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Commercial policies, unilateral versus bilateral foreign ownership, and welfare

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Abstract

This paper examines how cross-border ownership and restrictions affect commercial policies optimally chosen by the government of an importing country. Focusing on import competition in an oligopoly market served by two local producers and a foreign firm, we study and compare two partial ownership arrangements without corporate control: unilateral ownership by the foreign firm over a local producer and bilateral ownership between the two entities. The main findings are as follows: (i) When foreign ownership is unilateral, the optimal trade and industrial policies are an import tariff and a production subsidy, respectively. (ii) When foreign ownership is bilateral, the trade policy can be an import subsidy, and the industrial policy is a production subsidy. These results differ from the benchmark equilibrium without ownership, under which the optimal policy mix consists of an import tariff and a production subsidy. (iii) Unilateral foreign ownership always reduces domestic welfare. However, bilateral foreign ownership can increase domestic welfare when local producers' cost disadvantages are substantially high. (iv) Considering the usual lump-sum transfer for a balanced budget, bilateral ownership entails a lower public burden than two other scenarios for the government to finance its strategic use of trade and industrial policies.

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1 | INTRODUCTION

Notwithstanding the pandemic's impacts on commerce, multinational corporations' cross-border investments expanded significantly both before and after the crisis due to the faster level of trade openness in the world. The worldwide economic recovery is still going strong despite a resurgent pandemic, according to the October 2021 issue of the *World Economic Outlook*. The advanced economies grew by 5.2% in 2021 but contracted by 4.5% in 2022. In 2022, a 4.9% growth in the world economy was predicted. The strong economic performance over the years would make up for the 2020 crash by putting advanced economies back into pre-pandemic situations.[1] These reports indicated the importance of global connections in speeding up international trade and investment. Multinational companies (MNEs) have been seen to export aggressively, competing with locally owned businesses in importing countries. The critical issues confronting policymakers in importing countries include the following: (i) How do governments and industries of importing countries react to import penetration by MNEs when they also have partial ownership positions in the stocks or profits of local firms? (ii) Given that globalization compels the interconnection of trading nations to invest abroad, how will an importing country's choice of trade and industrial policies be affected by cross-border ownership structures? (iii) Can cross-border partial ownership benefit importing countries when domestic producers confront enormous cost disadvantages relative to their competitors from abroad? These challenging questions motivate us to develop a theoretical framework of import competition in oligopolistic markets with cross-border ownership, hoping to provide their answers and shed light on policy designs for importing countries.

Cross-border ownership arrangements are significant components of foreign direct investments for multinational enterprises or acquiring firms. Meanwhile, policymakers are interested in cross-border ownership structures as they affect consumer benefits and social welfare through their impacts on the production decisions of domestic firms. A frequently cited example of cross-border partial ownership is Renault, a French auto firm engaged in ownership arrangements with Nissan, a Japanese auto manufacturer. Specifically, Renault acquired a 44.3% equity stake in Nissan Motor, and Nissan Motor acquired a 15% stake in Renault. Another example of bilateral ownership is between Tencent Music Entertainment and Spotify had minority equity investments in each other's music streaming businesses in 2017.[2] Moreover, until 2021, Tencent owned 17% of JD.com, China's second-biggest e-commerce company. Interestingly, JD had a minority equity investment in Yixun, whose stake was owned by Tencent.[3] The ownership arrangements of firms' holding partial equity stakes in their rivals have been increasingly common in

[1]See https://www.imf.org/en/Publications/WEO/Issues/2021/10/12/world-economic-outlook-october-2021. See also the December 2021 issue of *World Economic Forum* at: https://www.weforum.org/agenda/2021/12/globalization-world-trade-bounce-back-from-covid-19/.

[2]See: https://www.wsj.com/articles/music-streaming-giants-spotify-and-tencent-music-swap-stakes-1512751939 and https://www.bbc.com/news/business-42285181.

[3]For more details, see: https://www.reuters.com/business/tencent-distribute-most-jdcom-stake-shareholders-2021-12-23, and https://www.prnewswire.com/news-releases/jdcom-and-tencent-form-strategic-partnership-to-transform-ecommerce-industry-in-china-249216001.html.

