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TO REGULATE OR TO DEREGULATE? THE ROLE OF DOWNSTREAM COMPETITION IN UPSTREAM MONOPOLY VERTICALLY LINKED MARKETS

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ABSTRACT

This paper attempts to cast light to the effect of monopoly regulation in Cournot markets compared to its effect in Bertrand markets. To this purpose, we use a simple model of a vertically linked market, where an upstream regulated natural monopoly is trading via two-part tariff contracts with a downstream duopoly. Combining our results to those of the existing literature on deregulated markets, we argue that when the downstream competition is in prices, efficiency dictates regulating the monopoly with a marginal cost based pricing scheme. However, this type of regulation leads to significant welfare loss, when the downstream market is characterized by Cournot competition.

Keywords: Bertrand, Cournot, marginal cost pricing, regulation, vertical relations

JEL classification: L43, L51

I. INTRODUCTION

Utilities such as energy, water supply, telecommunications and certain modes of transport such as rail, all include natural monopoly characteristics (i.e., electricity transmission, gas distribution, local loop telecommunications, etc.) arising from pervasive economies of scale and scope (Armstrong and Sappington, 2006). These characteristics mean that competition is unlikely to develop, or if it develops, it will be uneconomic because of the duplication of assets. As explained by Borenstein (2002), Mulligan and Tsui (2008), Acemoglu and Robinson (2013) inter alia, in order to reduce the negative impact of monopolization (i.e., high prices, low consumer surplus), the standard approach of policy-making from governments is to develop strong regulatory capabilities so that they can police the revenues and costs of production of the privatized utility firms and protect consumers from monopoly exploitation. At the same time, there needs to be commitment on the part of government to the regulatory rules to establish credibility on the part of the investors that the regulatory rules will bring about the intended

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outcome (i.e., the lowest possible regulated prices consistent with firm profitability). Where regulatory credibility is weak or absent, private investment decisions will be adversely affected.

In a seminal paper, Ordover and Panzar (1982) argue that in a vertically related industry where a monopolistic input is supplied to perfectly downstream competitive rivals, a two-part tariff pricing scheme is never optimal. The case of imperfect downstream competition where the regulator can set only the variable fee of the two-part tariff contract is examined by Panzar and Sibley (1989). They claim that the optimal variable fee is lower than the marginal cost of the upstream monopolist. In a similar framework, Valletti (1998) investigates regulatory actions targeted at the optimum fixed fee formulation. The common characteristic of the aforementioned studies is that downstream firms compete in quantities. Therefore, downstream price competition and the subsequent comparison between Cournot and Bertrand markets[1] are totally ignored. However, within the recent years many studies try to fill this gap in the literature by examining the role of linear and non-linear wholesale prices contracts in Cournot and Bertrand markets (Correa-López and Naylor, 2004; Correa-López, 2007; Arya *et al.*, 2008; Mukherjee *et al.*, 2012; Chirco and Scrimitore, 2013; Alipranti *et al.*, 2014; Manasakis and Vlassis, 2014). Notwithstanding, the interdependency between the nature of the downstream competition and the upstream monopoly regulation is a rather dormant area of research. More specifically, Yanez (2002), investigates the spillover effects from price regulation of a single product that is a substitute in consumption and vertically related to the product of another regulated industry such as electricity. Armstrong and Sappington (2006) study the choice between regulated monopoly and unregulated competition, highlighting the role of imperfect information. They argue that the appropriate choice between the two regimes is strongly affected by certain technological and demand characteristics such as the regulator's resources, the efficiency of tax systems and capital markets, and the strength of other prevailing institutions. Moreover, Sappington (2006) argues that when vertically integrated providers are present (i.e., telecommunications industry) the entrant's decision to make or buy critical production inputs may be largely insensitive to the price of these inputs. Lastly, Bergantino *et al.* (2011), explore the effectiveness of price and quality cap regulation where a (regulated) incumbent competes with his (unregulated) rivals under two regimes accounting for the Nash-Cournot and the Stackelberg framework respectively.

