Cross-border acquisitions from developing countries under decreasing returns to scale

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Abstract

We assume that a firm from a developing country wants to acquire a firm from a developed country with better technology. The acquirer, which may be a private firm or a state-owned firm, seeks to improve its efficiency in production. We assume that at most there is one acquisition, and that it needs to be authorized by both the government of the developing country and that of the developed country. Firms face decreasing returns to scale. We find that if the level of inefficiency of the acquirer is very high, the government of the developed country forbids acquisitions. The private firm from the developing country is the acquirer in two cases: if the level of inefficiency of the firms from that country is low and if it is high. If the level of inefficiency is intermediate, the acquirer is the state-owned firm.

Keywords Acquisition · Mixed oligopoly · Cournot competition

JEL classification L20 · L32 · L13

1 Introduction

The phenomenon of state-owned firms from developing countries conducting cross-border mergers and acquisitions has received growing attention in studies on international business.¹ In this regard, Huang and Wang (2011) point out that most Chinese outward FDI is undertaken by state-owned enterprises. Evidence

¹See Cuervo-Cazurra et al. (2014), Xie et al. (2017), and Paul and Benito (2018) for surveys on this issue.

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shows that deals in which state-owned firms are acquirers differ from those between private firms (Del Bo et al. 2017).

Recently, many governments in developed countries have regulated cross-border acquisitions by firms from developing countries, especially when the target of the acquisition is a leading technology firm, with the concern of national security.² However, considering the mixed cases recently in real world, which shows acquisitions by private and publicly-owned firms, we seek to study the economic reasons underlying cross-border acquisitions from developing countries. We believe that the analysis conducted to date of the welfare consequences of such cross-border acquisitions is insufficient. Motivated by this belief, we study acquisitions by firms from developing countries that can be vetoed by governments in both developing and developed countries.

Literature on FDI has studied cross-border merger and acquisitions in which foreign market access involves private firms. In this literature, Nocke and Yeaple (2007) highlight firms' heterogeneity in their mobile or immobile capacities when deciding the mode of foreign market access. Norbäck and Persson (2008) find that foreign firms are more likely to enter the domestic market through the acquisition of domestic assets than greenfield investment when the complementarity between domestic and foreign assets is high. Head and Ries (2008) consider that investors from different countries compete for control rights on overseas assets, and which country obtains those assets depends on its monitoring costs relative to rivals' in other countries. Finally, Fumagalli and Vasconcelos (2009) analyze how trade cost affects cross-border mergers in a sequential merger formation game.

Literature on FDI has also considered merger policy and welfare aspects of cross-border mergers. Head and Ries (1997) show that national welfare-maximizing regulators are more likely to approve cost-saving international horizontal mergers that reduce world welfare. Horn and Persson (2001) find that private and social incentives for mergers and acquisitions tend to differ for low levels of cost savings and weak merger synergies. Neary (2007) predicts that international differences in technology can result in bilateral mergers such that low-cost firms acquire higher-cost foreign firms, which are likely to increase the aggregate welfare. Haufler and Nielsen (2008) show, in a three-country model, that international cost-reducing mergers that benefit the firms involved will be permitted by either a national or a regional regulator, and that this is globally efficient. Moreover, Baziki et al. (2017) consider cross-border acquisitions by private equity firms and how they interact with those by multinational enterprises. They suggest that policies for improving the market for corporate control and financial markets in developing countries may be more socially desirable than those for restricting cross-border acquisitions by private equity firms.

The papers cited above do not consider cross-border acquisitions conducted by state-owned firms; that is precisely the main objective of this paper. In this regard, the literature on mixed oligopoly analyzes competition between state-owned firms and

² For example, the Spanish government has introduced a protection to domestic firms considered strategic against their acquisition or control by investors from outside the European Union. These investors may not acquire any participation equal to or greater than 10% of the share capital of a Spanish firm (https://www.abc.es/economia/abci-empresas-extranjeras-no-podran-comprar-mas-10-por-ciento-espanolas-202003190218_noticia.html). A similar measure has been taken by the Indian government (<https://foreignpolicy.com/2020/04/28/india-china-fdi-restrictions-coronavirus/>).

private firms. Focusing on the domestic market, that literature has studied mergers between private firms in the presence of a public firm and between public and private firms (see Bárcena-Ruiz and Garzón 2003, 2020a; Nakamura and Inoue 2007; Méndez-Naya 2008; Artz et al. 2009; Kamijo and Nakamura 2009; Gelves and Heywood 2013; Ye and Wu 2015).³ The study of mergers that focus on the world market is limited. In this regard, Heywood and McGinty (2011) examine cross-border mergers between domestic private firms and/or foreign private firms in the presence of a welfare maximizing public firm. Dong and Guo (2013) consider a developing country with one state-owned firm and n private firms. There is a developed country with two firms, and those firms own better technology. The state-owned firm is the acquirer in cross-border acquisition whereas the domestic private firm exports products. They analyze which of the foreign firms is acquired by the state-owned firm.

To analyze cross-border merger and acquisitions by firms from developing countries, we consider a world composed by three countries with segregated markets.⁴ In this model a developing country is served by two domestic firms, one privately-owned and the other publicly-owned, whereas a developed country is served by two domestic private firms. The firms in the two countries export products to a third country. Firms from the developing country are less efficient in production than those from the developed country. To overcome the disadvantage in efficiency, a firm from the developing country may acquire a firm from the developed country, incurring a fixed cost, thereby obtaining the technical know-how owned by the acquired firm.⁵ We assume that at most there is one acquisition, and that it needs to be permitted by both the government of the developing country and that of the developed country. Firms face decreasing returns to scale.

We assume in the paper that if a firm from a country that is less efficient in production wants to acquire a firm with better technology from a foreign country it needs permission from its government and, subsequently, from the foreign government. There is evidence supporting this assumption. In both North America and Europe the authorities have blocked acquisitions by Chinese firms, mainly in the technology sector, arguing national security reasons.⁶ Limitations on purchases of foreign companies can also come from the country of origin. Chinese firms need to have the full backing of the Chinese government in order to close foreign deals. They need approval to get enough foreign exchange, which is monitored closely by the government, to pay

³ Among others, this literature has examined privatization in international mixed oligopolies (Wang et al. 2009; Matsumura and Tomaru 2012; Bárcena-Ruiz and Garzón 2020b), trade policy (Pal and White 1998; Bárcena-Ruiz and Garzón 2005b), and welfare consequences of inward foreign direct investment (Matsumura et al. 2009).

⁴ This assumption characterizes markets that are not as integrated as the E.U. is. For example, the markets of China and the E.U. are separate although trade costs decreased dramatically after China joined the WTO. The segregated market assumption is used in many cross-border merger and acquisition papers based on international oligopoly models (see, for example, Horn and Persson 2001; Haufler and Nielsen 2008).

⁵ Thus, once a firm from the developed country is acquired its firm-specific assets (FSAs) can be transferred without costs to the acquirer from the developing country. As noted in FDI literature, FSAs can be easily transferred or shared within the boundary of a firm rather than between different firms (see Markusen 1995).

