Politics, Regulation and Investment in the Telecommunications Industry

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Abstract

This paper attempts to examine the vertically integrated incumbent's incentive to invest in its network, which can benefit both the incumbent and the independent rival. A Cournot model is developed that takes political economy issues into consideration, in which special-interest groups make political contributions to influence the regulator's access price decision. The game that is analyzed has three stages. Firstly, the incumbent makes an investment decision on its upstream network. Secondly, both firms lobby the regulator for a preferential access price. Then the regulator sets the access price under the political influence. Finally, two firms compete in quantities in the downstream retail market. The following main insights are derived. The presence of lobbying may provide an incentive for the incumbent to over-invest (compared to the monopoly level) if the independent rival cannot take full advantage of investment. However, it may also provide an incentive for the incumbent to under-invest (compared to the socially optimal level) if the independent rival has the same efficiency as the incumbent in using the investment. It is also demonstrated that if the regulator, under the political influence, sets the access price above the marginal cost, the incumbent wins the political competition and benefits from lobbying, while the rival's profit is lower than it would be in the absence of lobbying. Overall, the existence of lobbying may be welfare-reducing.

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1 Introduction

The development of telecommunications in China has been increasing rapidly since the 1990s. It has become one of the fastest-growing industries in China's national economy. The telecom revenue increased by approximately 20% annually between 1995 and 2000. Despite a depression in the world telecommunications sector after 2000, it still maintained a high rate of increase at around 10%. Especially in terms of investment, the Chinese telecommunications industry has been maintaining continuously high growth, over RMB200 billion every year since 2000 (see Figure 1). For four years after China's WTO entry in 2001, China Telecom (CT), the incumbent fixed network operator, spent 30-40% of its sales on investment per annum. Although this percentage has tended to decrease, it is still much higher than the level of other advanced telecommunications operators in the world. For example, the local exchange carriers in the US routinely spent 20-22% of their sales on replacing, refurbishing or upgrading plants and equipment[1]. British Telecom (BT), the main operator over fixed-line networks in the UK, spent 10-20% of its revenue on investment in the same four-year period (see Table 1).

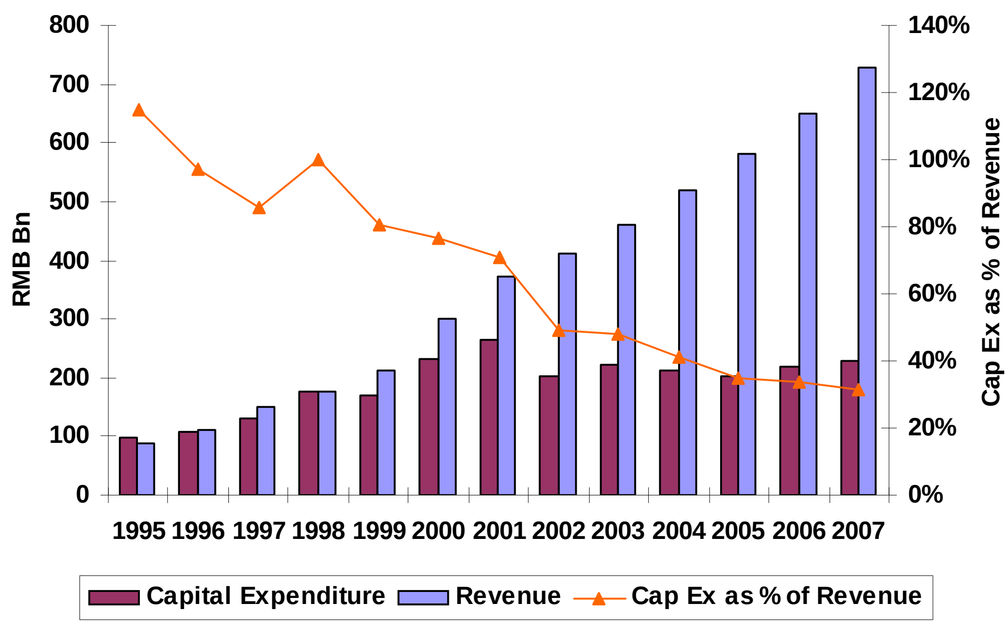

Figure 1: Revenue and Investment of the Chinese Telecommunications Industry

[1]See "Investment, Capital Spending and Service Quality in U.S. Telecommunications Networks: A Symbiotic Relationship", TIA.

Capital Expenditure as % of Revenue

Company	2002	2003	2004	2005
China Telecom	41.1%	36.2%	36.9%	33.1%
British Telecom	16.8%	12.7%	13.4%	12.9%

Source: Compiled by the author based on the annual reports of CT and BT.

Table 1: Comparison between CT and BT

In spite of the dramatic development in the past two decades, China's legislative process in telecommunications has lagged far behind compared to other countries like the US and the UK[2]. So far China still has no Telecommunication Act or something similar. Due to the lack of a state decree, most lobbying activities happen between individual carriers and the regulatory authority by means of behind-the-scene persuasion, complaint and exchange (Sheng, 2001). In China there is no explicit political donation as in the democratic countries, but the regulator is in fact receptive to political pressures to a great extent. The validity of seeking preferential policies not only depends on the nature and status of firms, for example whether the firms are state-owned, collectively-owned, joint venture or so on, but also depends on the firms' network and relationship with the regulatory department and competent officials. An example, which shows the regulatory outcome can be influenced by the politically powerful firm, is the MPT's asymmetric regulation towards China Unicom (CU), the first and main competitor against the incumbent China Telecom (CT). The historically close affiliation between CT and the regulator MPT inevitably affected the policy making. As a result, CU, hampered by the distorted regulation, developed very slowly at the beginning of its entry. The establishment of MII in 1998 crippled the close relationship between the incumbent CT and the regulator to some extent. Then the incumbent's political influence was further weakened by China's commitment to the WTO Basic Telecommunications Agreement, which requires that member countries be committed to establishing an independent regulatory body that "is separate from, and not accountable to any supplier of basic telecommunications services. The decision of the procedure used by regulators shall be impartial with respect to all market participants". All these observations help form the idea to examine the impact of political transactions on investment in the telecommunications

[2]The US Telecommunication Act was originally enacted in 1934 and the current one was implemented in 1996. The UK Telecommunication Act came into being in 1984.

industry.

The remainder of the paper is organized as follows: Section 2 gives a review of the relevant literature. Section 3 outlines the basic structure of the model, and the outcome of the game is presented in Section 4. It turns out that a closed form solution for all results can not be simplified and easily compared due to the complexity of coefficients. Hence, in order to gain some insight into the solution of the game, discrete values of weight parameter of social welfare and the level of spillover are assumed and then the results of the game are characterized in Section 5. Section 6 concludes the paper.

2 Literature review

When examining a network provider's investment incentives in the telecommunications industry, previous studies have mainly focused on the effect of access price both when there is no regulation and when the access price is regulated. Typically, they assume a benevolent government, which is immune from political pressures and regulates the access price to maximize welfare. Two recent papers regarding the investment in telecommunications are Foros (2004) and Kotakorpi (2006). Foros analyses the competition between a (facility-based) vertically integrated firm[3] and an independent competitor in the retail market for broadband Internet connectivity. He examines the vertically integrated monopolist's incentives to upgrade its network to broadband both with and without regulation of the access price. He assumes Cournot competition between the Internet Service Providers (ISPs) in the retail market with no horizontal differentiation in the downstream segment. Foros emphasizes that in the presence of access price regulation, the incumbent can use overinvestment (relative to the monopoly level) to deter entry when the incumbent's ability to offer value added services is much higher than that of the rival. Kotakorpi considers a similar framework with a vertically integrated network provider facing price-taking rival operators in the retail market. She demonstrates that the incumbent under-invests (relative to the socially optimal level) and when the rivals are relatively efficient in turning the investment into value added services, suboptimal investments can lead to foreclosure. Neither of them considers the effect of political influence on the access price regulation.