In this paper, we study the role of downstream competition in a regulated upstream natural monopoly. A novel aspect of our analysis is that we allow for a two-part tariff marginal cost based pricing scheme and we consider the role of its the nature, when the monopoly is regulated or deregulated. One additional key aspect of our analysis is that we take into account downstream competition and its intensity (Cournot or Bertrand). In some industries the nature of competition is better described by commitment to prices (i.e., when volume can be easily adjusted), while in others it is better described by commitment to output (i.e., when prices can be easily adjusted). We study how the effect of regulation differs between these two types of markets. We address a number of research questions such as: Is it preferable to regulate upstream natural monopolies (utilities), with a two-part tariff marginal cost based pricing scheme? Does upstream regulation stimulate total welfare? What is the role of the nature of downstream competition? We show that the answer to all these research questions depends solely on the type of downstream competition. If downstream rivals compete in quantities, then regulation is not preferred from the viewpoint of welfare when a two-part tariff is charged by the monopolist (this is the usual pricing scheme in utility companies–see for example Brown and Sibley, 1986; Newbery, 2002; Viscusi *et al.* 2005; Joskow, 2014). However, when the downstream market is characterized by price competition, marginal cost pricing is the ideal choice.

[1]This situation refers to the modeling of the oligopolistic interaction aiming at achieving less monopolization and therefore higher consumer surplus.

Our result has important policy implications for a number of markets with natural monopoly characteristics such as gas and electricity markets. Specifically, gas market is divided into five relevant market segments: a) the extraction/production of gas (i.e., upstream market), b) the transportation of gas via high pressure pipelines (i.e., transmission market), c) the transportation on medium and low pressure pipelines (i.e., distribution market), and finally, d) the storage of gas and e) the supply of gas to customers (i.e., downstream market).[2] In an empirical study, Davis and Muehlegger (2010), showed that in the market of the US natural gas distribution, which has natural monopoly characteristics with high fixed and low marginal costs (Newbery, 2002; Davis and Muehlegger, 2010), the ideal regulatory pricing of a marginal cost-based two-part tariff holds only for industrial customers. On the other hand, residential and commercial customers pay per-unit prices higher than the marginal cost alongside with a fixed monthly fee. According to Davis and Muehlegger (2010) this pricing policy leads to a huge welfare loss. Given the fact that industrial customers of natural gas (e.g., refineries, electricity generation, steel industry, cement industry, car industry, etc.) operate in markets characterized by quantity competition due to capacity constraints (Cabral, 2000; Motta, 2004), whereas commercial and residential customers mostly, compete, in prices, our results indicate that regulation is imposed to the wrong market segment. In other words, the price charged to commercial customers should be regulated with a marginal cost pricing rule, whereas the charges of industrial customers should be deregulated.

The rest of the paper is structured as follows: The model and the equilibrium analysis under regulated and deregulated monopoly are presented in the next two sections. Section IV compares the results and discusses the policy implications. A robustness analysis is conducted in Section V. Finally, Section VI concludes.

II. THE MODEL

Our setting follows that of Alipranti *et al.* (2014). We consider a vertically linked market with an upstream monopoly U, and two downstream firms D_1 and D_2. Monopolist's production is used as input by downstream firms in one-to-one proportion. The cost of buying this input is the only cost faced by the downstream firms. The marginal cost of the upstream monopolist is constant and equals $c > 0$.

Firms play a two-stage game. In stage one, the upstream monopoly bargains simultaneously and separately with its downstream clients over the terms of a two-part tariff contract consisting of a fixed tariff F and a per unit charge w (wholesale price). The bargaining between U and D_i's (with $i = 1, 2$) follows the standard Nash bargaining model. In stage two, the downstream firms compete in quantities (Cournot competition) or prices (Bertrand competition) after observing each other's contract terms (i.e., w and F) from the first stage. In the above-described environment, multiple equilibria can arise due to the multiplicity of the beliefs that the downstream firms can form when they receive out-of-equilibrium offers (McAfee and Schwartz, 1994). We avoid this problem by assuming immunity of the contract between U and D_i to a bilateral deviation of U with D_j, holding the contract with D_i constant (see Cremer and Riordan, 1987; Horn and Wolinsky, 1988; O'Brien and Shaffer, 1992; Milliou and Petrakis, 2007; Milliou and Pavlou, 2013; Alipranti *et al.*, 2014).