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various industries.[4] Considerable academic studies have contributed to our understanding of the competitive/anticompetitive effects of bilateral or overlapping ownership arrangements by rival firms in oligopolies.[5] It is known that, from the social welfare perspective, bilateral ownership arrangements among rival firms affect market competition negatively (e.g., Farrell & Shapiro, 1990; Hariskos et al., 2022; Reitman, 1994).[6]

Several interesting studies incorporate international ownership through equity markets into the literature on strategic trade policy. Utilizing the Brander-Spencer (1985) framework of competition in exporting a homogeneous product to a third-country market, Lee (1990) examines how trade policies are affected by the scenario that investors internationally own the exporting firms through equity markets. Lee (1990) shows that an increase in the international ownership share of the exporting firms causes the export subsidy and import tariff to decline at the same rate, implying that the international shareholdings of the firms do not affect trade patterns and their profits. Miyagiwa (1992) shows that, within the Brander-Spencer model, an export subsidy can lower rather than raise national welfare if domestic citizens hold shares of the foreign firm or if foreigners hold shares of the domestic firm. Dick (1993) empirically documents that international equity ownership weakens or reverses trade policy results. Edwards (2008) analyzes how an increase in international ownership share through stock markets affects governments' reactions to foreign direct investment and their policy decisions to protect domestic firms. Remarkably, Edwards (2008) finds that a high international equity share makes domestic protection unappealing. Van Long and Soubeyran (2001) present a generalization of Lee's (1990) neutrality proposition by showing that trade, profits, and world welfare are not affected by the international ownership of the exporting firms.

Alternatively, from the perspective of ownership arrangements between competing firms, Fanti and Buccella (2016) examine the situation when producers from separate countries engage in unilateral partial ownership and compete to export their products to a third-country market. The researchers show that if the ownership share is significantly large, the acquired firm's government finds it optimal to impose an export tax. When the ownership share is at least one-third, the equilibrium result of the exporting countries' policy game shifts from an activist regime to an asymmetric regime with only the acquiring firm's government making interventions. Din et al. (2016) analyze the bilateral ownership between two firms from different countries that compete to export a homogeneous product to a third-country market. The authors concentrate their analysis on an optimal tariff structure set by the third-country government and show that a lower (higher) tariff is imposed on the low-cost (high-cost) firm. As a result, when compared to a uniform tariff regime (i.e., the most-favorable-nation clause), tariff discrimination ends up increasing global welfare. The contribution by Ishikawa et al. (2011) investigates an import-competing market in which a foreign firm holds full ownership (100%) of a locally owned firm through direct investment. The authors show how import tariffs and production subsidies may benefit a foreign exporter at the expense of domestic firms. Consequently, a policy designed by the host country to restrict foreign ownership benefits domestic producers. Fanti and

[4]Some interesting examples of the industries include electricity power (Amundsen & Bergman, 2002), and steel (Gilo et al. (2006)). automobiles (Ono et al., 2004), and airlines (Clayton & Jorgensen, 2005), See more industries cited in Lopez and Vives (2019).

[5]See, for example, Flath (1992), Malueg (1992), Reitman (1994), Clayton and Jorgensen (2005), Gilo et al. (2006), Dietzenbacher and Temurshoev (2008), Fanti (2015, 2016), and Lopez and Vives (2019). Analyzing the case of a symmetric Cournot duopoly, Reitman (1994) shows that both firms have incentives to acquire a stake in each other's profits.

[6]Reynolds and Snapp (1986) analyze the implications of partial ownership arrangements between firms producing a homogeneous product and show that an increase in the share of bilateral ownership affects the industrial output negatively. Flath (1991) shows that, under duopolistic competition, a firm may have no incentive to acquire some shares of its rival's profit unless the firm's operating earnings are higher when its share of bilateral ownership increases.

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Buccella (2021) show that under cross-ownership, the use of tax by an exporting country as a strategic trade policy can be Pareto-superior to free trade when products are differentiated. Zhang and Lee (2023) consider a vertical market in which a portion of the upstream is passively owned by a foreign firm, and find that a tariff can strategically improve welfare by inducing technology transfer when foreign ownership is sufficiently high.

This paper contributes to the literature on cross-border ownership and trade by examining the optimal commercial policies of an importing country when its domestic producers have considerable cost disadvantages in the face of foreign competition without exporting. We concentrate on various situations where an importing country's government maximizes domestic welfare in determining trade and industrial policies under different ownership structures. Instead of looking at foreign direct investment (FDI) that seizes 100% or whole control of local business operations, we investigate how partial ownership arrangements affect the choice of trade and industrial industries for oligopolistic industries in importing countries. Specifically, we analyze the nature of Cournot competition in an import-competing domestic market served by two local producers and a foreign firm. We look at two different types of partial ownership arrangements without corporate control: unilateral (one-sided) ownership by a foreign firm over a local producer and bilateral (two-sided) ownership between the two entities.[7] We contrast their equilibrium results with the benchmark scenario of oligopolistic competition without foreign ownership to highlight differences in welfare implications.

The present study complements the contribution of Ishikawa et al. (2011), which analyzes commercial policy for an importing country with cross-border ownership. The following are some distinctions between the two analyses. First, Ishikawa et al. (2011) examine a foreign firm's export and investment decisions when it has complete control over a local producer in an import-competing market. The authors assume that the host government's import tariff and production subsidy policies are given. We analyze cross-border partial ownership that is bilateral or unilateral and devoid of corporate control, and examine how partial ownership structures affect the trade and industrial policies optimally chosen by an importing country's government. We show that the optimal trade policy can be an import subsidy under bilateral ownership. Second, Ishikawa et al. (2011) indicate that if import tariffs and production subsidies are zero, the host country's welfare may rise. Our analysis shows that when local producers face considerable cost disadvantages, domestic welfare may increase under bilateral ownership. Nevertheless, when foreign ownership is unilateral, domestic welfare inevitably decreases.