⁶ The German government has approved a law that may allow the stopping of investments that come from outside the E.U. Similarly, merger and acquisition deals in the U S are subject to scrutiny by the Committee on Foreign Investment which recently prevented the sale of Philips' lighting business to a group of buyers in Asia (<http://www.businessinsider.com/china-is-buying-a-lot-of-foreign-companies-2016-2>).

for the acquisitions. Also, many of the firms chasing after foreign deals are actually state-owned firms.⁷

We find that the firms from the developing country want to acquire a foreign firm with better technology if the fixed cost of acquisition is low. For intermediate costs only one of them wants to engage in cross-border acquisition. In that case, if the acquisition assures small (significant) gains in efficiency, only the private firm (the state-owned firm) from the developing country wants to engage in cross-border acquisition.

There is evidence of state-owned firms engaging in cross-border acquisition to access advanced technology. In 2012, Liu Gong Machinery Corp, one of the largest wheel loader manufacturers in the world, and a leading exporter of machines from China, acquired Huta Stalowa Wola and its distribution subsidiary. In the transaction, Liu Gong obtained core technologies that will help it advance its product designs and promote sales to Liu Gong's European customers.⁸ There is also evidence of private firms engaging in cross-border acquisition. For example, the Chinese automobile maker Geely acquired Volvo in 2010. In 2012, Sany Heavy Industry, a private Chinese construction equipment group acquired Putzmeister, a German company that makes high-tech concrete pumps.⁹

The acquisition has to be permitted by both governments. The government of the developing country grants permission for the acquisition to just one domestic firm: That which generates a greater increase in domestic welfare. If the inefficiency of the acquirer is very high, the developed-country government vetoes cross-border acquisitions by firms from developing countries. In general, if the inefficiency of the acquirer is low the developing country only permits its private firm to acquire a firm from the developed country and the government of the latter country does not block it. Social welfare in both countries increases with the acquisition. If the level of inefficiency is intermediate, the developing country only grants its state-owned firm permission to acquire. The government of the developed country does not block the acquisition although it prefers the private firm as the acquirer. Finally, if the level of inefficiency is high the government of the developed country only permits the foreign private firm to be the acquirer, so the government of the developing country has to grant permission to that firm although it prefers the state-owned firm as the acquirer.

⁷ The Chinese government regularly publishes a list of industries in which it wants firms to invest, and regulators must approve all aspects of a proposed deal. When state-owned banks determine which deals get financing, they tend to favor those that advance government objectives (<http://www.businessinsider.com/china-is-buying-a-lot-of-foreign-companies-2016-2>). Until recently, it has been observed that any Chinese investor bidding for an overseas project needs to pursue approval according to the formal procedures set in place by the government. Specifically, Chinese investors must first report project information to China's National Development and Reform Commission (the NDRC). This project information reporting requirement is sometimes referred to as the "road pass" regime, and the NDRC typically issues only one road pass for a particular transaction (<https://www.herbtsmithfreehills.com/latest-thinking/recent-development-on-chinas-outbound-investment-approval-filing-requirements-and>). Although the "road pass" regime has been abolished recently, the Ministry of Commerce still requires all deals to be registered and most of them need approvals from several other agencies (<https://www.ft.com/content/28f6b8d4-59cd-11e4-9787-00144feab7de>).

⁸ See <http://www.constructionequipment.com/liugong-acquire-hsw-dressta>, <http://remmag.com/international-news-0/liugong-finalizes-acquisition-polish-manufacturer-hsw>. Another example is the acquisition of Pirelli by the state-owned firm ChemChina, which gives the latter access to technology to make premium tires (<http://www.bbc.com/news/business-32015529>).

⁹ See <https://www.reuters.com/article/us-geely/chinas-geely-completes-volvo-buy-idUSTRE66S1TC20100802>, http://www.sanyhi.com/company/hi/en-us/media/30586_for_special_list_text_content.htm.

The results obtained in this paper permit to explain partially the reasons why firms from developing countries want to acquire firms from developed countries, and why governments may veto such acquisitions. For example, the acquisition of Hula Stalowa Wola by Lin Gong Machinery Corp., a Chinese publicly owned firm, had the objective of obtaining the best technology from the former firm. A similar example is the acquisition of Volvo by the private Chinese firm Geely. As these acquisitions increased the social welfare of both countries, their governments permitted them. However, there are also examples of acquisition attempts that were vetoed by the government of the developed-country since it reduced its social welfare. One recent veto was imposed by the German government to avoid the microchip maker Aixtron being purchased by Fujian Great Chip Investment Fund.¹⁰ In this last example, the different technological level between the two firms was the reason what prevented the acquisition.

The rest of the paper is organized as follows. Section 2 presents the model. Section 2.1 presents product market competition in the different cases analyzed. Section 2.2 examines cross-border acquisition by firms from the developing country. Sections 2.3 and 2.4 study whether the two governments permit cross-border acquisitions. Section 3 discusses the robustness of the results, and Section 4 concludes.

2 Model

Consider to countries, denoted by A and B . In country A there is a state-owned firm and a private firm, denoted by 0 and 1, respectively. In country B there are two private firms, denoted by 2 and 3, respectively. Consumers in each country are served by domestic firms only. Firms can export products to a third market situated in country C . This framework is illustrated in Fig. 1.

The three markets are segregated. Firms produce a homogenous product and the inverse demand functions in the three markets are given by:

$$\begin{aligned} p_A &= 1 - q_{0A} - q_{1A}, \\ p_B &= 1 - q_{2B} - q_{3B}, \\ p_C &= 1 - q_{0C} - q_{1C} - q_{2C} - q_{3C} \end{aligned} \quad (1)$$

where p_j is the price of products sold in country j ($j = A, B, C$) and q_{ij} denotes the output sold by firm i ($i = 0, 1, 2, 3$) in country j .

Initially firms in country A are less efficient in production than those in country B . Following De Fraja and Delbono (1989) and Bárcena-Ruiz and Garzón (2005a), we assume that firms face decreasing returns to scale. Specifically, the cost function of production of firm ij is given by:

$$C(q_{ij}) = k(q_{ij})^2/2 \quad (2)$$

¹⁰ See <https://www.cnbc.com/2017/08/23/germanys-chinese-takeover-regulations-could-have-a-downside.html>.

Fig. 1 Four-firms, three countries set-up

where parameter k measures efficiency in production, with $k < 4.8$.¹¹ To simplify the analysis and without loss of generality, parameter k for a firm in country B is normalized to 1, so $k = 1$ for $i = 2, 3$. As firms in country A are less efficient in production than those in country B , we assume that $k > 1$ for $i = 0, 1$. Moreover, there are no trade costs involved in firms serving country C .

To overcome the disadvantage in efficiency, a firm from country A considers acquiring a firm from country B .¹² Specifically, we assume that the acquirer has the same cost function as firms 2 and 3 after the acquisition. Without loss of generality, firm 2 is the potential acquired firm (the target firm; see Fig. 1). Due to antitrust regulation in country B , we assume that only one firm can be acquired by a foreign firm and that merger between firms 2 and 3 is forbidden (to prevent a monopoly).

The profit function of firm i from country B is given by:

$$\pi_i = p_B q_{iB} + p_C q_{iC} - (q_{iB} + q_{iC})^2 / 2, i = 2, 3 \quad (3)$$

The profit function of firm i from country A , when it does not acquire firm 2, is given by:

$$\pi_i = p_A q_{iA} + p_C q_{iC} - k(q_{iA} + q_{iC})^2 / 2, i = 0, 1 \quad (4)$$

¹¹ We assume that $k < 4.8$ to ensure that firm 1 can export products to country C .