Following Singh and Vives (1984) the inverse and the direct demand functions for downstream firm i are:

$$p_i = a - q_i - \gamma q_j \tag{1}$$

[2]It is worth mentioning that the gas supply market can be further divided into several sub-segments: i) supply of gas to dealers (including the local distribution companies), ii) supply of gas to gas-powered electricity plants, iii) supply of gas to large industrial customers, iv) supply of gas to small industrial and commercial customers, and v) supply of gas to household customers (Fafaliou and Polemis, 2009).

$$q_i = \frac{a - p_i - \gamma(a - p_j)}{1 - \gamma^2} \tag{2}$$

where $i, j = 1, 2$ (with $i \neq j$), a is a positive constant, p_i and q_i are the price and quantity of D_i, respectively and $\gamma \in (0, 1)$ is the rate of substitution between the products of the downstream firms. We also assume that $a > c$. Finally, in order to guarantee the existence of a pure strategy pairwise proof equilibrium we make the following assumption: $\beta \geqslant \bar{\beta}(\gamma) \equiv \frac{\gamma^3}{(2-\gamma)(2-\gamma^2)}$, where $\beta \in (0, 1]$ is the bargaining power of the upstream firm.

III. EQUILIBRIUM ANALYSIS

In this section we examine the equilibrium conditions under two different regimes: a) when the upstream monopoly is regulated via a two-part tariff where the wholesale price is fixed to marginal cost and b) when the upstream monopolist trades with its downstream rivals for both the wholesale price and the fixed tariff.

III.1 Regulated monopoly

We assume that the regulator imposes marginal cost pricing on the upstream monopoly. In this case, the equilibrium wholesale prices under both downstream Cournot (w_i^{C*}) and Bertrand competition (w_i^{B*}) will be equal to $w_1^{C*} = w_2^{C*} = w_1^{B*} = w_2^{B*} = w^* = c$.[3]

The equilibrium downstream and upstream profits for each mode $M = C, B$ of downstream competition are:

$$\Pi_{D_i}^{C*} = \left[q_i^{C*}\right]^2 - F_i^{C*} \tag{3}$$

$$\Pi_U^{C*} = 2(w^* - c)q_i^{C*} + F_i^{C*} + F_j^{C*} = F_i^{C*} + F_j^{C*} \tag{4}$$

$$\Pi_{D_i}^{B*} = \left(p_i^{B*} - c\right) q_i^{B*} - F_i^{B*} \tag{5}$$

$$\Pi_U^{B*} = 2(w^* - c)q_i^{B*} + F_i^{B*} + F_j^{B*} = F_i^{B*} + F_j^{B*} \tag{6}$$

The equilibrium fixed fee F_i^{M*}, solves the following Nash product:

$$F_i^{M*} = \arg\max_{F_i} \left[\Pi_U^M\left(F_i, F_j^{M*}\right) - d\left(F_j^{M*}\right)\right]^{\beta} \left[\Pi_{D_i}^M(F_i)\right]^{1-\beta} \tag{7}$$

where $d(F_j^{M*}) = (w^* - c)q_j^{mon} + F_j^{M*} = F_j^{M*}$, q_j^{mon} is the downstream monopoly quantity (disagreement point for U; it is the case where an agreement is not reached between U and downstream firm i and thus downstream firm j becomes a monopoly).

Comparing equilibrium quantities, prices, tariffs and profits (upstream and downstream),[4] we end up to the following Remark:

Remark 1. Under regulated upstream market (i) the final prices are higher (lower) under Cournot (Bertrand) competition while the opposite holds for the equilibrium output (ii) the equilibrium downstream and upstream profits are higher (lower) under Cournot (Bertrand) competition and (iii) consumers' surplus and total welfare are lower (higher) under Cournot (Bertrand) competition.

