorbs as far as possible market inefficiencies due to double marginalization and chooses to hold two thirds of the university (remaining a majority) even when the State is fully efficient.

Comparing graphically (Figures 5(a) and 5(b)), the levels of social welfare achieved in the commitment and no-commitment cases with its optimal level (social optimum), we note that:

- both cases lead to suboptimal situations, except for the unrealistic full efficiency case under commitment,
- the commitment case is socially better than the no-commitment one.

Est-ce que le zoom peut être accentué? Ce dont on a besoin c'est ce qui se passe, disons, entre 0.33 et 0.37, ou même plus serré, de manière à bien faire apparaître les deux valeurs limites et en ignorant le reste qui est déjà donné dans la figure d'ensemble.

Although the partial privatization is never adopted under the social optimum (Result 1), it is adopted under the two regimes (commitment and no commitment), with different values of the state's share. The social optimum is a completely centralized solution giving the choice to the social planner of all the variables of interest. The only constraint is the balance of offer and demand on the labor market. Under the commitment and no-commitment regimes, the firm chooses its price and the university chooses the tuition fees, the state choosing its share and the training quality while anticipating the choices of the university and the firm. These regimes are doubtless more representative of the real world, the no-commitment case seeming to represent more liberal governments. Hence, when the state can no longer directly manage the economy and the universities, partial privatization appears to be a pragmatic solution

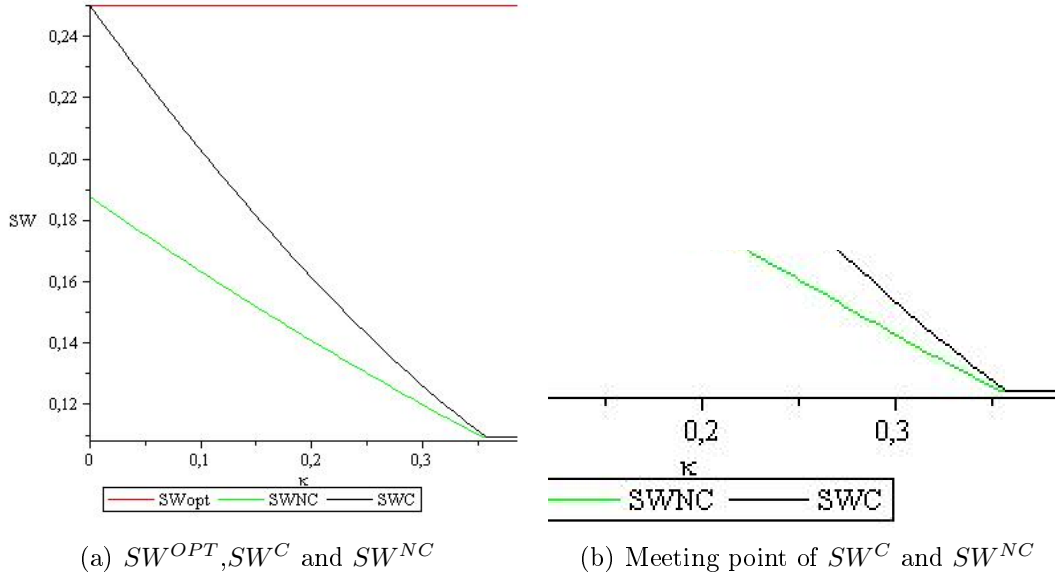


Figure 5: Comparison of social welfare at equilibrium in the commitment, no-commitment and optimum cases.

to overcome the inefficiencies of public management without losing sight of the general interest.

The social optimum being impossible to achieve, the commitment case appears as a second best solution when feasible. The no-commitment regime comes in the last position as it forbids optimal values of the state's share because of the impossibility to finance the university's losses. This simple model allows in a way to measure the loss in terms of social welfare due to the impossibility for the state to commit to cover the losses of the universities. This is so while we take into account only the effect of the university on the real economy through training and the labor market, which is clearly a small part of the externalities of higher education.