This paper improves on the above two by adopting the general approach of the political economy literature by assuming the government has its own incentive to set policies. This is related to the well established common agency model of political support developed by Grossman and Helpman (1994) whose theoretical foundation is based on Bernheim and Whinston (1986). Grossman and Helpman construct a model

[3] "Facility-based" operator refers to the one with its own network to which the consumers subscribe. On the contrary, "non-facility-based", or independent, operator that is without its own network, has to access to the "facility-based" operator's network so as to reach the end users. Thus this access is an essential input for the independent operator's service.

in which special-interest groups make political contributions in order to influence an incumbent government's choice of trade policy. In their model, politicians maximize their own welfare, which depends on total contributions collected and on the welfare of voters, rather than maximizing social welfare alone as a benevolent government does. Following Grossman and Helpman, many authors have considered the role of political transactions in a number of contexts. Recently a growing body of literature introduces the political economy approach into research in many fields, for instance the studies on international trade and environmental issues[4]. It is somewhat surprising that no such attempt has been made in the telecommunications industry and related regulatory policies. In terms of lobbying and investment, the only paper appears to be that of Damania (2003), who considers an international trade context where a domestic oligopoly competes with foreign producers and the domestic firms are protected by a tariff. Lobbying is introduced into this framework to examine the interaction between investment, lobbying and protectionist policy decisions. The central message of Damania's study is that when governments are receptive to political pressures, this may provide an incentive for firms to reject cost saving investments.

This paper is intended to examine the incumbent network provider's investment decisions given that the regulator sets the access price under the political influence. The main result is that the presence of political influence can provide an incentive for the incumbent to invest more than the socially optimal level if the rival's ability to use the investment is not very high and if the rival is not much more efficient than the incumbent.

3 The model

A model is set up with duopoly competition in the retail market. One firm, the incumbent with its own network, is vertically integrated and controls the essential input market for local access as well as provides services in the downstream retail market. The other is an independent rival, who does not have its own network but has to buy local access as an input to serve end users and thus compete with the subsidiary of the upstream monopolist. In the present model, the vertically integrated firm is assumed to be able to undertake an investment in its network, which may improve the efficiency (or reduce the cost) of both the incumbent and the entrant to supply the final services. For example, the firm can upgrade its network to facilitate easier access, faster delivery and fewer congestion problems in telephony services. Or, in the case of consumers using their telephone lines to access Internet, the firm may invest in upgrading narrowband to broadband Internet connectivity so as to increase the speed of communication, the capacity and quality of the network.

[4]The literature regarding politics and international trade, see Ma (2005), Damania (2003), Li and Chen (1998) and Grossman & Helpman (1995b); regarding politics and environment issues, see Yu (2005).

3.1 The basic setup

Assume that the aggregate domestic demand curve for the homogeneous product is linear and the inverse demand function $p = 1 - Q$, where Q is the total output of firms in the downstream retail market. The amount of the service provided by firm i is q_i $(i = 1, 2)$, thus $Q = q_1 + q_2$. The subscripts 1 and 2 indicate the facility-based integrated firm and the non-facility-based rival, respectively. The consumer surplus is given by $CS = \frac{(q_1+q_2)^2}{2}$.

On the supply side, regarding the vertically integrated firm's cost in the upstream segment for local access, this is simply normalized to zero since it plays no role in the analysis. The vertically integrated firm has the choice to invest in its infrastructure, which may involve upgrading its network or any activity in cost-reducing technology. Assume that it faces a quadratic network investment cost given by $\Gamma(m) = \mu m^2/2$, where m is the investment level by which the integrated firm can reduce its cost, or equivalently increase its efficiency in serving its end users. It is also assumed that this investment level does not have any effect on the upstream marginal cost. Since the incumbent and the rival use the same network, the rival may also benefit from, but may have different ability to take advantage of, this cost-reducing investment. The fraction of the benefits from the investment that spills over to the rival is denoted by β $(0 \leqslant \beta \leqslant 1)$[5], so that the rival's marginal cost to supply the retail services is reduced by βm. The profit functions for both firms are then given by

$$\Pi_1^G = [p - (c_1 - m)]\, q_1 + a q_2 - \frac{1}{2}\mu m^2 \tag{1}$$

$$\Pi_2^G = [p - (c_2 - \beta m) - a]\, q_2 \tag{2}$$

$\Pi_i^G (i = 1, 2)$ denotes gross-of-contributions profits. c_i $(i = 1, 2)$ is the marginal cost in the downstream market when both firms serve the end users before any investment occurs. a denotes the access charge that the rival pays to use the incumbent's network. Assume that $a \geqslant 0$, that is, the access price is at least as much as the marginal cost of running the network, which is assumed zero in this study. Since the vertically integrated firm is active in both upstream and downstream segments, its profit comes from its retail services (first part of profit function (1)) as well as the sale of access to its rival (second part of profit function (1)). For the independent downstream rival,

[5] In fact, β here measures the rival's relative ability to use the infrastructure improvement invested by the incumbent. If we assume β_1 and β_2 are spillovers from the facility-based firm to its own subsidiary and the rival respectively, then we should have $\beta = \frac{\beta_2}{\beta_1}$. Therefore, when $0 < \beta < 1$, the rival has lower ability to use the investment. When $\beta = 0$, the rival has no way of getting any benefit from the investment. When $\beta = 1$, the rival benefits from the investment the same as the incumbent's subsidiary. In this paper, the value of β is restricted to be no more than 1, that is we exclude the possibility that the rival has a higher ability to use the investment. The reason is, in the presence of access price regulation, the investment is the only strategic tool for the incumbent to compete against its rival. Consequently, the incumbent chooses to invest only when it believes this activity would bring no less benefit to itself than to its rival.

the access charge can be regarded as another part of marginal cost when the firm needs the essential input from the incumbent to complete its service.

Following Grossman and Helpman (1994), it is assumed that the government is interested in both aggregate well-being and political contributions. The aggregate social welfare, as commonly defined, includes consumer surplus as well as firms' gross-of-contributions profits, which is given by

$$W = \Pi_1^G + \Pi_2^G + CS$$

where

$$\Pi_i^G = \Pi_i + S_i \quad i = 1, 2$$

Π_i is firm i's net profit (gross profit less contributions). S_i is firm i's political contribution. In democratic countries, such as the US, this W reflects an average voter's welfare; while in countries of highly centralized and authoritarian governments, such as China, even if there is no concern of re-election, a higher aggregate social welfare helps to portray an image of higher political achievement, which in turn helps to consolidate the politician's position (Li & Chen, 1998). The other factor that the government cares about is political contributions or bribes from lobby groups. These political contributions are valued by the government because they can be used in many ways, such as financing a politician's re-election campaign in the case of democratic politics or improving a politician's personal consumption in general.

Following the political economy literature, a linear objective function is adopted for the government which maximizes a weighted sum of political contributions and aggregate social welfare

$$G = S_1 + S_2 + \lambda W$$

where λ is the weight attached to the aggregated social welfare relative to political contributions. The only restriction for λ is $\lambda \geqslant 0$. If $\lambda = 0$, the government cares only about political contributions. If $\lambda \to \infty$, the above equation becomes the same as when the government is benevolent and not captured by political contributions. In order to focus on the competition between two firms, it is assumed that politically unorganized consumers have no means to influence policy like the firms do. The reason can be because of either governmental pro-industry policy or the "free-rider" problem of consumers' lobbying.

3.2 The timing of the game

Consider a four-stage game and the timing is as follows:

- *Stage 1*: The vertically integrated firm makes an investment in the cost-reducing technology or upgrading its network. With this investment, the incumbent can reduce its marginal cost of providing its service by m. The rival, who also uses the network, can reduce its marginal cost by βm.

- *Stage 2*: Each interest group (firm) simultaneously determines its policy-contingent contribution schedule $S_i(a)$ $(i = 1, 2)$ to lobby for its favorable policy, i.e. the access price.

- *Stage 3*: The government (regulator), who is self-interested and under the pressure of interest groups, sets the access price a to the downstream independent firm.

- *Stage 4*: Two firms compete à la Cournot in the retail market.

The reason why the investment occurs first is that it is irreversible and normally is a huge amount in the telecommunications industry. In contrast, the access price can be changed more easily and quickly. Although the government can act as a first-mover in the above game, its commitment to the ex ante regulation may not be credible. Therefore in this paper it is assumed the government can only set the access price after the investment takes place.

4 Equilibrium outcomes of the game

The game is solved by backward induction.