[3] Where the superscripts C and B denote Cournot and Bertrand downstream competition, respectively.
[4] All the relevant algebraic formulations are included in the Appendix in the Supplementary Material.

Proof. See Appendix in the Supplementary Material. □

Similar to conventional wisdom, Remark 1 informs us that competition in prices is more competitive than competition in quantities. In other words, Cournot competition yields higher prices and lower output than Bertrand competition. In this case, under a regulated two-part tariff pricing scheme based on the marginal cost of the upstream monopoly, the downstream firms are less efficient under Cournot competition. As a consequence, they charge higher prices and they produce a smaller quantity than under Bertrand competition. Moreover, according to Remark 1, downstream profits are higher under Cournot than under Bertrand competition. This is due to the fact that the negative impact of the aggressiveness of competition on profits dominates the higher fixed fee charged in Cournot's case. Finally, Remark 1 informs us that under a regulated two part-tariff regime, a market with Bertrand competition is more efficient than a market with Cournot competition. The higher consumers' surplus under Bertrand competition is enough to dominate the higher upstream and downstream profits in the Cournot case and hence total welfare is higher under Bertrand competition. Overall, it turns out that in a regulated vertically linked market with upstream monopoly and trading with non-linear contracts, Bertrand competition is more socially desirable than Cournot competition.

Given Remark 1, it turns out that two-tier industries in which the upstream market is perfectly competitive (i.e., upstream marginal cost pricing) are to a major extent equivalent with one-tier industries where Bertrand is more efficient than Cournot competition.[5] In this respect the fixed fee charged by the upstream monopolist does not affect the driving force of our findings.

III.2 Deregulated monopoly

Alipranti *et al.* (2014) showed that the main results of subsection III.1 are reversed when the upstream monopoly is deregulated (by a marginal cost based two-part tariff pricing scheme) and therefore is free to negotiate its wholesale prices. More specifically, their findings can be summarized as follows: In a deregulated upstream monopoly trading via two-part tariffs with two downstream rivals, Cournot downstream competition is more efficient (in the sense that it is characterized by higher consumers' surplus and total welfare) than Bertrand downstream competition.

IV. REGULATED VS. DEREGULATED UPSTREAM MONOPOLY

In this section we compare the equilibrium outcomes under the two different regimes.

Alipranti *et al.* (2014) assume without loss of generality that marginal cost is zero both upstream and downstream. The corresponding results with respect to the equilibrium quantities and the total welfare in their context under a non-zero marginal cost c for the upstream monopolist are presented in the Appendix in the Supplementary Material.

Proposition 1. It is efficient to regulate (deregulate) an upstream natural monopoly via a marginal cost-based two-part tariff if the downstream competition takes place in prices (quantities).

Proof. See Appendix in the Supplementary Material. □

[5]When the regulator imposes marginal cost pricing on the upstream firm, it is exactly the same as if the upstream firm did not exist and downstream firms had a marginal cost equal to the marginal cost of the upstream firm and paid a lump sum (which is akin to a fixed cost and does not affect pricing at the margin). It is also for that reason that β (which captures the degree of substitutability) does not appear into the expressions for prices or quantities, but only for profits.

TABLE 1
Nature of downstream competition and regulation

	Regulation		*Deregulation*	
	Cournot	*Bertrand*	*Cournot*	*Bertrand*
$\gamma = 0.3$				
CS	0.208	0.225	0.218	0.215
TW	0.528	0.541	0.535	0.533
$\gamma = 0.5$				
CS	0.203	0.251	0.233	0.220
TW	0.474	0.502	0.492	0.485
$\gamma = 0.8$				
CS	0.194	0.327	0.297	0.230
TW	0.410	0.457	0.450	0.428

The intuition behind the result in Proposition 1 is simple. The intensity of the so-called commitment problem (see, among others, Hart and Tirole, 1990; Saggi and Vettas, 2002; Rey and Verge, 2004 and de Fontenay and Gans, 2005) will lead the upstream monopolist to charge quantity-competing downstream firms a wholesale price lower than its marginal cost. In this way, the optimal result is achieved since the low marginal cost of the downstream firms will partially offset the distortion caused by the imperfect downstream competition (Panzar and Sibley, 1989). Therefore, an increase in the wholesale price as a result of the marginal cost pricing imposed by the regulator will lead to an inefficient outcome. The reasoning is reversed in the case of downstream price competition.