5 Conclusion

We analyzed a model of vertical successive monopolies where one initially public university sells “qualification” to students/workers who “sell” skilled labor to one producing firm who itself “sells” a final product to consumers. We suppose that State ownership generates additional costs. In the first step of the game, the government determines the quality of training and the proportion of shares it decides to hold in the university and the proportion which will be held by the private sector. At the second step, the university chooses the level of tuition fees. At the third step, the firm chooses its price. Salaries adjust balancing supply and demand on the labor market. We prove that, when the State commits to cover the university's losses, partial privatization obtains at equilibrium for low levels of public inefficiency, otherwise the university is fully privatized. Moreover, under the constraint that the university should not make losses (the no-commitment case), the results are only slightly dif-

ferent: the private sector owns one third of the university for small values of the inefficiency parameter while full privatization obtains for large values. In the two cases the State holds a large majority in the university.

Comparing the two cases with the optimum, we prove that the commitment case is closer to the optimum, thus appearing to be a second best.

Our analysis may be extended in several directions. In the first place, we did not introduce formally as is often done, a shadow cost λ of public funds. Such a shadow cost reflects the fact that "distortionary taxation inflicts disutility $1+\lambda$ on taxpayers in order to levy 1 for the state"⁶. However, what we called the "commitment case" simply corresponds to the case where the shadow cost $\lambda = 0$ while our "no-commitment case" corresponds to an infinite value of λ . Since similar qualitative results are obtained in these two extreme cases, it can safely be conjectured that they would also obtain for intermediate values of the shadow cost.

In our model, we suppose that the training quality is determined by the state. This is a natural assumption as the sector of education is generally regulated by the state, even in the most liberal countries. But this is not the only possible assumption. The potential employer, i.e. the firm, may be the one who decides the quality of training, according to its needs, especially in periods of high unemployment. This quality may also be decided by the university itself arguing that the university is in touch with the employers more than the state and that it would be safer for the employment of graduates to let the university decide the quality of training. Finally, this quality may be decided through a negotiation between the state and the employer. The university, through the employer representation in the governance boards, may as a matter of fact allow cooperation between the government and the industry on the questions related to education, where both parties may negotiate over the contents of courses and training programs.

Another issue of interest is to introduce vertical integration allowing the firm to train itself its workers. Finally we can extend our model to the oligopoly case, either in the education sector, interestingly between a public university and a private one, or on the output market with at least two firms serving the same market.

Appendix

Proof of Result 1. At optimum, the government maximizes social surplus in terms of t , β and p .

$$\begin{aligned} SW &= SC(t, p, \beta) + SL(t, p, \beta) + \Pi^U(t, p, \beta) + \Pi^F(t, p, \beta) \\ &= \frac{(\bar{\theta}e - p)^2}{2e} + \frac{(\omega - t)^2}{2e} + (t - \beta ke)(\bar{\theta} - \frac{p}{e}) + (p - \omega)(\bar{\theta} - \frac{p}{e}) \end{aligned}$$

⁶Laffont and Tirole (1993), page 55.

Substituting the equilibrium wage ω given in Equation 1, we obtain:

$$SW = \frac{(\bar{\theta}e - p)(p - \beta ke)}{e} \quad (3)$$

The FOC respectively w.r.t p , β and t gives $p = \frac{1}{2}e(\bar{\theta} + \beta k)$, $\beta = 0$, however, t is undetermined.

Then we obtain $p^{opt} = \frac{1}{2}e\bar{\theta}$ and $\beta^{opt} = 0$. Thus from the equilibrium wage relationship (1), we obtain $\omega^{opt} - t^{opt} = \frac{1}{2}\bar{\theta}e$, yielding $\Pi^{Uopt} + \Pi^{Fopt} = 0$ and $SW^{opt} = \frac{1}{4}\bar{\theta}^2e$. Maximizing SW w.r.t. e yields $e = \bar{q}$. \square

Proof of Lemma 1. We solve by backward induction. At the third step of the game, the firm maximizes its profit with respect to p . Inserting the expression of ω obtained in Equation 1 into the firm's profit:

$$\Pi^F = (p - (\bar{\theta}e - p + t))(\bar{\theta} - \frac{p}{e}) = (2p - \bar{\theta}e - t)(\bar{\theta} - \frac{p}{e}). \quad (4)$$

The FOC w.r.t p gives $p = \frac{3\bar{\theta}e + t}{4}$. Substituting this value for p in (1), we obtain $\omega = \frac{\bar{\theta}e + 3t}{4}$.