4.1 Stage 4: Retail market competition

In the last stage, taking the investment level and the access price as given, both firms maximize their profits by choosing quantities. Thus the equilibrium outputs are given by the solutions to the first order conditions

$$q_1^* = \frac{2\Delta_1 - \Delta_2}{3} + \frac{1}{3}a + \frac{2-\beta}{3}m \tag{3a}$$

$$q_2^* = \frac{-\Delta_1 + 2\Delta_2}{3} - \frac{2}{3}a + \frac{-1+2\beta}{3}m \tag{3b}$$

$$Q^* = q_1^* + q_2^* = \frac{\Delta_1 + \Delta_2}{3} - \frac{1}{3}a + \frac{1+\beta}{3}m \tag{3c}$$

Here let $\Delta_1 = 1 - c_1$ and $\Delta_2 = 1 - c_2$ for simplicity of notation. Δ_i $(i = 1, 2)$ can be interpreted as firms' production efficiency. The bigger the value of Δ_i $(i = 1, 2)$, the more efficient the firm is in its production. Assume that $\Delta_1 \geqslant 0$ and $\Delta_2 \geqslant 0$. From (3), it can be noted that the incumbent's quantity increases with the access price ($\frac{\partial q_1^*}{\partial a} > 0$), while the rival's decreases with the access price ($\frac{\partial q_2^*}{\partial a} < 0$). This is due to the fact that the access charge is an extra cost for the rival which the incumbent's subsidiary does not need to bear[6]. From the inverse demand function $p = 1 - Q$, the

[6]It implies, given the freedom to set the access charge, the vertically integrated firm has an incentive to raise a so high to disadvantage its rival in the competition, which is known as "raising rival's cost" strategy. In that case, foreclosure may happen.

retail price is given by

$$p^* = 1 - \frac{\Delta_1 + \Delta_2}{3} + \frac{1}{3}a - \frac{1+\beta}{3}m$$

Clearly the market equilibrium price rises with the access price ($\frac{\partial p^*}{\partial a} > 0$).

Accordingly, two firms' gross-of-contributions profits are given by

$$\begin{aligned}
\Pi_1^{G*} &= \left(\frac{2\Delta_1 - \Delta_2}{3} + \frac{1}{3}a + \frac{2-\beta}{3}m\right)^2 + a\left(\frac{-\Delta_1 + 2\Delta_2}{3} - \frac{2}{3}a + \frac{-1+2\beta}{3}m\right) - \frac{1}{2}\mu m^2 \\
\Pi_2^{G*} &= \left(\frac{-\Delta_1 + 2\Delta_2}{3} - \frac{2}{3}a + \frac{-1+2\beta}{3}m\right)^2
\end{aligned}$$

4.2 Stage 2 and 3: The political equilibrium

In stage 2 and 3, the firms lobby the policy maker for their favorable access price and the government sets a under the political pressure. This two-stage game is quite similar to those in the political economy literature which focus on competition for the political influence. Specifically, a subgame perfect Nash equilibrium for these two stages is a policy-contingent political contribution schedule $S_i(a)$ for each firm and access price a, which satisfy: (i) the contribution is feasible and maximizes each interest group's (net) profit given the contribution from the other group; (ii) by setting access price a, the government maximizes its welfare, taking the contribution schedules as given.

Following Grossman and Helpman (1994), in this paper the "truthful contribution schedule" is applied to solve the political equilibrium. This schedule asserts that each firm sets its contribution schedule so that the marginal change in the contribution for a small change in the policy matches the effect of the policy change on the firm's gross welfare (around the equilibrium), that is,

$$\frac{\partial \Pi_i^G(a^*)}{\partial a^*} = \frac{\partial S_i(a^*)}{\partial a^*} \tag{4}$$

These contribution schedules are noted as "locally truthful" in Grossman and Helpman (1994). Both Bernheim and Whinston (1986) and Grossman and Helpman (1994) have showed it can be extended to a *truthful contribution schedule* that *everywhere* reflects the true preference of the lobby. As equation (4) shows, the "truthful contribution schedule" virtually pays the excess of an interest group's gross welfare relative to some base level. Formally, a truthful contribution function takes the form

$$S_i(a, B_i) = \max\left[0, \Pi_i^G - B_i\right] \tag{5}$$

for some B_i, which is a constant and some base level of welfare chosen by firm i. Expression (5) indicates that the truthful contribution schedule makes the government the residual claimant.

Let a^* be the access price level in the presence of lobbies from both firms and a_i $(i = 1, 2)$ be the access price level in the presence of lobby from firm i $(i = 1, 2)$ only, that is, the contribution offered by firm j $(j = 1, 2;\ j \neq i)$ is zero. The subgame perfect Nash equilibrium of Stage 2 and 3 can be characterized by the following Lemma.

Lemma 1 *(i) The equilibrium level of access price satisfies:*

$$a^* = \arg\max_a \Pi_1^G (a) + \Pi_2^G (a) + \lambda W (a)$$

(ii) The equilibrium levels of political contributions are:

$$S_i (a^*, B_i) = \left[\Pi_j^G (a_j) + \lambda W (a_j)\right] - \left[\Pi_j^G (a^*) + \lambda W (a^*)\right] \quad \textit{for } i, j = 1, 2;\ i \neq j \tag{6}$$

where a_j is the access price level when the contribution offered by firm i were zero, that is,

$$a_j = \arg\max_a \Pi_j^G (a) + \lambda W (a)$$

Proof. See Appendix 6. ■

Lemma 1 shows an interesting property of the equilibrium with the truthful contribution schedule. As it is shown in (i), in equilibrium, truthful contribution schedules will induce the government to behave as if it were maximizing a social welfare function with different weights on different members of society. For example, the incumbent firm and the rival receive a weight of $1 + \lambda$ on their surplus respectively, and the consumers, who are assumed to have no lobbying power, receive the smaller weight of λ.

4.2.1 Equilibrium access price under the political influence

Next equilibrium access price a^* is calculated, which maximizes the government's welfare when the contributions are offered by both firms

$$a^* = \arg\max_a \Pi_1^G (a) + \Pi_2^G (a) + \lambda W (a) \tag{7}$$

The first order condition of (7) yields the solution to a^*, which is given by

$$a^* = \frac{(5 + 4\lambda)\,\Delta_1 - (4 + 5\lambda)\,\Delta_2}{2 + \lambda} + \frac{(5 + 4\lambda) - (4 + 5\lambda)\,\beta}{2 + \lambda} m \tag{8}$$

The second order condition is satisfied as

$$\frac{\partial^2 G}{\partial a^2} = -\frac{2 + \lambda}{9} < 0$$

Note that

$$\frac{\partial a^*}{\partial m} = \frac{(5 + 4\lambda) - (4 + 5\lambda)\,\beta}{2 + \lambda} > 0 \text{ iif } \beta < \frac{5 + 4\lambda}{4 + 5\lambda} < \frac{5}{4} \text{ or } 0 < \lambda < \frac{5 - 4\beta}{5\beta - 4}$$

The investment of the incumbent can have a positive effect on the access price under certain conditions.

Substituting (8) into (3) yields the equilibrium quantities as functions of the investment level, which are given by

$$
\begin{aligned}
q_1^* &= \frac{(3+2\lambda)\,\Delta_1-(2+2\lambda)\,\Delta_2}{2+\lambda}+\frac{(3+2\lambda)-(2+2\lambda)\,\beta}{2+\lambda}m && \text{(9a)}\\
q_2^* &= \frac{-(4+3\lambda)\,\Delta_1+(4+4\lambda)\,\Delta_2}{2+\lambda}+\frac{-(4+3\lambda)+(4+4\lambda)\,\beta}{2+\lambda}m && \text{(9b)}\\
Q^* &= \frac{-(1+\lambda)\,\Delta_1+(2+2\lambda)\,\Delta_2}{2+\lambda}+\frac{-(1+\lambda)+(2+2\lambda)\,\beta}{2+\lambda}m && \text{(9c)}
\end{aligned}
$$

Assume that $q_2^* > 0$, otherwise the rival is foreclosed from the retail market, which leaves the incumbent a monopolist. The firms' gross-of-contribution profits, $\Pi_1^G(a^*)$ and $\Pi_2^G(a^*)$, and the consumer surplus, $CS(a^*)$, can be calculated after substituting (8) and (9) into (1), (2) and $CS=\frac{1}{2}Q^2$. Accordingly, $\Pi_1^G(a^*)+\lambda W(a^*)$ and $\Pi_2^G(a^*)+\lambda W(a^*)$ can be derived easily.