Proposition 1 is illustrated in Table 1.

Table 1 illustrates our findings for different values of γ. The second (third) and the fourth (fifth) columns illustrate the case of downstream Cournot (Bertrand) competition under regulated and deregulated upstream monopoly, respectively. We assume the following functional forms and parameter values: $a = 1$, $\beta = 0.6$ and $c = 0.08$ [The value of β is approximated based on Draganska *et al.* (2010), while the value of c is based on Davis and Muehlegger (2010)]. The values of γ are those used by Correa-López (2007). In general, parameter values were chosen so as to generate realistic results.

By comparing the equilibrium downstream profits under the two different regimes, we get the following Corollaries:

Corollary 1. Under marginal cost pricing regulation of the upstream monopoly, downstream firms will endogenously choose to compete in quantities (market objective) while the total welfare criterion dictates competition in prices (policy objective). Therefore, there is a misalignment between market and policy objectives.

Corollary 2. In a deregulated vertically linked market, downstream firms will endogenously choose to compete in quantities (market objective) which is exactly what the total welfare criterion dictates (policy objective). Therefore, there is an alignment between market and policy objectives.

Our findings have important implications for the type of policies imposed by the National Regulatory Authorities (NRAs) on natural monopolies such as network industries (electricity, natural gas distribution segments, telecommunications networks, etc.). We argue that when

downstream Bertrand competition is present, by applying a non-linear pricing mechanism leading to a marginal price equal to marginal cost, the NRAs increase the level of production and eliminate the deadweight loss associated with the existence of the (upstream) monopoly. In such cases (e.g., commercial and residential customers of natural gas) the NRAs can efficiently allow the monopolist to recoup its fixed costs by charging fixed fees that do not depend on the level of production (Davis and Muehlegger, 2010). On the other hand, when downstream Cournot competition is present (e.g., industrial customers of natural gas) and customers are paying both a fixed monthly fee and a price per unit equal to marginal cost of the upstream monopoly, our findings reveal that a two-part tariff pricing scheme leads to significant welfare loss. In other words, in the imposition of a two-part tariff marginal cost pricing scheme, the regulatory authorities should indeed take into account the nature of downstream competition. Our results indicate that the NRAs should be skeptical on the type of regulation in the two-tier industries. Similarly, they indicate that it is important in the evaluation of an effective regulatory scheme that the downstream rivals compete in prices rather than quantities because otherwise different policy implications could be drawn.

V. LINEAR PRICING

To further check for the robustness of our findings, we consider the case where the upstream monopolist trades with the downstream firms via linear contracts. By dropping F (the fixed tariff) and conducting the same analysis as above, we get the following equations:

$$CS^{C}_{lwreg} = \frac{(1+\gamma)(2-\beta)^2(a-c)^2}{4(2+\gamma)^2} \tag{8}$$

$$TW^{C}_{lwreg} = CS^{C}_{lwreg} \times \frac{\beta(1+\gamma)+2(3+\gamma)}{1+\gamma} \tag{9}$$

$$CS^{B}_{lwreg} = \frac{(a-c)^2[\gamma^3(1-\beta)(1-\gamma)-2(\beta+\gamma)+\beta\gamma(1-\gamma)+4]^2}{(1+\gamma)(2-\gamma)^2[\gamma^3(1-\beta)(1-\gamma)-2\gamma(1+\beta\gamma)+4]^2} \tag{10}$$