¹² We assume that firms 2 and 3 cannot acquire firms in country A . This may be due to the many restrictions imposed by the government of country A . This applies to many industries in developing countries such as construction, automobiles, infrastructure building, etc.

If a firm from country A (firm 0 or 1) acquires firm 2, it becomes a multiproduct firm with two plants, and its profit function is given by:

$$\pi_i = p_A q_{iA} + p_C q_{iC} + p_B q_{2B} + p_C q_{2C} - (q_{iA} + q_{iC})^2 / 2 - (q_{2B} + q_{2C})^2 / 2 - G - F, i = 0, 1 \quad (5)$$

where G is the lump-sum payment made to firm 2 by the acquirer to ensure that the acquisition is accepted, and F is the fixed cost of acquisition incurred by firm i .¹³

Social welfare in each country is given by the sum of the producer surplus and the consumer surplus in that country. Social welfare in country A is given by:

$$W_A = PS_A + CS_A = \pi_0 + \pi_1 + CS_A \quad (6)$$

where π_0 and π_1 are given by (4) when there is no acquisition and by (5) when there is one; the consumer surplus is given by $CS_A = (q_{0A} + q_{1A})^2 / 2$. The social welfare in country B is given by $W_B = \pi_2 + \pi_3 + CS_B$ when firm 2 is not acquired by a firm from country A , and by $W_B = G + \pi_3 + CS_B$ when it is; the consumer surplus is given by $CS_B = (q_{2B} + q_{3B})^2 / 2$.

The objective of this paper is to analyze FDI conducted by a (privately or publicly owned) firm from a developing country in an international mixed oligopoly under quantity competition. To that end, we propose the following timing: In the first stage, government A decides which of its two domestic firms, if any, may acquire foreign firm 2. In the second stage government B decides whether the acquisition is permitted. In the third stage, if the acquisition is allowed, the firm authorized by governments A and B (firm 0 or 1) decides whether or not to acquire firm 2 and how much to offer the owners of firm 2 in the former case, and the owners of firm 2 decide whether or not to accept the offer. In the fourth stage, firms independently and simultaneously choose the outputs that they sell in their domestic markets and in country C . We solve the game by backward induction from the last stage of the game to obtain a sub-game perfect Nash Equilibrium.

2.1 Stage 4: Product market competition

Next we solve the fourth stage of the game in each of the subgames. In this stage, firms choose the outputs that they sell in their domestic markets and in country C .

2.1.1 Benchmark: No acquisition

We consider first that neither firm from country A acquires a firm in country B . This case is denoted by subscript N . In the fourth stage of the game firms from countries A and B choose the output that they sell in the domestic and foreign countries. Firm 1 chooses q_{1A} and q_{1C} that maximizes its profit function, given by $\pi_1 = p_A q_{1A} + p_C q_{1C} - k(q_{1A} + q_{1C})^2 / 2$. Firm 0 chooses q_{0A} and q_{0C} that maximizes the social welfare of country A given by $W_A = PS_A + CS_A = \pi_0 + \pi_1 + CS_A$, where $\pi_0 = p_A q_{0A} + p_C q_{0C} - k(q_{0A} +$

¹³ This cost involves, for example, learning investment by the acquirer to facilitate the transfer of FSAs, coordination between organizations and rearrangements of production lines.

$q_{0C})^2/2$. Firm i chooses q_{iB} and q_{iC} that maximizes its profit function, given by $\pi_i = p_B q_{iB} + p_C q_{iC} - (q_{iB} + q_{iC})^2/2$, $i = 2, 3$.

It can be shown that firm 0 does not export to country C , so $q_{0C} = 0$.¹⁴ By replacing $q_{0C} = 0$ into the profit functions of the firms and solving the first order conditions for the problems of the firms, we obtain that their outputs are the following:

$$\begin{aligned} q_{0A} &= \frac{22 + 46k}{22 + 81k + 52k^2}, q_{1A} = \frac{k(13 + 6k)}{22 + 81k + 52k^2}, q_{1C} = \frac{9 + 27k - 6k^2}{22 + 81k + 52k^2} \\ q_{2B} &= q_{3B} = \frac{5 + 18k + 10k^2}{22 + 81k + 52k^2}, q_{2C} = q_{3C} = \frac{2 + 9k + 12k^2}{22 + 81k + 52k^2} \end{aligned} \quad (7)$$

From (7) we obtain that $q_{1C} > q_{2C} = q_{3C}$ if and only if $k < 1.2993$, $q_{0A} > q_{1A}$ and $q_{2B} = q_{3B} > q_{1A}$. As only the state-owned firm, firm 0, cares about the consumer surplus and both firms are equally inefficient, it produces more than private firm 1, thus increasing market competition in country A . This causes private firm 1 to sell less in its domestic market than private firms 2 and 3 in theirs. Firm 1 exports more to country C than firms 2 and 3 when parameter k is low enough ($k < 1.2993$). This is because firm 1 sells less in the domestic market than the other firms so it has a cost advantage, because costs are quadratic.

By substituting expression (7) into (3) and (4), we obtain the profit of firms:

$$\begin{aligned} \pi_{0N} &= \frac{2k(11 + 23k)^2}{(22 + k(81 + 52k))^2}, \pi_{1N} = \frac{162 + 1053k + 2300k^2 + 1264k^3 + 144k^4}{2(22 + 81k + 52k^2)^2} \\ \pi_{2N} &= \pi_{3N} = \frac{107 + 810k + 2143k^2 + 2340k^3 + 972k^4}{2(22 + 81k + 52k^2)^2} \end{aligned} \quad (8)$$

Finally, from (7) we obtain the consumer and producer surpluses (CS_{iN} , PS_{iN} , $i = A, B$), and the social welfare (W_{iN} , $i = A, B$). To simplify the presentation of results, these expressions (collected in Lemma A1) are relegated to Appendix 1.

2.1.2 The state-owned firm engages in cross-border acquisition

In this section we consider that the state-owned firm from the developing country acquires foreign firm 2, thereby obtaining the efficient technology. We denote this case by subscript M . This acquisition implies that the state-owned firm lowers its production costs. This firm has two productive plants now, one located in country A (plant 0) and the other located in country B (plant 2), and each plant may serve two markets. In the fourth stage of the game, the state-owned firm chooses the output of plants 0 and 2 (q_{0A} , q_{0C} , q_{2B} and q_{2C}) that maximizes $W_A = PS_A + CS_A = \pi_0 + \pi_1 + CS_A$, where $\pi_0 = p_A q_{0A} + p_C q_{0C} + p_B q_{2B} + p_C q_{2C} - (q_{0A} + q_{0C})^2/2 - (q_{2B} + q_{2C})^2/2 - G - F$. Firm 1 chooses q_{1A}

¹⁴ The state-owned firm does not care about consumers in country C . Moreover, this firm produces more than the private firms (with the same efficiency) since it takes domestic consumer surplus into account. Serving country C means producing more, which strongly increase the costs of the state-owned firm since production costs are quadratic, so it does not serve country C . This result is not due to the cost function considered in the model, it also arises if we assume constant marginal costs of production.

and q_{1C} that maximizes $\pi_1 = p_A q_{1A} + p_C q_{1C} - k(q_{1A} + q_{1C})^2/2$, and firm 3 chooses q_{3B} and q_{3C} to maximize $\pi_3 = p_B q_{3B} + p_C q_{3C} - (q_{3B} + q_{3C})^2/2$.