Integrating the value of p in the equilibrium output Q sold to consumers, we obtain⁷

$$Q(t) = \frac{\bar{\theta}e - t}{4e}. \quad (5)$$

At the second step of the game, we determine the level of tuition fees set by the university. First, we write SW as gross utility of consumers minus gross disutility of workers minus costs of "producing" qualified workers. Gross utility of consumers writes as

$$\int_{\theta^*}^{\bar{\theta}} \theta e \, d\theta = e \frac{\bar{\theta}^2 - \theta^{*2}}{2},$$

where $\theta^* = \frac{p}{e}$ is the marginal consumer type between the consumers who purchase and those who do not purchase the good.

Gross disutility of workers obtains as

$$\int_0^{\alpha} e \alpha \, d\alpha = e \frac{\alpha^{*2}}{2},$$

where $\alpha^* = \frac{\omega - t}{e}$ is the marginal worker type between those who choose to work and those who choose idleness.

Now SW can be written as

$$SW = e \frac{\bar{\theta}^2 - \theta^{*2}}{2} - e \frac{(\bar{\theta} - \theta^*)^2}{2} - \beta ke(\bar{\theta} - \theta^*).$$

⁷More precisely, this expression is valid only when $Q(t) \geq 0$, otherwise $Q(t) = 0$. This is so because the equation giving the output as function of the firm's price $Q = \bar{\theta} - \frac{p}{e}$ is valid only when the output is nonnegative, i.e. when the price is not too high.

Given the linear relation existing between $Q(t)$ and t at the equilibrium of the third step, it is convenient to express SW as function of Q . We obtain:

$$SW(Q) = e(-Q^2 + \bar{\theta}Q - \beta kQ). \quad (6)$$

Tuition fees are determined so as to maximize:

$$G = \beta e(-Q(t)^2 + \bar{\theta}Q(t) - \beta kQ(t)) + (1 - \beta)(t - \beta k e)Q(t).$$

The FOC w.r.t t gives $t = \frac{e(2\bar{\theta} + \beta(2k - 3\bar{\theta}))}{(4 - 3\beta)}$.

Substituting this value for t in the equilibrium of the third step of the game for the price and salary we obtain respectively, $p = \frac{e(7\bar{\theta} - 6\bar{\theta}\beta + \beta k)}{2(4 - 3\beta)}$ and $\omega = \frac{e(5\bar{\theta} - 6\bar{\theta}\beta + 3k\beta)}{2(4 - 3\beta)}$.

We integrate the equilibrium value of t in (5). The sign of $Q(t)$ is the same as $(\bar{\theta} - \beta k)$ then $Q = 0$ if $\beta > \frac{\bar{\theta}}{k}$ and all surpluses are equal to zero, $Q = \frac{(\bar{\theta} - \beta k)}{2(4 - 3\beta)}$ otherwise and all surpluses are positive.

□

Proof of Proposition 1.

Substituting the value for $Q = \frac{(\bar{\theta} - \beta k)}{2(4 - 3\beta)}$ into Equation 6 one obtains SW as function of β for $\beta \leq \frac{\bar{\theta}}{k}$,

$$SW(\beta) = e \frac{(7 - 6\beta)(\bar{\theta} - k\beta)^2}{4(4 - 3\beta)^2}$$

As SW is zero for all $\beta > \frac{\bar{\theta}}{k}$ and $SW(0) = \frac{7e\bar{\theta}^2}{64} > 0$, it follows that SW is never maximum for values of $\beta \geq \frac{\bar{\theta}}{k}$.