4.2.2 Political contributions

To calculate the contribution from each firm, let a_1 (a_2) denote the access price that jointly maximizes the welfare of the incumbent (the rival) and the government, equivalently, the contribution offered by the rival (the incumbent) is zero. According to Lemma 1, access prices a_1 and a_2 can be derived from

$$
\begin{aligned}
a_1 &= \arg\max_a \Pi_1^G+\lambda\left(\Pi_1^G+\Pi_2^G+CS\right) && \text{(10a)}\\
a_2 &= \arg\max_a \Pi_2^G+\lambda\left(\Pi_1^G+\Pi_2^G+CS\right) && \text{(10b)}
\end{aligned}
$$

The first order condition of (10a) with respect to a is

$$
\begin{aligned}
&\frac{\partial\Pi_1^G}{\partial a}+\lambda\left(\frac{\partial\Pi_1^G}{\partial a}+\frac{\partial\Pi_2^G}{\partial a}+\frac{\partial CS}{\partial a}\right)\\
=\;&\frac{(1+4\lambda)\,\Delta_1+(4-5\lambda)\,\Delta_2}{9}-\frac{10+\lambda}{9}a+\frac{(1+4\lambda)+(4-5\lambda)\,\beta}{9}m
\end{aligned}
$$

The second order condition is fulfilled as $-\frac{10+\lambda}{9}<0$. Access price a_1, set by the government when the rival makes no political contribution, is thus given by

$$
a_1=\frac{(1+4\lambda)\,\Delta_1+(4-5\lambda)\,\Delta_2}{10+\lambda}+\frac{(1+4\lambda)+(4-5\lambda)\,\beta}{10+\lambda}m \qquad (11)
$$

Substituting (11) into (1), (2) and $CS=\frac{1}{2}Q^2$ gives rise to the firms' gross-of-contribution profits, $\Pi_1^G(a_1)$ and $\Pi_2^G(a_1)$, and the consumer surplus, $CS(a_1)$. Accordingly, $\Pi_1^G(a_1)+\lambda W(a_1)$ can also be obtained. Given $\Pi_1^G(a_1)+\lambda W(a_1)$ and

$\Pi_1^G(a^*) + \lambda W(a^*)$, the political contribution from the rival can be derived from the following

$$S_2^*(a^*, B_2) = \left[\Pi_1^G(a_1) + \lambda W(a_1)\right] - \left[\Pi_1^G(a^*) + \lambda W(a^*)\right]$$

The political contribution of the incumbent can be derived in the same way. The first order condition of (10b) with respect to a is

$$\begin{aligned} & \frac{\partial \Pi_2^G}{\partial a} + \lambda\left(\frac{\partial \Pi_1^G}{\partial a} + \frac{\partial \Pi_2^G}{\partial a} + \frac{\partial CS}{\partial a}\right) \\ = \quad & \frac{4(1+\lambda)\Delta_1 - (8+5\lambda)\Delta_2}{9} + \frac{8-\lambda}{9}a + \frac{4(1+\lambda) - (8+5\lambda)\beta}{9}m \end{aligned}$$

Checking the second order condition

$$\frac{\partial^2 G}{\partial a^2} = \frac{8-\lambda}{9}$$

Note that if $\lambda < 8$, the optimization problem yields a minimum. It is because the access price is part of the rival's cost to provide the retail service. So the rival always prefers an access price as low as possible. Consequently, when the political contribution is from the rival only, the lower the access price, the higher the government's welfare. Together with the assumption that $a \geqslant 0$, the government will achieve its maximum at $a_2 = 0$, that is, the access price will be set at the marginal cost level of running the network. Thus it is assumed that $\lambda < 8$ henceforth in the following analysis[7]. Substituting $a_2 = 0$ into the profit functions and CS function yields the following

$$\begin{aligned} \Pi_1^G(a_2 = 0) &= \left(\frac{2\Delta_1 - \Delta_2}{3} + \frac{2-\beta}{3}m\right)^2 - \frac{1}{2}\mu m^2 \\ \Pi_2^G(a_2 = 0) &= \left(\frac{-\Delta_1 + 2\Delta_2}{3} + \frac{-1+2\beta}{3}m\right)^2 \\ CS(a_2 = 0) &= \frac{1}{2}\left(\frac{\Delta_1 + \Delta_2}{3} + \frac{1+\beta}{3}m\right)^2 \end{aligned}$$

Furthermore, $\Pi_2^G(a_2 = 0) + \lambda W(a_2 = 0)$ can be also calculated. Given $\Pi_2^G(a_2 = 0) + \lambda W(a_2 = 0)$ and $\Pi_2^G(a^*) + \lambda W(a^*)$, the political contribution of the incumbent can be derived by

$$S_1^*(a^*, B_1) = \left[\Pi_2^G(a_2 = 0) + \lambda W(a_2 = 0)\right] - \left[\Pi_2^G(a^*) + \lambda W(a^*)\right]$$

4.3 Stage 1: The incumbent's investment choice

This section investigates the incumbent's investment decisions. To find out whether the presence of lobbying affects the incumbent's investment level, the cases in the absence of lobbying will be examined first.

[7] When $\lambda > 8$, the optimization problem yields a maximum, which contradicts the fact that the rival lobbies for a low access price.

4.3.1 Investment in the absence of lobbying

Consider a market regulated by a benevolent government without any political influence. The government does not impose any requirement over retail prices, but monitors the level of the access charge. With cost-based regulation, the access price is set equal to the marginal cost, i.e. $a^{NL} = 0$ in this paper. Superscript NL denotes the terms of social optimum with no lobbying. Substituting $a^{NL} = 0$ into (3) yields the equilibrium quantities

$$q_1^{NL} = \frac{2\Delta_1 - \Delta_2}{3} + \frac{2-\beta}{3}m \tag{12a}$$

$$q_2^{NL} = \frac{-\Delta_1 + 2\Delta_2}{3} + \frac{-1+2\beta}{3}m \tag{12b}$$

$$Q^{NL} = \frac{\Delta_1 + \Delta_2}{3} + \frac{1+\beta}{3}m \tag{12c}$$

In this case, the incumbent has no revenue from access. Thus its objective function is given by

$$\max_m \Pi_1^{NL} = \left(\frac{2\Delta_1 - \Delta_2}{3} + \frac{2-\beta}{3}m\right)^2 - \frac{1}{2}\mu m^2 \tag{13}$$

The first order condition of (13) yields the optimal investment level of the incumbent when the access price is zero

$$m^{NL} = \frac{2(2-\beta)(2\Delta_1 - \Delta_2)}{9\mu - 2(2-\beta)^2} \tag{14}$$

For the second order condition to be fulfilled, it is assumed that

$$9\mu - 2(2-\beta)^2 > 0$$

Substituting (14) into (12) would yield the quantities as functions of parameters λ, β, Δ_1 and Δ_2.

For the sake of comparison in the following analysis, consider the monopoly case where the incumbent is the only firm in the market. Thus its profit function is given by

$$\Pi_1 = [p - (c_1 - m)]\, q_1 - \frac{1}{2}\mu m^2$$

where $p = 1 - q_1$. The first order condition with respect to q_1 yields the optimal quantity as a function of m. Substituting q_1 into the incumbent's profit function and taking the first order condition with respect to m would yield the monopoly optimal investment level

$$m^M = \frac{\Delta_1}{2\mu - 1} \tag{15}$$

Superscript M denotes the monopoly level.

4.3.2 Investment with political contributions

Next, the vertically integrated firm's investment decision is investigated when both firms can lobby the government for their favorable access prices. In such a situation, the incumbent faces the following optimization problem

$$\max_m \Pi_1 = \max_m \left[\Pi_1^G (a^*) - S_1 (a^*)\right]$$

which maximizes its net profit after the political contribution. The first order condition with respect to m gives the equilibrium investment level of the incumbent

$$m^* = \frac{(E - F\beta)\Delta_1 - (F - H\beta)\Delta_2}{9(2+\lambda)\mu - \left(E - 2F\beta + H\beta^2\right)} \tag{16}$$

where

$$\begin{aligned} E &= 41 + 48\lambda + 16\lambda^2 \\ F &= 28 + 45\lambda + 20\lambda^2 \\ H &= 20 + 42\lambda + 25\lambda^2 \end{aligned}$$

For the second order condition to be satisfied, assume that

$$9(2+\lambda)\mu - \left(E - 2F\beta + H\beta^2\right) > 0$$

This holds for example if the parameter μ is large enough.