It can be checked that, by the same reasons than in the Section 3, plant 0 does not export to country C (so $q_{0C} = 0$). By replacing $q_{0C} = 0$ into the profit functions of the firms, and solving the first order conditions for their problems, we obtain that the outputs of firms are the following:

$$\begin{aligned} q_{0A} &= \frac{6 + 14k}{18 + 27k}, q_{1A} = \frac{6 - k}{18 + 27k}, q_{1C} = \frac{9 + k}{18 + 27k} \\ q_{2B} &= \frac{9 + 16k}{54 + 81k}, q_{3B} = q_{3C} = \frac{14k - 9}{54 + 81k}, q_{2C} = \frac{14k - 9}{54 + 81k} \end{aligned} \quad (9)$$

From (9) we obtain that $q_{0A} > q_{1A}$, $q_{2B} > q_{3B}$ and $q_{3C} > q_{2C}$ ($q_{2C} > 0$ since $k > 1$). Thus, the state-owned firm sells more than firm 1 in country A . In country B it also sells more through plant 2 than its rival, firm 3. Moreover, firm 1 sells more (less) than the other firms in country C when its inefficiency in production is low (high) enough. Specifically, $q_{1C} > q_{3C} > q_{2C} > 0$ if $k < 18/13$, $q_{3C} > q_{1C} > q_{2C}$ if $18/13 < k < 36/11$, and $q_{3C} > q_{2C} > q_{1C}$ if $k > 36/11$, where $q_{1C} = q_{2C}$ for $k = 36/11 \approx 3.27$, and $q_{1C} = q_{3C}$ for $k = 18/13 \approx 1.38$.

The state-owned firm takes the consumer surplus into account and is more efficient in production than firm 1, so it sells more than firm 1 in country A . Moreover, the state-owned firm maximizes the social welfare of country A , so it takes into account the profit of firm 1 when it decides the output that plant 2 sells in country C . Therefore, although plant 2 is as efficient as firm 3 it exports less to encourage firm 1 to sell more there, given that outputs are strategic substitutes. As explained in the above section, this means that plant 2 sells more in country B than firm 3, because costs are quadratic. Given that firm 1 sells less output in the domestic market (country A) and given the strategic effect of plant 2, firm 1 exports more (less) to country C than firm 3 if its inefficiency is low (high) enough.

2.1.3 The private firm engages in cross-border acquisition

In this case private firm 1 acquires firm 2, which means that it obtains the efficient technology and lowers its production costs. We denote this case by subscript m . After the acquisition firm 1 has two productive plants, one located in country A (plant 1) and the other in country B (plant 2). The profits of the state-owned firm and the private firm are given by (4) and (5), respectively.

In the fourth stage of the game, private firm 1 chooses the output of plants 1 and 2 (q_{1A} , q_{1C} , q_{2B} and q_{2C}) that maximizes $\pi_1 = p_A q_{1A} + p_C q_{1C} + p_B q_{2B} + p_C q_{2C} - (q_{1A} + q_{1C})^2/2 - (q_{2B} + q_{2C})^2/2 - G - F$. The state-owned firm chooses q_{0A} and q_{0C} that maximizes (6), and firm 3 chooses q_{3B} and q_{3C} that maximizes (3) for $i = 3$. It can also be checked that in this case firm 0 does not export to country C , so $q_{0C} = 0$. By replacing $q_{0C} = 0$ in (4) to (6) and solving the first order conditions for the problems of the firms, we find that their outputs are the following:

$$\begin{aligned} q_{0A} &= \frac{35}{29 + 51k}, q_{1A} = \frac{2(8k - 3)}{29 + 51k}, q_{1C} = \frac{3(4 + k)}{29 + 51k} \\ q_{2B} &= \frac{9 + 11k}{29 + 51k}, q_{2C} = \frac{8k - 3}{29 + 51k}, q_{3B} = q_{3C} = \frac{5 + 10k}{29 + 51k} \end{aligned} \quad (10)$$

From (10) we obtain that $q_{0A} < q_{1A}$ if $k > 41/16 \approx 2.56$, $q_{2B} > q_{3B}$, $q_{1C} + q_{2C} > q_{3C}$, $q_{3C} > \max\{q_{1C}, q_{2C}\}$. Thus, in country *A* the private firm (firm 1) sells more than its rival, firm 0, unless the latter firm is efficient enough. It also sells more in country *B* than its rival (firm 3) through plant 2. Moreover, it exports products to country *C* from plants 1 and 2. Each plant of firm 1 sells less there than firm 3, and firm 1 sells more total output there than firm 3. Finally, firm 1 exports more (less) from plant 1 than from plant 2 if the state-owned firm is efficient (inefficient) enough. Specifically, $q_{1C} \geq q_{2C}$ if $k \leq 3$ and $q_{2C} > q_{1C}$ if $k > 3$.

In country *A*, after the acquisition, firm 1 is more efficient in production than firm 0. Outputs are strategic substitutes, so when the inefficiency is high enough firm 0 produces less than firm 1; otherwise firm 1 produces less than firm 0.

When firm 1 decides the output sold by one plant it takes into account the profit of the other. This means that each plant exports less than its rival, firm 3, given that outputs are strategic substitutes. However, firm 1 exports more total output since it exports products from two plants whereas firm 3 exports from only one. Finally, as explained, firm 1 sells more products in country *A* when the inefficiency of the state-owned firm is high (low) enough. It follows that firm 1 exports less output through plant 1 and thus exports more through plant 2 when parameter k is high (low) enough. By the same reasoning as in the above section, given that plant 2 of firm 1 exports less than firm 3, it sells more in country *B*.

2.2 Stage 3: Cross-border acquisition

In the third stage, firm 0 pays the amount G to the owners of firm 2. The amount to be paid is the profit made by the owners of firm 2 when there is no acquisition, so $G = \pi_{2N}$,¹⁵ where π_{2N} is given by Lemma A1 (see Appendix 1). By replacing $G = \pi_{2N}$ and expression (8) in (1) to (6), the profit of firms (π_{iM} , $i = 0, 1, 2, 3$), the consumer and producer surpluses (CS_{iM} , PS_{iM} , $i = A, B$), and the social welfare (W_{iM} , $i = A, B$) are obtained. These expressions, collected in Lemma A2, are relegated to Appendix 1.

Next we analyze whether firm 0 wants to acquire firm 2. From Lemmas A1 and A2 (see Appendix 2) we obtain that $W_{AM} = W_{AN}$ for $F = F_{0W}$, where:

$$F_{0W} = \frac{1417886k^4 + 7750746k^5 + 3435136k^6 - 98172 - 1098288k - 4383467k^2 - 6034491k^3}{729(2 + 3k)^2(22 + 81k + 52k^2)^2}.$$

Lemma 1 *In equilibrium, the state-owned firm wants to engage in cross-border acquisition if $F \leq F_{0W}$.*

Proof See Appendix 2.