We want to study the maxima of this function SW with respect to β over the interval $[0, 1]$. It may be easily seen that this is equivalent to studying the maxima with respect to β , over the interval $[0, \min\{1, \frac{1}{\kappa}\}]$, of function⁸

$$H(\beta) = \frac{(7 - 6\beta)(1 - \kappa\beta)^2}{4(4 - 3\beta)^2}$$

where $\kappa = \frac{k}{\bar{\theta}}$. It is easy to compute

$$H'(\beta) = \frac{(1 - \kappa\beta)}{2(4 - 3\beta)}(-9\kappa\beta^2 - 9(1 - 4\kappa)\beta + 9 - 28\kappa).$$

$H'(\beta)$ is of the same sign as the second term in the RHS, which is a second-order polynomial denoted by $f(\beta) = (-9\kappa\beta^2 - 9(1 - 4\kappa)\beta + 9 - 28\kappa)$, except when $\kappa = 0$.

For $\kappa = 0$:
 $H(\beta) = \frac{7 - 6\beta}{4(4 - 3\beta)^2}$, then $H'(\beta) = \frac{9(\beta - 1)}{2(3\beta - 4)} > 0$ for all values of $\beta \in [0, 1]$. Hence, H is increasing w.r.t β and $\beta^* = 1$.

⁸The two functions reach their maxima at the same point.

For $\kappa > 0$ according to the sign of the determinant of the second-order polynomial, one obtains:

- For all values of $\kappa \in [\frac{3}{8}, \frac{3}{4}]$, the determinant is negative, hence $H'(\beta) < 0$ always and H is decreasing w.r.t β , hence $\beta^* = 0$.

- For all values of $\kappa \in]0, \frac{3}{8}[\cup]\frac{3}{4}, +\infty[$, f has two roots and only the largest one $\hat{\beta}$ may correspond to a local maximum of function H , as the sign of f is positive before and negative after:

$$\hat{\beta}(\kappa) = \frac{1}{6\kappa}(12\kappa - 3 + \sqrt{9 - 36\kappa + 32\kappa^2})$$

More precisely, given the negative sign of the coefficient of the second-order term (-9κ) , there are three potential local maxima: $\beta = 0$, $\beta = \hat{\beta}$ and $\beta = \min(1, \frac{1}{\kappa})$. Moreover $\beta = \min(1, \frac{1}{\kappa})$ is a local maximum only when $\hat{\beta} > \min(1, \frac{1}{\kappa})$.

- For $\kappa \in]0, \frac{3}{8}[$:
we are going to prove that $\hat{\beta}(\kappa) \in [0, 1]$.

Since $\frac{\partial \hat{\beta}(\kappa)}{\partial \kappa} = \frac{-4\kappa^2}{2\sqrt{9-36\kappa+32\kappa^2}(-6\kappa+3+\sqrt{9-36\kappa+32\kappa^2})} < 0$, $\lim_{\kappa \rightarrow 0} \hat{\beta}(\kappa) = 1$ and $\lim_{\kappa \rightarrow \frac{3}{8}} \hat{\beta}(\kappa) = \frac{2}{3}$, then, $0 < \hat{\beta}(\kappa) < 1$.

Thus only $\beta = 0$ and $\hat{\beta}$ are potentially local maxima of H . We then need to compare $H(\hat{\beta})$ with $H(0)$. It turns out that $H(\hat{\beta}) \geq H(0)$ if $\kappa \leq \frac{3}{28}(9 - 4\sqrt{2}) \simeq 0.3581954$, and $\beta^* = \hat{\beta}(\kappa)$. Otherwise, $H(\hat{\beta}) < H(0)$ and $\beta^* = 0$.

- For $\kappa \in]\frac{3}{4}, +\infty[$:
 - If $\kappa \in]\frac{3}{4}, 1[$, since $\hat{\beta}(\kappa) - 1 = \frac{6\kappa-3+\sqrt{9-36\kappa+32\kappa^2}}{6\kappa} > 0$ and $f(1) < 0$ for $\kappa < 1$, then the roots of the polynomial are necessarily both larger than $\beta = 1$. Thus $f(\beta) < 0$ for all values of $\beta \in [0, 1]$, hence H is decreasing w.r.t β and $\beta^* = 0$.
 - If $\kappa \in [1, +\infty[$, we have to maximize⁹ $H(\beta)$ on $[0, \frac{1}{\kappa}]$.