With the calculated optimal investment level (16), substituting it into (8) and (9) determines the access price and quantities produced, which gives the reduced expressions for a and q_i with parameters λ, β, Δ_1 and Δ_2.

5 Analysis with discrete cases

From the previous section, it is noted that the equilibrium investment level depends on the exogenously given parameter μ, the spillover β, the welfare weight parameter λ and the firms' production efficiency terms Δ_1 and Δ_2. Although the optimal investment level can be substituted to derive the quantities, profits, political contributions and social welfare, it turns out that the resulting expressions are too messy to provide a clear characterization of the outcomes. Therefore the following analysis in this section will be simplified in two steps. First, assume that $\Delta_1 = \Delta_2 = \Delta$ in what follows and postpone a discussion of the impact of asymmetric efficiencies to a later section. This enables the analysis to focus on the effect of spillover β and the social welfare weight λ. Second, assume discrete values for the spillover parameter β and derive the corresponding solutions of the game. This helps to gain insights into the qualitative features of the outcomes. Thus, the spillover parameter β is restricted to values from the set $\left\{0, \frac{1}{2}, 1\right\}$. By this restriction, it is possible to look at the extreme cases of no spillover ($\beta = 0$) and maximum spillover ($\beta = 1$) and also to consider the case of "medium" spillover ($\beta = \frac{1}{2}$).

5.1 Investment analysis

- Case 1: $\beta = 1$

In this case, there is full spillover and thus the rival is as efficient as the incumbent of using the investment. For the simplicity of comparison, let $\mu = 2$. The equilibrium investment level of the incumbent given by expression (16) is reduced to

$$m^* = \frac{\lambda^2 + 5}{-\lambda^2 + 18\lambda + 31}\Delta \tag{17}$$

At this investment level, the equilibrium access price is given by

$$a^*(m^*) = \frac{18(\lambda - 1)}{\lambda^2 - 18\lambda - 31}\Delta \tag{18}$$

When $\lambda = 1$, $a = 0$. Since the access price is assumed not to be negative, the equilibrium access price is expressed by

$$a^*(m^*) = \max\left\{\frac{\lambda - 1}{\lambda^2 - 18\lambda - 31}18\Delta, 0\right\}$$

When $a^* = 0$, $m^* = \frac{1}{8}\Delta$. Compared to the investment level in the absence of lobbying given by expression (14),

$$m^* = \frac{1}{8}\Delta < \frac{2}{9}\Delta = m^{NL}$$

Given the investment level (17) and the access price (18), it can be shown that

$$q_2^*(a^*(m^*), m^*) = \frac{18\lambda}{-\lambda^2 + 18\lambda + 31}\Delta = 0 \text{ if } \lambda = 0$$

Thus, there is foreclosure when $\lambda = 0$. At $q_2^*(a^*(m^*), m^*) = 0$, $m^* = \frac{5}{31}\Delta$. Compared to the socially optimal investment level in the absence of lobbying given by expression (14),

$$m^* = \frac{5}{31}\Delta < \frac{2}{9}\Delta = m^{NL}$$

The equilibrium investment level is thus expressed by

$$m^* = \begin{cases} \frac{\lambda^2+5}{-\lambda^2+18\lambda+31}\Delta & \text{if } \lambda < 1 \\ \frac{1}{8}\Delta & \text{if } 1 \leq \lambda \end{cases}$$

Figure 2 depicts a clear picture of the case when $\beta = 1$.

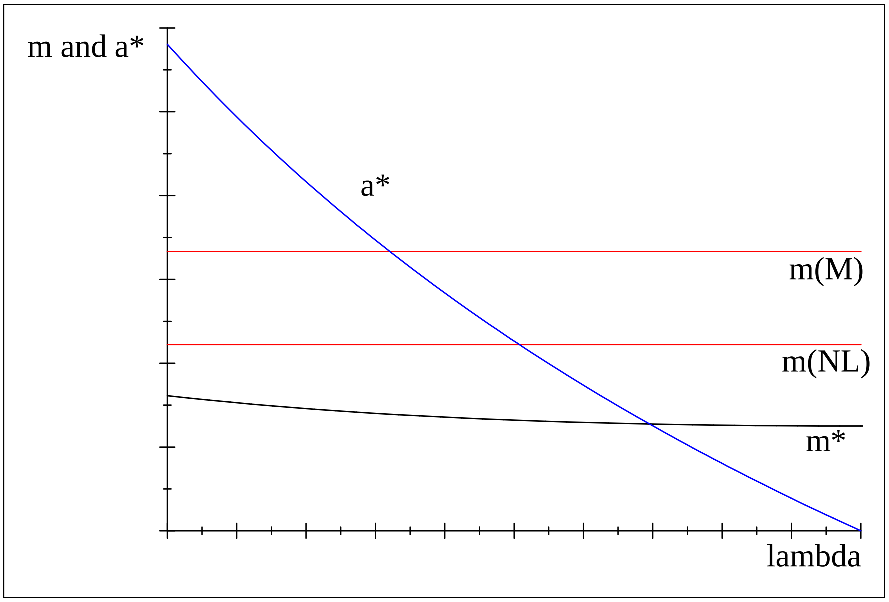

Figure 2: Case 1: $\beta = 1$

As shown in Figure 2, the incumbent wins the political competition if $a^* > 0$. When $\lambda = 0$, the rival is foreclosed from the retail market and does not contribute. When $\lambda \geqslant 1$, since the access price is set at zero, the incumbent does not contribute. When $\lambda \in (0, 1)$, both the incumbent and the rival contribute. Thus Figure 2 demonstrates the access price and investment levels where the contributions from the incumbent and the rival are both positive. In terms of investment, it gives the following statement:

Lemma 2 *In the presence of lobbying, given that there is full spillover, the incumbent "under-invests" compared to both the socially optimal level and the monopoly level.*

When the rival is as efficient as the incumbent of using the investment to reduce its marginal cost of serving end users, with more investment, the rival can increase its gross profits. According to the truthful contribution function 5, for a constant base level B_i, the higher the gross profit Π_i^G, the higher the political contribution S_i, and thus the stronger the lobbying power. Given the rival having the same ability to use the investment as the incumbent, a high level of investment may not only make the rival aggressive in the retail market, but also increase the rival's lobbying power to influence the access price regulation. Therefore, the incumbent will under-invest, even lower than the socially optimal level so as to soften the retail competition and mitigate the rival's political influence.

- Case 2: $\beta = \frac{1}{2}$

In this case, there is medium spillover and thus the rival cannot take full advantage of the incumbent's investment. Still for simplicity of comparison, let $\mu = 2$. The equilibrium investment level of the incumbent given by expression (16) is reduced to

$$m^* = \frac{2(\lambda - 3)}{3(\lambda - 4)}\Delta \tag{19}$$

At this investment level, the equilibrium access price is given by

$$a^*(m^*) = \frac{2\left(\lambda^2 - 5\lambda + 5\right)}{(\lambda + 2)(4 - \lambda)}\Delta \tag{20}$$

When $\lambda = 1.382$, $a = 0$. Since the access price is assumed not to be negative, the equilibrium access price is expressed by

$$a^*(m^*) = \max\left\{\frac{2\left(\lambda^2 - 5\lambda + 5\right)}{(\lambda + 2)(4 - \lambda)}\Delta, 0\right\}$$

When $a^* = 0$, $m^* = 0.412\Delta$. Compared to the investment level in the absence of lobbying given by expression (14),

$$m^* = 0.412\Delta > \frac{2}{9}\Delta = m^{NL}$$

Given the investment level (19) and the access price (20), it can be shown that

$$q_2^*(a^*(m^*), m^*) = \frac{-200\lambda + 47\lambda^2 + 96}{27(\lambda + 2)(\lambda - 4)}\Delta = 0 \text{ if } \lambda = 0.5515$$

Thus, there is foreclosure when $\lambda = 0.5515$. At $q_2^*(a^*(m^*), m^*) = 0$, $m^* = 0.4734\Delta$. Compared to the monopoly investment level given by expression (15),

$$m^* = 0.4734\Delta > \frac{1}{3}\Delta = m^M$$

The equilibrium investment level is thus expressed by

$$m^* = \begin{cases} \frac{2}{3}\frac{28\sqrt{7}+41}{28\sqrt{7}+88}\Delta & \text{if} \quad \lambda \leq \frac{200-\sqrt{21952}}{94} \\ \frac{2(\lambda-3)}{3(\lambda-4)}\Delta & \text{if} \quad \frac{200-\sqrt{21952}}{94} < \lambda < \frac{5-\sqrt{5}}{2} \\ \frac{2}{3}\frac{\sqrt{5}+1}{\sqrt{5}+3}\Delta & \text{if} \quad \frac{5-\sqrt{5}}{2} \leq \lambda \end{cases}$$

Figure 3 depicts a clear picture of the case when $\beta = \frac{1}{2}$.