The increase in efficiency of the state-owned firm raises social welfare so this firm wants to engage in cross-border acquisition if the fixed cost of acquisition it has to pay is low enough ($F \leq F_{0W}$). In addition, F_{0W} increases with parameter k since the greater

¹⁵ Firms from country *A* do not compete with each other to acquire firm 2, so there is no bidding competition, since only one of them is authorized by its government to buy firm 2, so the acquiring firm pays just the reservation price for the acquired firm, π_{2N} .

the increase in efficiency due to the acquisition is, the greater the fixed cost of acquisition that firm 0 is able to pay will be.

Next we solve the third stage when firm 1 is the acquirer. Firm 1 pays the amount G to the owners of firm 2. The amount to be paid is the profit made by the owners of firm 2 when there is no acquisition, so $G = \pi_{2N}$, where π_{2N} is given by Lemma A1. By replacing $G = \pi_{2N}$ and expression (9) in (1) to (6) the profit of firms (π_{im} , $i = 0, 1, 2, 3$), the consumer and producer surpluses (CS_{im} , PS_{im} , $i = A, B$), and the social welfare (W_{im} , $i = A, B$) can be obtained. These expressions, collected in Lemma A3, are relegated to Appendix 1.

We analyze now whether firm 1 may acquire firm 2. From Lemmas A1 and A3 (see Appendix 2) we obtain that $W_{Am} = W_{AN}$ for $F = F_{1\pi}$, where:

$$F_{1\pi} = \frac{283-276357k-1894846k^2-3308101k^3+590959k^4+4133556k^5+1742756k^6}{2(29+51k)^2(22+81k+52k^2)^2}.$$

Lemma 2 *In equilibrium, firm 1 wants to engage in cross-border acquisition if $F \leq F_{1\pi}$.*

Proof see Appendix 2.

The increase in efficiency of private firm 1 permits this firm to obtain greater market share and profits, so this firm wants to engage in cross-border acquisition if the fixed cost of acquisition it has to pay is low enough ($F \leq F_{1\pi}$). In addition, $F_{1\pi}$ increases with parameter k since the greater the increase in efficiency due to the acquisition is, the greater the fixed cost of acquisition that firm 1 is able to pay will be.

Next we analyze whether or not the state-owned firm wants to acquire firm 2 for a greater range of value of parameters than firm 1. It is easy to check (see Appendix 2) that $F_{0W} > F_{1\pi}$ if and only if $k > 1.0388$. From Lemmas 1 and 2 the following result emerges.

Proposition 1 *In equilibrium, if $F \geq \max\{F_{0W}, F_{1\pi}\}$ there is no acquisition; if $F_{1\pi} > F \geq F_{0W}$ only the private firm from country A wants to engage in cross-border acquisition; if $F_{0W} > F \geq F_{1\pi}$ only the state-owned firm wants to engage in cross-border acquisition; finally, if $F < \min\{F_{0W}, F_{1\pi}\}$ the two firms from country A want to engage in cross-border acquisition.*

The result shown in Proposition 1 is illustrated in Fig. 2. This figure represents the fixed cost of acquiring firm 2 as a function of the parameter that measures efficiency in production, k . Both F_{0W} and $F_{1\pi}$ increase with parameter k so, as shown in Proposition 1, there are four zones.

Proposition 1 shows that neither firm in country A wants to engage in cross-border acquisition if the fixed cost is high enough (i.e. if $F \geq \max\{F_{0W}, F_{1\pi}\}$); this case corresponds to Zone Ia of Fig. 2. Both firms from country A want to do so if the fixed cost is low enough (i.e. if $F < \min\{F_{0W}, F_{1\pi}\}$); this case corresponds to Zone Ic of Fig. 2. This result is due to the increase in efficiency of production: in the first case the fixed cost is high enough in regard to the increase in efficiency, while in the second case it is low enough.

If $F_{0W} > F \geq F_{1\pi}$ (Zone Ib of Fig. 2) only firm 0 wants to engage in cross-border acquisition. If $F_{1\pi} > F \geq F_{0W}$ (Zone Id of Fig. 2) only firm 1 wants to engage in cross-border acquisition. This last case arises when the inefficiency of the firms from country A is low enough (i.e. when $k < 1.0388$). The explanation of this result is the following:

Fig. 2 Illustration of Proposition 1

When parameter k is high ($k > 1.0388$), the increase in efficiency due to the acquisition of the foreign firm is also high. This enables firm 0 to increase considerably the output sold in country A, thereby increasing the welfare of that country. Thus, firm 0 can afford greater fixed costs than firm 1. However, when the increase in efficiency is low ($k < 1.0388$) the increase in the welfare of country A due to the acquisition made by firm 0 is fewer. In that case the fixed costs that firm 0 can afford are lower than that of firm 1.

2.3 Stage 2: Should government in country B allow cross-border acquisition?

We now solve the second stage of the game, analyzing whether government B permits the acquisition of firm 2 by a foreign firm from the developing country. Government B permits such acquisition if it increases the social welfare of country B, so the welfare obtained by country B in the different cases must be compared. It is proved in Appendix 3 that $W_{BM} = W_{BN}$ if $k = 3.8012$, $W_{Bm} = W_{BN}$ if $k = 3.8092$, and $W_{BM} = W_{Bm}$ if $k = 4.0381$.

Lemma 3 *In equilibrium: $W_{Bm} > W_{BM} > W_{BN}$ if $k < 3.8012$, $W_{Bm} > W_{BN} > W_{BM}$ if $3.8012 < k < 3.8092$, $W_{BN} > W_{Bm} > W_{BM}$ if $3.8092 < k < 4.0381$, and $W_{BN} > W_{BM} > W_{Bm}$ if $4.0381 < k$.*

Proof see Appendix 3.

Lemma 3 shows that whether government B permits the acquisition of one of its domestic firms depends only on parameter k , the parameter that measures the inefficiency in production of firms from country A, since the fixed cost of the acquisition is paid by the foreign firms. The consumer surplus in country B is higher with acquisition than without it since more output is sold there. Moreover, more total output is sold in

country B when firm 0 engages in acquisition than when firm 1 does if k is low enough. Thus, the consumer surplus is higher in that case so the consumers in country B are in favor of the acquisition.¹⁶

The producer surplus of country B includes the profits obtained by its domestic firms. To compare the producer surplus with and without acquisition it suffices to compare the profit obtained by firm 3 in both cases, since the payment made to the owners of firm 2 for the acquisition equals its profit without acquisition.¹⁷ If k is high enough ($k > 2.1082$), the acquirer from country A can strategically use its two plants when competing with firm 3 in the different markets, since it can produce more than without acquisition. Thus, firm 3 obtains less profit than without acquisition. When k is low enough ($k < 1.1815$), the increase in the acquirer's output is not enough for it to use its plants strategically, so firm 3 obtains more profits. In that case, firm 3 obtains less profit when firm 0 makes the acquisition than when firm 1 does, since plant 0 sells more output domestically, resulting in more exports from country A . Finally, if k is intermediate ($2.1082 > k > 1.1815$) the outputs sold domestically by plant 0 increase further, encouraging more exports from country A . This makes firm 3 worse off than when there is no acquisition, so firm 3 obtains more (less) profit if the acquirer is firm 1 (firm 0).