$\hat{\beta}(\kappa) - \frac{1}{\kappa} = \frac{12\kappa-9+\sqrt{9-36\kappa+32\kappa^2}}{6\kappa} > 0$ over this interval and we can easily prove that¹⁰ $f(\frac{1}{\kappa}) < 0$. Then both roots of f are larger than $\frac{1}{\kappa}$, implying that $f(\beta) < 0$ for all values of $\beta \in [0, \frac{1}{\kappa}]$. Hence H reaches its maximal value for $\beta^* = 0$.

⁹Here $\min(1, \frac{1}{\kappa})$ shifts to $\frac{1}{\kappa}$.

¹⁰The sign of this expression is the same as $-28\kappa^2 + 27\kappa - 9$ which is a second order polynomial with a negative determinant.

From Equation 6 and knowing that equilibrium quantity at the second step of the game writes $Q = \frac{(\bar{\theta} - \beta k)}{2(4 - 3\beta)}$, we easily deduce that SW is increasing w.r.t e . Hence maximizing SW w.r.t e gives $e^* = \bar{q}$. \square

Proof of Corollary 1.

We substitute the equilibrium value β^* in the expressions of the price, salary, quality, profits and surpluses at the equilibrium of the second step given in Lemma 1. \square

Proof of Proposition 2.

We solve the game under the constraint that the university does not make losses. It amounts to look if $t \geq \beta ke$ when $\kappa \in [0, \frac{3}{28}(9 - 4\sqrt{2})[$.

$$t - \beta ke = \frac{e(2\bar{\theta} + \beta(2k - 3\bar{\theta}))}{4 - 3\beta} - \beta ke = e \frac{3\beta - 2}{3\beta - 4}(\bar{\theta} - k\beta) \geq 0.$$

The condition reduces to $\frac{3\beta - 2}{3\beta - 4} \geq 0$. It must then be that $0 \leq \beta^* \leq \frac{2}{3}$. Let's check if $0 \leq \hat{\beta}(\kappa) \leq \frac{2}{3}$:

$$\begin{cases} \frac{\partial \hat{\beta}(\kappa)}{\partial \kappa} = \frac{4\kappa^2}{k^2\sqrt{9-36\kappa+32\kappa^2}(6\kappa-3-\sqrt{9-36\kappa+32\kappa^2})} < 0; \\ \lim_{\kappa \rightarrow \frac{3}{28}(9-4\sqrt{2})} \hat{\beta}(\kappa) = 0.81769 > \frac{2}{3}. \end{cases}$$

Hence $\hat{\beta}(\kappa) > \frac{2}{3}$ for all values of $\kappa \in]0, \frac{3}{28}(9 - 4\sqrt{2})[$. Partial privatization with $\beta = \hat{\beta}(\kappa)$ is never feasible on this interval. Only $\beta = 0$ and $\beta = \frac{2}{3}$ are potential maxima of SW . We then need to compare¹¹ $SW(0)$ and $SW(\frac{2}{3})$. It turns out that $SW(\frac{2}{3}) > SW(0)$ if $0 \leq \kappa \leq \frac{6-\sqrt{21}}{4}$ and $\beta^* = \frac{2}{3}$. Otherwise if $\frac{6-\sqrt{21}}{4} < \kappa < \frac{3}{28}(9-4\sqrt{2})$, $SW(\frac{2}{3}) < SW(0)$ and $\beta^* = 0$.

From Equation 6 and knowing that equilibrium quantity at the second step of the game writes $Q = \frac{(\bar{\theta} - \beta k)}{2(4 - 3\beta)}$, we easily deduce that SW is increasing w.r.t e . Hence maximizing SW w.r.t e gives $e^* = \bar{q}$. \square

Proof of Corollary 2.

We substitute the equilibrium value of $\beta = \frac{2}{3}$ in the expressions of prices, salary, quality, profits and social welfare given as a function of β at the equilibrium of the second step in proof of Lemma 1. \square

¹¹The sign of $SW(0) - SW(\frac{2}{3})$ is the same as $(-15 + 48\kappa - 16\kappa^2)$.

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