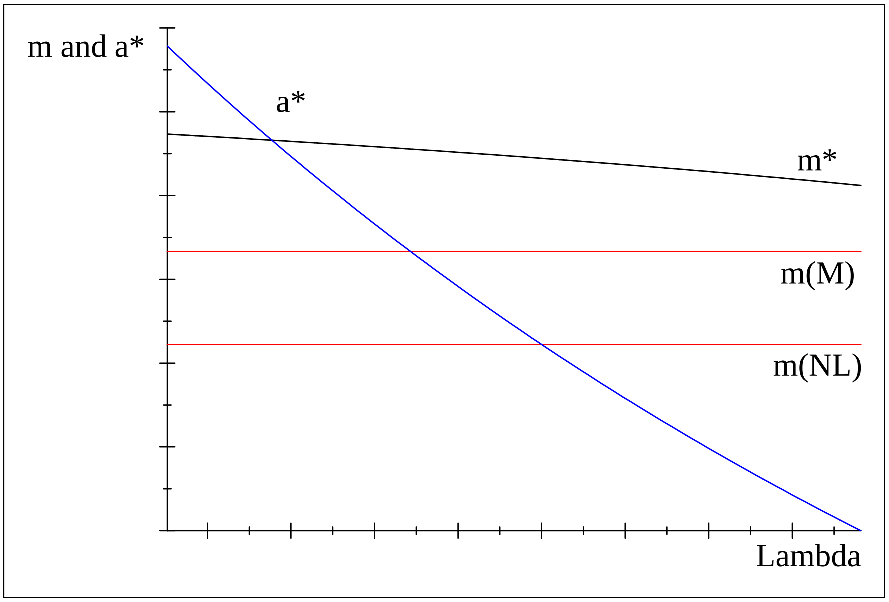

Figure 3: Case 2: $\beta = \frac{1}{2}$

As shown in Figure 3, the incumbent wins the political competition if $a^* > 0$. When $\lambda \leq \frac{200-\sqrt{21952}}{94}$, the rival is foreclosed from the retail market and does not contribute. When $\lambda \geqslant \frac{5-\sqrt{5}}{2}$, since the access price is set at zero, the incumbent does not contribute. When $\lambda \in \left(\frac{200-\sqrt{21952}}{94}, \frac{5-\sqrt{5}}{2}\right)$, both the incumbent and the rival contribute. Thus Figure 3 demonstrates the access price and investment levels where the contributions from the incumbent and the rival are both positive. In terms of investment, it gives the following statement:

Lemma 3 *In the presence of lobbying, given that there is medium spillover, the incumbent "over-invests" compared to both the socially optimal level and the monopoly level.*

Overinvestment happens in this case because the rival cannot take full advantage of the incumbent's investment. On the one hand, the vertically integrated incumbent lowers its marginal cost more than the rival and thus can commit itself to be more aggressive in the retail market by overinvesting (market strategic effect). On the other hand, the enhancing gross profit due to the investment can lead to a stronger lobbying power for the incumbent, which can induce the government to choose a higher access price (politically strategic effect). These two effects reinforce each other and therefore result in an overinvestment conducted by the incumbent.

- Case 3: $\beta = 0$

In this case, there is no spillover and thus the rival cannot take any advantage of the incumbent's investment. Let $\mu = 7$ for simplicity of comparison, which guarantees the rival can be active in the retail market for some range of λ. The equilibrium investment level of the incumbent given by expression (16) is reduced to

$$m^* = \frac{-4\lambda^2 + 3\lambda + 13}{-16\lambda^2 + 15\lambda + 85}\Delta \tag{21}$$

At this investment level, the equilibrium access price is given by

$$a^*(m^*) = \frac{3(13\lambda - 25)}{-15\lambda + 16\lambda^2 - 85}\Delta \tag{22}$$

When $\lambda = \frac{25}{13}$, $a = 0$. Since the access price is assumed not to be negative, the equilibrium access price is expressed by

$$a^*(m^*) = \max\left\{\frac{3(13\lambda - 25)}{-15\lambda + 16\lambda^2 - 85}\Delta, 0\right\}$$

When $a^* = 0$, $m^* = \frac{4}{55}\Delta$. Compared to the investment level in the absence of lobbying given by expression (14),

$$m^* = \frac{4}{55}\Delta = m^{NL}$$

Given the investment level (21) and the access price (22), it can be shown that

$$q_2^*(a^*(m^*), m^*) = \frac{4\left(-24\lambda + 5\lambda^2 + 13\right)}{3\left(-15\lambda + 16\lambda^2 - 85\right)}\Delta = 0 \text{ if } \lambda = 0.6224$$

Thus, there is foreclosure when $\lambda = 0.6224$. At $q_2^*(a^*(m^*), m^*) = 0$, $m^* = 0.1511\Delta$. Compared to the monopoly investment level given by expression (15),

$$m^* = 0.1511\Delta > \frac{1}{13}\Delta = m^M$$

The equilibrium investment level is thus expressed by

$$m^* = \begin{cases} \left(\frac{187}{767} - \frac{8}{767}\sqrt{79}\right)\Delta & \text{if} \quad \lambda \leq \frac{24-\sqrt{316}}{10} \\ \frac{-4\lambda^2+3\lambda+13}{-16\lambda^2+15\lambda+85}\Delta & \text{if} \quad \frac{24-\sqrt{316}}{10} < \lambda < \frac{25}{13} \\ \frac{4}{55}\Delta & \text{if} \quad \frac{25}{13} \leq \lambda \end{cases}$$

Figure 4 depicts a clear picture of the case when $\beta = 0$.

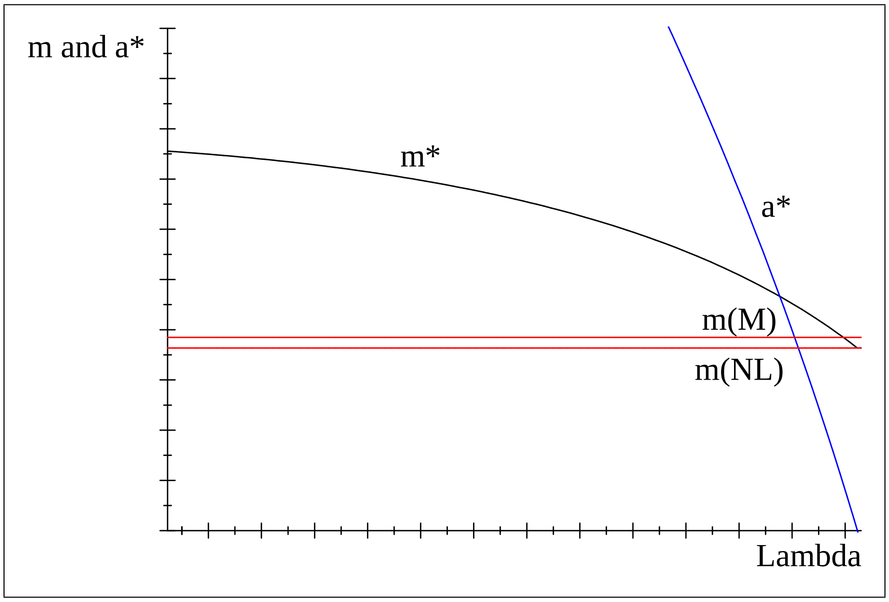

Figure 4: Case 3: $\beta = 0$

As shown in Figure 4, the incumbent wins the political competition if $a^* > 0$. When $\lambda \leq \frac{24-\sqrt{316}}{10}$, the rival is foreclosed from the retail market and does not contribute. When $\lambda \geqslant \frac{25}{13}$, since the access price is set at zero, the incumbent does not contribute. When $\lambda \in \left(\frac{24-\sqrt{316}}{10}, \frac{25}{13}\right)$, both the incumbent and the rival contribute. Thus Figure 4 demonstrates the access price and investment levels where the contributions from the incumbent and the rival are both positive. In terms of investment, it gives the following statement:

Lemma 4 *In the presence of lobbying, given that there is no spillover, the incumbent is most likely to "over-invest" compared to both the monopoly level and the socially optimal level.*

Overinvestment is most likely to happen in this case due to the same reason as in Case 2. It is different from Case 2 that at $a = 0$, the incumbent will invest the same as socially optimal level. Since the rival cannot use the investment at all, the incumbent only needs to invest the same as in the case of no lobbying where the access price is also zero, without worrying that the rival will lobby more.