When k is low enough ($k < 3.8012$), social welfare in country B is higher with the acquisition of firm 2 by any foreign firm than without acquisition. This is because the increase in the consumer surplus due to acquisition dominates in social welfare since the inefficiency of the firms from country A is low. When k is high enough ($k > 3.8092$), the decrease in producer surplus outweighs the increase in consumer surplus due to acquisition. Thus, as firms from country A are highly inefficient, the social welfare of country B is greater when its government forbids acquisitions. When k is intermediate ($3.8012 < k < 3.8092$) social welfare in country B is higher (lower) with acquisition by firm 1 (firm 0) than without acquisition. In this case, both the consumer surplus and the producer surplus are important in explaining the result. With the lower consumer surplus, without acquisition the social welfare in country B is not greater. Moreover, the greater (lower) producer surplus with acquisition by firm 1 (firm 0) explains the result.

From Lemma 3 it can be concluded which firms from the developing country are authorized by government B to acquire firm 2.

Proposition 2 *In equilibrium: if $k < 3.8012$ the acquisition of firm 2 by any foreign firm increases the welfare of country B ; if $3.8012 \leq k < 3.8092$ government B only allows firm 1 to acquire firm 2; finally, if $3.8092 \leq k$ government B forbids acquisitions.*

Lemma 3 shows that, as the firms from country A become more inefficient, it is less attractive for country B that firm 2 be acquired by a firm from country A . In case of acquisition, one firm from country A increases its efficiency which reduces the producer surplus of country B . Therefore, Proposition 2 states that there are no acquisitions if the inefficiency in production of the acquirers is high enough (i.e. if $k \geq 3.8092$). However, if the inefficiency in production of the firms in country A is low enough,

¹⁶ It can be checked (see Appendix 3) that $CS_{BN} < \min\{CS_{BM}, CS_{Bm}\}$, with $CS_{BM} > CS_{Bm}$ if $k < 4.0381$.

¹⁷ It can be checked (see Appendix 3) that $\pi_{3m} > \pi_{3N} > \pi_{3M}$ if $k < 1.8515$, $\pi_{3m} > \pi_{3N} > \pi_{3M}$ if $1.8515 < k < 2.1082$ and $\pi_{3N} > \max\{\pi_{3M}, \pi_{3m}\}$ if $k > 2.1082$, with $\pi_{3m} > \pi_{3M}$ if $k < 4.0381$.

government B allows the acquisition since it increases its welfare. In that case, government B prefers that the acquirer be the private firm to the public one due to the effect on its producer surplus. Thus, if $k < 3.8012$ government B permits the acquisition of firm 2 by any foreign firm although welfare is greater if the acquirer is the private firm. However, if $3.8012 \leq k < 3.8092$ government B only allows the foreign private firm to acquire firm 2.

2.4 Stage 1: Should government in country A allow cross-border acquisition?

In the first stage of the game government A decides whether or not to allow one of its domestic firms to acquire foreign firm 2.¹⁸ Before solving stage 1 we analyze whether cross-border acquisition is socially desirable for country A . From Lemmas 1 and 2 and Lemmas A1 to A3 (see Appendix), the following result is obtained. Denote F_{1W} as the value of parameter F such that $W_{Am} = W_{AN}$ (the value of F_{1W} is relegated to Appendix 4).

Lemma 4 *In equilibrium: if $k \leq 1.0613$ and $F < F_{1W}$ welfare in country A is greater when firm 2 is acquired by the private firm; if $k > 1.0613$ and $F < F_{0W}$ welfare in country A is greater when firm 2 is acquired by the state-owned firm; finally, if $F \geq \max\{F_{0W}, F_{1W}\}$ acquisitions reduce welfare in country A .*

The result shown in Lemma 4 is illustrated in Fig. 3. This figure represents the different zones that appear in Lemma 4, as a function of parameters F and k . Lemma 4 shows that from a social welfare viewpoint cross-border acquisition is socially undesirable for country A if $F \geq \max\{F_{0W}, F_{1W}\}$ since the fixed cost of the acquisition is high enough (Zones *Ila* and *Ilf* of Fig. 3). When the fixed cost is low enough, the welfare of country A is greater if one domestic firm acquires firm 2. Thus, the government of country A allows one domestic firm to make the acquisition thereby generating greater welfare in the country. The identity of the acquirer, firm 0 or firm 1, depends on the extent of the efficiency gains obtained by the local firm with the acquisition.

Appendix 3 proves that the welfare of country A is greater if the acquirer is firm 0 than if it is firm 1 (i.e. $W_{AM} > W_{Am}$) if $k > 1.0613$ (Zones *Ila*, *Ilb* and *Ilc* of Fig. 3). In both cases the acquiring firm has to pay the fixed cost F , so the comparison does not depend on that parameter. It depends only on the gains in efficiency due to the acquisition, measured by parameter k . Thus, it is better from a social welfare viewpoint for the acquirer to be the state-owned firm if the increase in efficiency is high (i.e. if $k > 1.0613$). It is because when the increase in efficiency due to the acquisition is high, the consumer surplus is greater if the acquirer is the public firm ($CS_{AM} > CS_{Am}$).¹⁹ Otherwise it is better for the acquirer to be the private firm since now $CS_{AM} < CS_{Am}$ (Zones *Ild*, *Ile* and *Ilf* of Fig. 3). Finally, for the welfare of country A to be increased, the fixed cost of acquisition has to be low enough. Thus, when $k > 1.0613$ cross-border acquisition by the state-owned firm increases the social welfare of country A if $F < F_{0W}$ (Zones *Ilb* and *Ilc* of Fig. 3). When $k < 1.0613$ cross-border acquisition by the private firm increases the social welfare of country A if $F < F_{1W}$ (Zones *Ild* and *Ile* of Fig. 3).

¹⁸ It has to be noted that as firm 0 maximizes social welfare, its objective function is the same than that of country A .

¹⁹ It can be checked (see Appendix 4) that $CS_{AM} > CS_{Am}$ if $k > 1.0613$.

Fig. 3 Illustration of Lemma 4

Lemma 4 shows which firm may acquire firm 2, if any, from the social welfare viewpoint of country A. Next we solve stage 1 to analyze which acquisition is actually carried out. To do this we have to take into account the following: First, the acquisition is allowed if it increases domestic welfare. Second, government A grants permission for the acquisition to be made by the firm that thereby increases domestic welfare most. Third, government A has to take into account vetoes by government B. Finally, government A has to take on board that firm 1 (firm 0) does not want to acquire firm 2 if $F > F_{1\pi}$ ($F > F_{0W}$). From Propositions 1 and 2 and Lemma 4 we obtain the following result, which is illustrated in Fig. 4.