$$TW^{B}_{lwreg} = CS^{B}_{lwreg} \times A \tag{11}$$

$$CS^{C}_{lreg} = (1+\gamma)\left(\frac{a-c}{2+\gamma}\right)^2 \tag{12}$$

$$TW^{C}_{lreg} = (a-c)^2\frac{(3+\gamma)}{(2+\gamma)^2} \tag{13}$$

$$CS^{B}_{lreg} = (1+\gamma)\left(\frac{a-c}{(1+\gamma)(2-\gamma)}\right)^2 \tag{14}$$

$$TW^{B}_{lreg} = \frac{(a-c)^2(3-2\gamma)}{(1+\gamma)(2-\gamma)^2} \tag{15}$$

where $A = [\gamma^3(1-\beta)(1-\gamma)-2(\beta+\gamma)+\beta\gamma(1-\gamma)+4][12+2\beta-(14+\beta)\gamma-(7\beta-4)\gamma^2+(3+\beta)\gamma^3+(1-\beta)\gamma^4(2\gamma-5)]$ and subscripts $lreg$ (reg) and $lwreg$ ($wreg$) denote the existence and the absence of regulation in the upstream monopoly in the linear (non-linear)

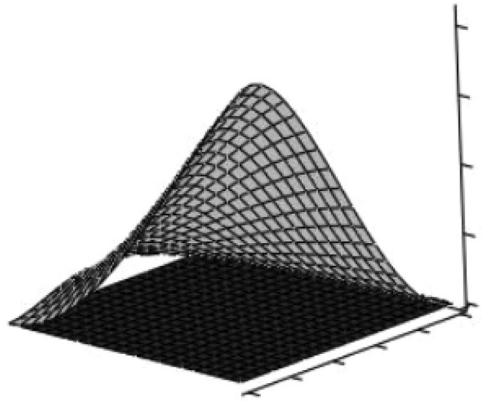

Fig. 1. Consumers' surplus – Bertrand vs. Cournot downstream competition.

Note: ${CS^B}_{lwreg} - {CS^C}_{lwreg}$ gives a result of the form $(c-a)^2 \frac{y(\beta,\gamma)}{g(\beta,\gamma)}$ with $g(\beta, \gamma) > 0$. $y(\beta, \gamma)$(light grey surface plot) is depicted in the vertical axis and $\beta \in (0, 1]$,$\gamma \in (0, 1)$in the horizontal axes. The dark grey surface plot is the zero hyperplane.

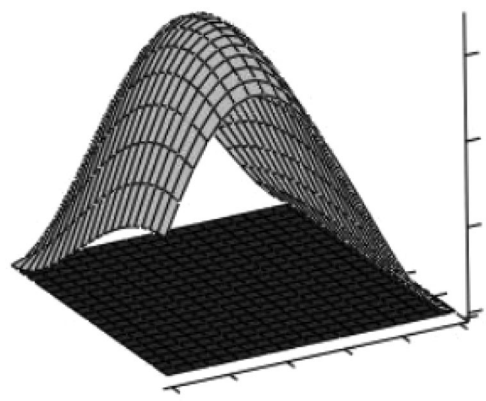

Fig. 2. Total welfare – Bertrand vs. Cournot downstream competition.

Note: ${TW^B}_{lwreg} - {TW^C}_{lwreg}$ gives a result of the form $(c-a)^2 \frac{y(\beta,\gamma)}{g(\beta,\gamma)}$ with $g(\beta, \gamma) > 0$. $y(\beta, \gamma)$(light grey surface plot) is depicted in the vertical axis and $\beta \in (0, 1]$,$\gamma \in (0, 1)$in the horizontal axes. The dark grey surface plot is the zero hyperplane.

pricing regime, respectively. It can be easily shown that 12-15 are equivalent to those generated in the case of non-linear marginal cost pricing (subsection III.1). Given this result and by performing tedious calculations, we get $CS^B_{lreg} = CS^B_{reg} > CS^C_{lreg} = CS^C_{reg}$, $CS^B_{lreg} > CS^B_{lwreg} > CS^C_{lwreg}$, $CS^C_{lreg} > CS^C_{lwreg}$, $TW^B_{lreg} = TW^B_{reg} > TW^C_{lreg} = TW^C_{reg}$, $TW^B_{lreg} > TW^B_{lwreg} > TW^C_{lwreg}$ and $TW^C_{lreg} > TW^C_{lwreg}$. Figures 1–6 illustrate the validity of the previous inequalities.[6] Moreover from the aforementioned inequalities and the discussion in Section IV, it follows that $CS^C_{wreg} > CS^C_{lwreg}$ and $TW^C_{wreg} > TW^C_{lwreg}$.