The following Proposition concludes the results of three discrete cases.

Proposition 1 *When the rival has a lower ability to use the investment ($0 < \beta < 1$), the incumbent has an incentive to overinvest (compared to the monopoly level). However, when the rival can take full advantage of the investment ($\beta = 1$), the incumbent has an incentive to under-invest (compared to the socially optimal level).*

5.2 Welfare analysis

It has been proven that the incumbent makes more investment with than without political contributions when $\beta < 1$, that is, when the rival cannot take full advantage of investment. Does the overinvestment in the presence of lobbying improve or reduce social welfare? The following analysis will answer this question. For simplicity of comparison, let $\lambda = 1$ in what follows.

The results of consumer surplus, the incumbent's profit, the rival's profit and social welfare are summarized in the following tables (Tables 2-4) for three discrete values of β respectively. Note that Π_i $(i = 1, 2)$ in the tables is net-of-contribution profit.

Table 2: For $\lambda = 1$ and $\beta = 1$

	Lobbying	Comparison	No Lobbying
CS	$\frac{18\mu^2}{(9\mu-2)^2}\Delta^2$	$=$	$\frac{18\mu^2}{(9\mu-2)^2}\Delta^2$
Π_1	$\frac{9\mu^2}{(9\mu-2)^2}\Delta^2$	$=$	$\frac{9\mu^2}{(9\mu-2)^2}\Delta^2$
Π_2	$\frac{27\mu^2}{11(9\mu-2)^2}\Delta^2$	$<$	$\frac{9\mu^2}{(9\mu-2)^2}\Delta^2$
W	$\frac{36\mu^2}{(9\mu-2)^2}\Delta^2$	$=$	$\frac{36\mu^2}{(9\mu-2)^2}\Delta^2$

Table 3: For $\lambda = 1$ and $\beta = 1/2$

	Lobbying	Comparison	No Lobbying
CS	$\frac{2}{9}\Delta^2$	$<$	$\frac{(4\mu-1)^2}{18(2\mu-1)^2}\Delta^2$
Π_1	$\frac{-24\mu+16\mu^2+15}{9(4\mu-5)^2}\Delta^2$	$>$	$\frac{2\mu}{9(2\mu-1)}\Delta^2$
Π_2	$\frac{(4\mu-9)^2}{33(4\mu-5)^2}\Delta^2$	$<$	$\frac{1}{9}\Delta^2$
W	$\frac{2\left(-68\mu+32\mu^2+39\right)}{9(4\mu-5)^2}\Delta^2$	$<$	$\frac{(4\mu-1)(8\mu-3)}{18(2\mu-1)^2}\Delta^2$

Table 4: For $\lambda = 1$ and $\beta = 0$

	Lobbying	Comparison	No Lobbying
CS	$\frac{2(3\mu-13)^2}{(9\mu-35)^2}\Delta^2$	$<$	$\frac{2(3\mu-4)^2}{(9\mu-8)^2}\Delta^2$
Π_1	$\frac{3\left(-18\mu+3\mu^2+35\right)}{(9\mu-35)^2}\Delta^2$	$>$	$\frac{\mu}{9\mu-8}\Delta^2$
Π_2	$\frac{27(\mu-7)^2}{11(9\mu-35)^2}\Delta^2$	$<$	$\frac{(3\mu-4)^2}{(9\mu-8)^2}\Delta^2$
W	$\frac{12\left(-23\mu+3\mu^2+46\right)}{(9\mu-35)^2}\Delta^2$	$<$	$\frac{4\left(12-20\mu+9\mu^2\right)}{(9\mu-8)^2}\Delta^2$

Tables 2-4 show that for $\lambda = 1$ and $\beta < 1$ (either $\beta = 0$ or $\beta = \frac{1}{2}$), the vertically integrated firm's profit is more with than without lobbying. The intuition behind this is that the integrated firm, through its political contribution, can induce the government to set a higher access price, which in turn increases its profit by disadvantaging its rival in the competition of the downstream market. It also implies the integrated firm has an incentive to exert its political pressure to influence the government's regulatory policy. However, the consumer surplus, the rival's profit and social welfare are less with than without lobbying. When $\beta = 1$, the consumer surplus, the incumbent's profit and social welfare are the same with as without lobbying. While the rival's profit and the social welfare are still less with than without lobbying. Although given that $\beta = 1$, the vertically integrated firm loses its incentive to lobby and chooses not to make any political contribution, the rival still has to exert its political pressure for the access price to be set equal to the marginal cost. Otherwise the integrated firm would like to lobby, which would increase the access price. Consequently, the net-of-contribution profit of the rival is less in the presence of lobbying.

Proposition 2 *When the government values political contributions and social welfare equally (i.e. $\lambda = 1$), the vertically integrated firm benefits from lobbying, given that the rival has a lower ability to take advantage of the investment (i.e. $\beta < 1$). But the vertically integrated firm has no incentive to lobby, given that the rival can take full advantage of the investment (i.e. $\beta = 1$). As far as the rival is concerned, compared to that in social optimum without any political influence, its profit is lower in the presence of lobbing regardless of the spillover. In terms of social welfare, it turns out that lobbying may be welfare-reducing.*

Proof. These results follow from straight-forward comparisons of the resulting expressions in Tables 2-4. ■

5.3 Further discussion

In this section, some further results of the model are discussed.

- More weight on social welfare: The previous analysis is mainly based on the discrete case with $\lambda = 1$, i.e. the government values equally the political contributions and the social welfare. What will change if the government puts more weight on social welfare than on political contributions? The discrete case when $\lambda = 2$ is taken as an example to get the insight into the qualitative features. To be consistent with the analysis, assume that the access price without lobbying is set equal to the marginal cost, which requires that $\mu \geqslant 12$ when $\beta = 0$ and $\mu \geqslant \frac{11}{4}$ when $\beta = \frac{1}{2}$. However, in the situation under the political influence with $\lambda = 2$, the necessary conditions for the positive access price, quantities and profits are $6 < \mu < \frac{20}{3}$ when $\beta = 0$ and $\frac{11}{6} < \mu < \frac{15}{6}$ when $\beta = \frac{1}{2}$. As it can be noted, a sufficiently high value of μ can not guarantee a positive access price in the presence of lobbying and thus result in $a^* = 0$. Hence, in the case with $\lambda = 2$, the vertically integrated firm will choose not to lobby at all, which yields the same investment level as that with no political influence. The following proposition summarizes this result:

  Proposition 3 *When the government values social welfare more than political contributions, the vertically integrated firm has no incentive to lobby if parameter μ is sufficiently high.*

  Intuitively, if the integrated firm's political influence is not efficient and meanwhile if the investment is too costly, it is not worth lobbying for a higher access price.

- Asymmetric production efficiency: In fact, the comparative production efficiency of two firms has the same effect as that of spillover. Suppose that the vertically integrated firm is more efficient than the rival in production, i.e. $\Delta_1 > \Delta_2$. The integrated firm can foreclose the rival by more investment if the spillover is not greater than one. This is equivalent to the case where two firms have same production efficiency but the rival has lower ability to use the vertically integrated firm's investment. On the other hand, if the rival is more efficient than the vertically integrated firm in production, i.e. $\Delta_2 > \Delta_1$, the integrated firm has an incentive to catch up by overinvestment if the spillover is not high. And the integrated firm may also choose not to make any investment at all and even possibly it may be competed out of the downstream market if the rival has very high ability to use the investment. This is equivalent to the case where two firms have the same production efficiency, but the rival has higher ability to use the investment, for example $\beta > 1$[8]. Therefore the conclusions obtained in the previous analysis for the symmetric efficiencies can still hold even if the production efficiencies differ.