Proposition 3 *In equilibrium: firm 1 acquires firm 2 when $F < F_{1\pi}$ if $k \leq 1.0613$ and if $3.8092 > k \geq 3.8012$; firm 0 acquires firm 2 if $3.8012 \geq k > 1.0613$ and $F < F_{0W}$, and if $1.0613 \geq k > 1.0388$ and $F_{1\pi} < F < F_{0W}$. For the rest of the values of the parameters there are no acquisitions.*

Figure 4 shows the value of parameters F and k in three cases: when firm 1 is the acquirer, when firm 0 is the acquirer and, finally, when there are no acquisitions. The explanation of the result shown in Proposition 3 is the following: As shown in Lemma 4, government A allows cross-border acquisition only if it improves the welfare of its country. When the acquisition is appropriate for firms and is not vetoed by government B, government A decides which domestic firm may be the acquirer. Government B permits cross-border acquisition if it improves the welfare of country B. As seen in Proposition 2, this happens if $k \leq 3.8092$; however, if $3.8012 \geq k > 3.8092$ the acquirer has to be firm 1. Moreover, Proposition 1 states that firm 1 (firm 0) wants to acquire firm 2 if $F < F_{1\pi}$ ($F < F_{0W}$). Taking into account the above results and Lemma 4, government A chooses the acquirer whose cross-border acquisition behavior is welfare superior for country A.

Fig. 4 Illustration of Proposition 3

Several areas need to be distinguished. The first is for $k \leq 1.0613$. In this area firm 1 acquires firm 2, which is permitted by both governments, if $k \leq 1.0613$ and $F < F_{1\pi}$ (Zones IV and V of Fig. 4). In this area firm 1 wants to acquire firm 2, welfare in country A is greater when firm 2 is acquired by firm 1 (as explained in Lemma 3), and the acquisition is permitted by government B (as explained in Lemma 4). If $1.0388 < k \leq 1.0613$ and $F_{1\pi} < F < F_{1W}$ (Zone VI of Fig. 4), firm 1 does not want to acquire firm 2. However, the social welfare of both countries increases if firm 0 acquires firm 2 (see Lemmas 3 and 4), so both governments permit the acquisition.

The second area is for $3.8012 \geq k > 1.0613$. In this area if $F < F_{0W}$ (Zones I and III of Fig. 4), firm 2 is acquired by firm 0, which is permitted by both governments (see Lemmas 3 and 4). In this case, government B prefers firm 1 as the acquirer, but acquisition by any firm from country A increases its welfare, so government B cannot veto such an acquisition. As a result, firm 2 is acquired by firm 0.

The third area is for $3.8092 > k > 3.8012$. In that case, if $F < F_{1\pi}$ (Zone II of Fig. 4) firm 1 is the acquirer, which is permitted by both governments. In this case government A prefers firm 0 as the acquirer since it is welfare superior for country A (see Lemma 4). However, to ensure a feasible cross-border acquisition that improves welfare regarding the case without acquisition, government A chooses firm 1 as the acquirer. As a result, firm 2 is acquired by firm 1.

Finally, in the remainder areas there are no acquisitions due to three reasons: neither firm from country A wants to acquire firm 2 since it is too expensive for them,

government B forbids it because the firms from country A are highly inefficient, and government A forbids it.

3 Robustness of the results

The results obtained in the paper depend on the assumption of decreasing returns to scale. If we assume constant marginal costs of production, that are higher for firms in country A than for those in country B (and, in country A , the public firm has a higher cost than the private one), the main results of the paper do not hold. It has to be noted that under decreasing returns production costs increase with the output level, which does not happen with constant marginal costs of production. In addition, the public firm tends to produce more than the private ones, since it maximizes social welfare. Therefore, under constant marginal costs of production the public firm can produce more than with decreasing returns. This means that the result of Proposition 1 in which there is an area such that only firm 1 acquires firm 2 does not hold. It is also obtained that country B is indifferent to who is the acquirer of firm 2. This is because firms in country B produce the same output, whether the acquirer is firm 0 or firm 1. Therefore, the result of Proposition 2 does not hold. Finally, the welfare of country A is higher if the acquirer is the public firm than if it is the private one. This means that firm 0 is the one that acquires firm 2, except if parameter F is very large (in which case no firm acquires firm 2). Therefore, the result of Proposition 3 does not hold. This discussion leads to conclude that the assumption of decreasing returns to scale is a key assumption for the results obtained in the paper.

4 Conclusion

Empirical evidence shows that state-owned and private firms from developing countries conduct cross-border acquisitions seeking to obtain superior technologies. In addition, governments are increasingly turning their attention to such acquisitions. On the one hand, firms from developing countries may need the approval of their governments, so those governments in fact decide which domestic firm is the potential acquirer. On the other hand, governments from developed countries may veto acquisitions by foreign firms to avoid reductions in their welfare. We study this issue in the paper, assuming decreasing returns to scale, seeking to fill the gap in the literature.

We find that firms from the developing country want to acquire a firm with better technology if the fixed cost of acquisition is low. For intermediate values of this cost only one of them wants to acquire a firm from the developed country. In that case only the private (state-owned) firm from the developing country acquires a firm with better technology if the gains in efficiency are small (significant). However, the acquisition has to be permitted by both governments. If the inefficiency of the acquirer is very high the government of the developed country blocks cross-border acquisitions. In general, if the inefficiency of the acquirer is low the developing country permits its private firm to acquire a firm from the developed country and the government of the latter country

does not block it. If the level of inefficiency is intermediate the developing country only permits its state-owned firm to be the acquirer and the government of the developed country does not block the acquisition although it prefers the private firm as the acquirer. If the inefficiency of the acquirer is high the developed country only permits the foreign private firm to be the acquirer, so the government of the developing country has to give permission to the private firm even though it prefers the state-owned firm as the acquirer.

In this paper we consider a state-owned firm conducting cross-border acquisition as a process of nationalization. It may be also interesting to study how the optimal privatization of state-owned firms interacts with the possibility of this firm being an acquirer in cross-border acquisition in a developing country. Another extension of the paper is to consider a Greenfield investment in the advanced country by a firm from the developing country. Finally, another extension of the paper is to consider exogenous factors that could affect the acquisition of foreign firms, for example, by lowering the price accepted by the target firm. We leave these issues for future research.

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Appendix 1

Lemma A1 *When neither firm from country A acquires firm 2, in equilibrium:*

$$\begin{aligned} CS_{AN} &= \frac{(22 + 59k + 6k^2)^2}{2(22 + 81k + 52k^2)^2}, CS_{BN} = \frac{2(5 + 18k + 10k^2)^2}{(22 + 81k + 52k^2)^2} \\ PS_{AN} &= \frac{162 + 1537k + 4324k^2 + 3380k^3 + 144k^4}{2(22 + 81k + 52k^2)^2}, PS_{BN} = \frac{107 + 810k + 2143k^2 + 2340k^3 + 972k^4}{(22 + 81k + 52k^2)^2} \\ W_{AN} &= \frac{646 + 4133c + 8069c^2 + 4088c^3 + 180c^4}{2(22 + 81c + 52c^2)^2}, W_{BN} = \frac{157 + 1170k + 2991k^2 + 3060k^3 + 1172k^4}{(22 + 81k + 52k^2)^2} \end{aligned}$$