[6]We use figures instead of algebraic expressions for reader-friendly purposes.

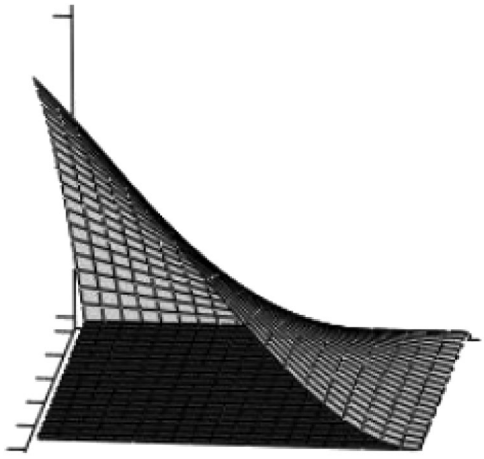

Fig. 3. Consumers' surplus – Regulated vs. deregulated upstream monopoly with Bertrand downstream competition.

Note: $CS^B{}_{lreg} - CS^B{}_{lwreg}$ gives a result of the form $(c-a)^2 \frac{y(\beta,\gamma)}{g(\beta,\gamma)}$ with $g(\beta, \gamma) > 0$. $y(\beta, \gamma)$(light grey surface plot) is depicted in the vertical axis and $\beta \in (0, 1]$,$\gamma \in (0, 1)$in the horizontal axes. The dark grey surface plot is the zero hyperplane.

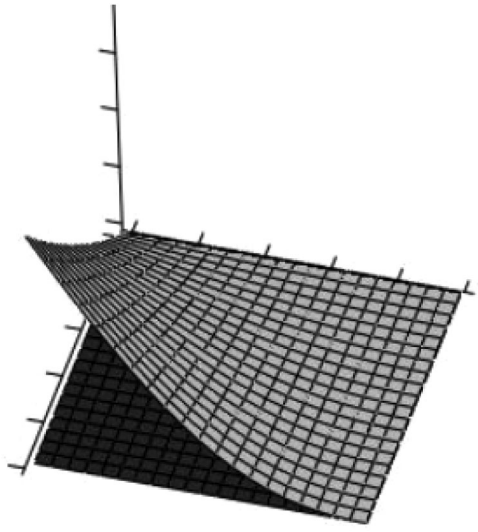

Fig. 4. Total welfare – Regulated vs. deregulated upstream monopoly with Bertrand downstream competition.

Note: $TW^B{}_{lreg} - TW^B{}_{lwreg}$ gives a result of the form $(c-a)^2 \frac{y(\beta,\gamma)}{g(\beta,\gamma)}$ with $g(\beta, \gamma) > 0$. $y(\beta, \gamma)$(light grey surface plot) is depicted in the vertical axis and $\beta \in (0, 1]$,$\gamma \in (0, 1)$in the horizontal axes. The dark grey surface plot is the zero hyperplane.

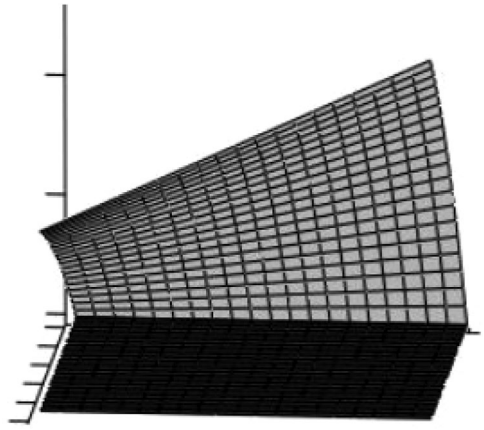

Fig. 5. Consumers' surplus – Regulated vs. deregulated upstream monopoly with Cournot downstream competition.