[8] The case with $\beta > 1$ is not considered in this paper.

- The continuous case: The previous analysis is based on the discrete cases. In order to check the validity of the results for the general case, one can calculate the outcomes of the game for all values of $\beta \in [0, 1]$. After an extensive numerical study, it can be proved that the results are in line with the observations that have been presented in the simple discrete cases in the previous sections. In this sense the results obtained are robust.

6 Conclusion

This study is motivated by the observation from the Chinese telecommunications industry, which has been enjoying a high growth rate since the 1990s, maintaining distinctly high levels of investment compared to other countries. Many studies have shown that regulatory policies in China are influenced by interest groups' lobbying. The connection between the individual firm and the regulatory authority is still the most powerful factor in the Chinese lobbying context and should not be ignored. In China there are no explicit political donations to political parties as there are in democratic countries, but the regulator is in fact receptive to the political pressures exerted by various interest groups to a great extent due to the lack of a state decree, such as a Telecommunication Act. Those firms with close contacts to the regulatory body can have overwhelming influence on the policy. In this context, this paper has addressed the issue of whether the incumbent has incentive to invest more in its network in the presence of the political influence.

In this paper, a market is modelled with one facility-based vertically integrated incumbent competing with a non-facility-based independent rival in the downstream retail market. The incumbent controls network access and sells it to its rival. The access price is regulated by the regulator. It is assumed that the incumbent can undertake a cost-saving investment that improves its efficiency of serving the end users. Meanwhile the rival may also benefit from this investment (spillover effect) when it uses the incumbent's network. In contrast to existing literature, the regulator in this study is assumed receptive to the lobbying group demands. It has only one regulatory instrument available, namely the access price. The main result obtained is: given that the regulator is concerned with political contributions, the vertically integrated incumbent has an incentive to overinvest (compared to both the socially optimal level and the monopoly level), if the rival cannot take full advantage of investment. In addition, if the regulator values political contributions less highly, the vertically integrated incumbent may lose the incentive to lobby and will invest no more than the socially optimal level. Overall, the presence of lobbying may be welfare-reducing.

Intuitively, given that the regulator is receptive to the lobby group demands, the vertically integrated firm has two instruments to utilize in order to compete against the rival: either by investment or by lobbying the regulator for a high access price. On the Industrial Organization side, under Cournot competition, by adopting a more efficient network (or technology on the network), the incumbent lowers its marginal cost and makes it possible to credibly commit to higher output levels. Therefore, there is a market strategic incentive for the incumbent to over-invest in updating its network (or adopting cost-reducing technology), although the investment spillover may affect the outcome if the rival is more efficient in using the updated network. On the political economy side, the lobbying power of the incumbent determines the level of the access price. With a higher access price, the rival would be placed in a disadvantage situation in the downstream competition. Therefore the incumbent has a politically strategic incentive to lobby for a favorable access price. As the study has shown that the political contribution is linked to the gross profit, which is in turn determined by the investment level. Consequently, the incumbent's lobbying incentive reinforces its investment incentive provided that the investment can bring more gross profit, hence stronger political power, for the incumbent.

In this study, it is assumed that consumers are excluded from the lobbying activities. In fact, nowadays consumers have a strong impact on regulatory policies which should not be ignored. It would be interesting to examine whether the results in this study are altered if consumers' political influence is also taken into consideration. In addition, due to the complexity of the coefficients, only the discrete case is analyzed to draw the results in this study. It would be more robust if the model can be improved to obtain general characterization of the solutions.

References

[1] Bernheim, B.D. and Whinston, M. (1986), 'Menu Auctions, Resource Allocation, and Economic Influence', *Quarterly Journal of Economics*, vol.101, pp.1-31.

[2] Damania, R. (2003), 'Protectionist Lobbying and Strategic Investment', *The Economic Record*, vol.79, pp.57-69.

[3] Foros, Ø. (2004), 'Strategic Investments with Spillover, Vertical Integration and Foreclosure in the Broadband Access Market', *International Journal of Industrial Organization*, vol.22(1), pp.1-24.

[4] Gao, P. and Lyytinen, K. (2000), 'Transformation of China's Telecommunications Sector: a Macro Perspective', *Telecommunications Policy*, 24, 719-730.

[5] Grossman, G. E. and Helpman, E. (1994), 'Protection for Sale', *American Economic Review*, vol. 84, pp.833-50.

[6] Grossman, G. E. and Helpman, E. (1995b), 'Trade Wars and Trade Talks', *Journal of Political Economy*, vol. 103, pp. 675-708.

[7] Kotakorpi, K. (2006), 'Access Price Regulation, Investment and Entry in Telecommunications', *International Journal of Industrial Organization*, vol. 24, pp. 1013-1020.

[8] Li, D. and Chen, Q. (1998), 'Why Aren't Foreign Direct Investments (FDI's) Always Welcome? – A Political Economy Analysis', University of Michigan, mimeo.

[9] Ma, J. (2005), 'Politics of Competition for Foreign Direct Investment: A Simple Theory', University of Southampton, working paper.

[10] Sheng, B. (2001), 'The Political Economy of Trade Policy in China', Copenhagen Business School, Department of Management, Politics & Philosophy, working paper.

[11] Telecommunication Industry Association (TIA), 'Investment, Capital Spending and Service Quality in U.S. Telecommunications Networks: A Symbiotic Relationship'.

[12] Yu, Z. (2005), 'Environmental Protection: A Theory of Direct and Indirect Competition for Political Influence', *Review of Economic Studies*, vol. 72, pp.269-286.

[13] Zhang, B. (2002), 'Understanding China's Telecommunications Policymaking and Reforms: a Tale of Transition Toward Liberalization', *Telematics and Informatics*, 19, 331-349.

Appendix

Proof of Lemma 1

(i) The equilibrium level of access price maximizes the government's objective function, i.e.

$$a^* = \arg\max_a S_1(a) + S_2(a) + \lambda W(a)$$

A truthful contribution function takes the form

$$S_i(a, B_i) = \max\left[0, \Pi_i^G - B_i\right]$$

Hence, the optimal access price maximizes

$$a^* = \arg\max_a \left[\Pi_1^G(a) - B_1\right] + \left[\Pi_2^G(a) - B_2\right] + \lambda W(a) \qquad \text{if } B_1 \leqslant \Pi_1^G(a^*) \text{ and } B_2 \leqslant \Pi_2^G(a^*)$$

which gives rise to

$$a^* = \arg\max_a \Pi_1^G(a) + \Pi_2^G(a) + \lambda W(a)$$

as B_i is a constant.

(ii) Given the contribution schedules, the government's objective function is given by

$$G = \begin{cases} S_i\left(a^*, B_i\right) + S_j\left(a^*, B_j\right) + \lambda W\left(a^*\right) & \text{if both firms lobby} \\ S_j\left(a_j, B_j\right) + \lambda W\left(a_j\right) & \text{if no contribution from firm } i \end{cases}$$

Firm i will raise its base level B_i until the government is indifferent between choosing a^* and a_j (see the discussion in Grossman and Helpman (1994)). This means by setting

$$S_i\left(a^*, B_i\right) + S_j\left(a^*, B_j\right) + \lambda W\left(a^*\right) = S_j\left(a_j, B_j\right) + \lambda W\left(a_j\right) \quad \text{for } i = 1, 2;\ i \neq j$$

firm i's optimal contribution S_i can be solved by

$$S_i\left(a^*, B_i\right) = \left[S_j\left(a_j, B_j\right) + \lambda W\left(a_j\right)\right] - \left[S_j\left(a^*, B_j\right) + \lambda W\left(a^*\right)\right] \quad \text{for } i = 1, 2;\ i \neq j \tag{23}$$

Together with truthful contribution schedule to rewrite (23) gives

$$S_i\left(a^*, B_i\right) = \left[\Pi_j^G\left(a_j\right) + \lambda W\left(a_j\right)\right] - \left[\Pi_j^G\left(a^*\right) + \lambda W\left(a^*\right)\right] \quad \text{for } i = 1, 2;\ i \neq j \tag{24}$$

Q.E.D.