Lemma A2 *When firm 0 acquires firm 2, in equilibrium:*

$$\begin{aligned} \pi_{0M} &= \frac{20412 + 495144k + 3344275k^2 + 9812673k^3 + 13731650k^4 + 8710434k^5 + 1920562k^6}{729(2 + 3k)^2(22 + 81k + 52k^2)^2} - F \\ \pi_{1M} &= \frac{234 + 237k + 4k^2}{162(2 + 3k)^2}, \pi_{3M} = \frac{4(9 + 16k)^2}{729(2 + 3k)^2}, CS_{AM} = \frac{(12 + 13k)^2}{162(2 + 3k)^2}, CS_{BM} = \frac{(9 + 11k)^2}{162(2 + 3k)^2} \\ PS_{BM} &= \frac{625644 + 6722604k + 28973735k^2 + 64030734k^3 + 76648735k^4 + 47338164k^5 + 11915084k^6}{1458(2 + 3k)^2(22 + 81k + 52k^2)^2} \\ PS_{AM} &= \frac{1060128 + 9528444k + 32943980k^2 + 56369511k^3 + 51444880k^4 + 23491764k^5 + 3938468k^6}{1458(2 + 3k)^2(22 + 81k + 52k^2)^2} - F \\ W_{AM} &= \frac{1687392 + 15506460k + 55156160k^2 + 97555851k^3 + 92063185k^4 + 43897500k^5 + 8051252k^6}{1458(2 + 3k)^2(22 + k(81 + 52k))^2} - F \\ W_{BM} &= \frac{2(244620 + 2545812k + 10575695k^2 + 22455486k^3 + 25817020k^4 + 15332607k^5 + 3714935k^6)}{729(2 + 3k)^2(22 + 81k + 52k^2)^2} \end{aligned}$$

Lemma A3 *When firm 1 acquires firm 2, in equilibrium:*

$$\begin{aligned}\pi_{1m} &= \frac{136525 + 1088412k + 3575590k^2 + 7297176k^3 + 10433275k^4 + 7847172k^5 + 2117300k^6}{(29 + 51k)^2(22 + 81k + 52k^2)^2} - F \\ \pi_{3m} &= \frac{100(1 + 2k)^2}{(29 + 51k)^2}, \pi_{0m} = \frac{1225k}{2(29 + 51k)^2}, CS_{Am} = \frac{(29 + 16k)^2}{2(29 + 51k)^2}, CS_{Bm} = \frac{49(2 + 3k)^2}{2(29 + 51k)^2} \\ PS_{Am} &= \frac{136525 + 1681312k + 7941490k^2 + 18137201k^3 + 20752675k^4 + 11159572k^5 + 2117300k^6}{2(29 + 51k)^2(22 + k(81 + 52k))^2} - F \\ PS_{Bm} &= \frac{186787 + 2097716k + 9484750k^2 + 22028944k^3 + 27672315k^4 + 17863916k^5 + 4691372k^6}{2(29 + 51k)^2(22 + 81k + 52k^2)^2} \\ W_{Am} &= \frac{543569 + 5127788k + 18814795k^2 + 34346041k^3 + 33109555k^4 + 15825428k^5 + 2809524k^6}{2(29 + 51k)^2(22 + k(81 + 52k))^2} - F \\ W_{Bm} &= \frac{281651 + 3080852k + 13528230k^2 + 30454984k^3 + 37058020k^4 + 23168852k^5 + 5883836k^6}{2(29 + 51k)^2(22 + 81k + 52k^2)^2}\end{aligned}$$

Appendix 2

$$\begin{aligned}W_{AM} - W_{AN} &= F_{0W} - F > 0 \text{ if } F < F_{0W} \\ \pi_{1m} - \pi_{1N} &= F_{1\pi} - F > 0 \text{ if } F < F_{1\pi} \\ F_{0W} - F_{1\pi} &= \left(165950532 + 1624724640k + 6440068837k^2 + 13760185209k^3 + 16469844128k^4 + \right. \\ &\quad \left. 5485161801k^5 - 13887648677k^6 - 18275754864k^7 - 6435355356k^8 \right) / \\ &\quad \left(1458(2 + 3k)^2(29 + 51k)^2(22 + 81k + 52k^2)^2 \right) > 0 \text{ if and only if } k > 1.0388\end{aligned}$$

Appendix 3

$$\begin{aligned}W_{BM} - W_{BN} &= \frac{31428 + 306468k + 1164397k^2 + 2146374k^3 + 1823657k^4 + 335898k^5 - 259622k^6}{729(2 + 3k)^2(22 + 81k + 52k^2)^2} > 0 \text{ if } k < 3.8012, \\ W_{Bm} - W_{BN} &= \frac{17577 + 184100k + 758934k^2 + 1526968k^3 + 1424574k^4 + 317180k^5 - 212908k^6}{2(29 + 51k)^2(22 + 81k + 52k^2)^2} > 0 \text{ if } k < 3.8092 \\ W_{BM} - W_{BM} &= \frac{3321 - 2124k - 52954k^2 - 56004k^3 + 17136k^4}{1458(2 + 3k)^2(29 + 51k)^2} > 0 \text{ if } k > 4.0381 \\ CS_{BM} - CS_{BN} &= \frac{(18 + 53k + 27k^2 + 32k^3)(378 + 1889k + 2691k^2 + 1112k^3)}{162(2 + 3k)^2(22 + 81k + 52k^2)^2} > 0, \\ CS_{Bm} - CS_{BN} &= \frac{(18 + 42k + 13k^2 + 72k^3)(598 + 3150k + 4845k^2 + 2112k^3)}{2(29 + 51k)^2(22 + 81k + 52k^2)^2} > 0, \\ CS_{BM} - CS_{Bm} &= \frac{(6k^2 - 9 - 22k)(513 + 1534k + 1128k^2)}{162(2 + 3k)^2(29 + 51k)^2} > 0 \text{ if } k < 4.0381 \\ \pi_{3M} - \pi_{3N} &= \frac{1620 + 126612k + 899945k^2 + 2261106k^3 + 1918945k^4 - 373428k^5 - 839500k^6}{1458(2 + 3k)^2(22 + 81k + 52k^2)^2} > 0 \text{ if } k < 1.8185, \\ \pi_{3M} - \pi_{3N} &= \frac{6813 + 102284k + 531650k^2 + 1201456k^3 + 1046085k^4 - 59116k^5 - 364972k^6}{2(29 + 51k)^2(22 + 81k + 52k^2)^2} > 0 \text{ if } k < 2.1082 \\ \pi_{3m} - \pi_{3M} &= \frac{4(9 + 22k - 6k^2)(531 + 1868k + 1626k^2)}{729(2 + 3k)^2(29 + 51k)^2} > 0 \text{ if } k < k = 4.0381\end{aligned}$$

Appendix 4

$$W_{Am}-W_{AN} = \frac{283-258933k-1876894k^2-3710002k^3-121598k^4+4660100k^5+2341344k^6}{2(29+51k)^2(22+81k+52k^2)^2} - F = F_{1W}-F > 0 \text{ if } F < F_{1W},$$

$$W_{AM}-W_{Am} = \frac{-342873-937053k-560128k^2+655032k^3+927522k^4}{1458(2+3k)^2(29+51k)^2} = F_{0W}-F_{1W} > 0 \text{ if } k > 1.0632$$

$$CS_{Am}-CS_{AN} = \frac{k(-132-379k+526k^2)(1276+5534k+5987k^2+1138k^3)}{2(29+51k)^2(22+81k+52k^2)^2} > 0$$

$$CS_{AM}-CS_{Am} = \frac{5(174+412k+219k^2)(-174-82k+231k^2)}{162(2+3k)^2(29+51k)^2} > 0 \text{ if } k > 1.0633$$

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