Note: ${CS^C}_{lreg} - {CS^C}_{lwreg}$ gives a result of the form $(c-a)^2 \frac{y(\beta,\gamma)}{g(\beta,\gamma)}$ with $g(\beta, \gamma) > 0$. $y(\beta, \gamma)$(light grey surface plot) is depicted in the vertical axis and $\beta \in (0, 1]$,$\gamma \in (0, 1)$in the horizontal axes. The dark grey surface plot is the zero hyperplane.

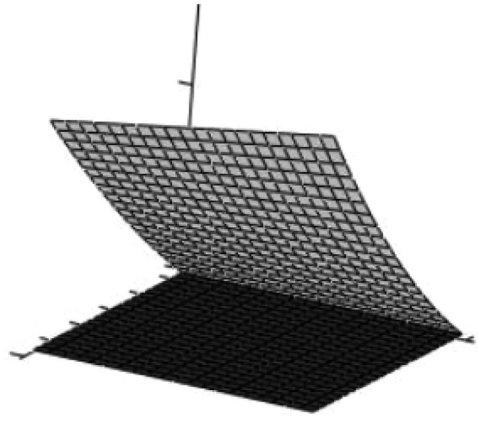

Fig. 6. Total welfare – Regulated vs. deregulated upstream monopoly with Cournot downstream competition.

Note: ${TW^C}_{lreg} - {TW^C}_{lwreg}$ gives a result of the form $(c-a)^2 \frac{y(\beta,\gamma)}{g(\beta,\gamma)}$ with $g(\beta, \gamma) > 0$. $y(\beta, \gamma)$(light grey surface plot) is depicted in the vertical axis and $\beta \in (0, 1]$,$\gamma \in (0, 1)$in the horizontal axes. The dark grey surface plot is the zero hyperplane.

The absence of the fixed fee in the case where trading occurs via linear contracts, eliminates the commitment problem and leads to results consistent with conventional wisdom (Bertrand competition is more efficient than Cournot competition). The main findings of the above analysis can be summarized in the following Corollary:

Corollary 3. The level of consumers' surplus and total welfare remain unchanged under marginal cost pricing regardless of the type of the tariff charged by the upstream monopoly

(i.e., linear or non-linear). Moreover, the dilemma of regulation presented in section IV does not exist under linear contracts; efficiency dictates regulation of the upstream monopoly regardless of the type of the downstream competition.

The equivalence between linear and non-linear tariffs can be explained as follows: when trading occurs via linear contracts, the fixed tariff representing the profits of the monopoly under non-linear tariffs is distributed to the downstream firms. However, this change does not alter the final results.

VI. CONCLUDING REMARKS

In this paper we investigate whether the decision of regulating or deregulating an upstream monopoly is based on the nature of the downstream competition (Cournot vs. Bertrand). To this purpose, we use a simple model of a vertically linked market, where an upstream regulated monopoly is trading via two-part tariff contracts with a downstream duopoly. Our findings indicate that the nature of downstream competition in vertically linked markets with an upstream natural monopoly constitutes an important signal for the regulator. We show that monopoly regulation consisting of a non-linear marginal cost based pricing scheme is efficient under downstream Bertrand competition and inefficient under downstream Cournot competition. Our findings suggest that the regulatory authorities' decisions of whether or not they should regulate a market with upstream natural monopoly characteristics should depend, among other things, on the nature of downstream competition. We have to stress however, that the aforementioned results are not necessarily robust to alternative assumptions regarding the upstream market structure and/or the contracting procedure/contract type. For example when the upstream monopolist trades with downstream firms via linear contracts then the type of the downstream competition does not affect the decisions of the regulator. This implies that the results regarding the comparison of Cournot and Bertrand competition depend on the specific features of the vertically linked markets. Furthermore, the important policy implications of our results call for further investigation through empirical research.

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APPENDIX