We summarize the main findings of our study as follows. When foreign ownership is unilateral, optimal trade and industrial policies for an importing country are an import tariff and a production subsidy, respectively. When foreign ownership is bilateral, the trade policy can be an import subsidy, and the industrial policy is a production subsidy. These results under bilateral ownership contrast the traditional import-competing market without foreign ownership, in which the policy mix consists of an import tariff and a production subsidy. We also find that the optimal subsidy rate to domestic producers is the *highest* in the benchmark equilibrium without foreign ownership. However, the subsidy rate is higher under bilateral than unilateral foreign ownership.

Furthermore, we show that the effect of cross-border partial ownership on an importing country's welfare depends on such factors as the cost disadvantage of local firms relative to their foreign

[7]Note from industrial organization and antitrust literature (e.g., Salop & O'Brien, 2000) that there is an important distinction between financial interest and corporate control. Corporate control refers to situations under which shareholders can make decisions for their firm. In the present study, we focus our analysis on the aspect of financial interest (or "silent investment") in receiving a fraction of a firm's profits without having discretion over the firm's decisions. Salop and O'Brien (2000) indicate that "[a] corporate control structure characterized by a silent financial interest is one in which the acquiring firm is entitled to a share of the acquired firm's profits but has no power to control or even influence the decisions of the acquired firm" (p. 577).

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competitors, the ownership structure (unilateral or bilateral), and foreign ownership limitations (i.e., equity shares). The benchmark situation without foreign ownership has the highest domestic welfare when local producers' cost disadvantages are not critically high. This is because both consumer and producer surpluses are at their highest levels. Foreign ownership that is unilateral always reduces domestic welfare. However, bilateral foreign ownership can improve domestic welfare if local producers have considerable cost disadvantages. This outcome entails an increase in the volume of foreign exports through reducing the tariff rate, which may increase domestic welfare but at the expense of consumers. When declines in tariff revenues and consumer surplus are more than offset by rises in domestic profits, bilateral foreign ownership increases domestic welfare. Lastly, our model has implications for how an importing country's optimal policy mix affects its public finances. Assuming the usual lump-sum transfer to ensure a balanced budget, bilateral ownership implies a lower public burden than two other scenarios for the government to finance its strategic trade and industrial policies.

The rest of the paper is as follows. Section 2 lays out an analytical framework of an import-competing oligopoly market and examines the benchmark equilibrium without foreign ownership. We then analyze bilateral and unilateral foreign ownership arrangements. Section 3 compares the equilibrium results across the different scenarios, discusses the effects on the choice of trade and industrial policies, and analyzes their differences in welfare implications. Section 4 concludes.

2 | OPTIMAL TRADE AND INDUSTRIAL POLICIES FOR AN IMPORT-COMPETING INDUSTRY

Consider an import-competing home market served by a foreign firm and two domestic firms (denoted by 1 and 2). The firms produce a homogeneous good and face a linear demand: $p = 1 - x_f - (y_{h1} + y_{h2})$, where x_f is the quantity of the output exported by the foreign firm, and y_{hi} is that of the output produced by the ith domestic firm ($i = 1, 2$). We assume that the foreign firm's marginal cost of production is constant at c_f, and that of each domestic firm's is constant at c_d, where $c_f < c_d$.[8] This discrepancy reflects that the foreign firm's production technology is more efficient than that of the domestic firms. For simplicity, we assume that $0 = c_f < c_d = c$, where $0 < c < 1/2$.[9] The value of c measures the cost disadvantage of domestic production (or the cost advantage of foreign production).[10]

The locally produced goods are only intended for home consumption and not for exportation due to cost disadvantages. This enables us to study import competition and analyze an importing country's socially optimal choice of trade and industrial policies. Denote $t(>0)$ as a tariff rate on foreign imports. If $t < 0$, the trade policy is an import subsidy. Also, denote $s(>0)$ as a subsidy rate on domestic production. If $s < 0$, the industrial policy is a tax. The foreign firm's profit function is:

$$\pi_f = \left[1 - x_f - (y_{h1} + y_{h2}) - t\right] x_f, \tag{1}$$

and the two domestic firms' profit functions are:

$$\pi_{h1} = \left[1 - x_f - (y_{h1} + y_{h2}) + s - c\right] y_{h1}, \tag{2}$$

[8]In an international context, the possible sources of the production cost differences between home and foreign countries may be variations in technology and factor endowments.

[9]This assumption guarantees that each firm produces positive output in the presence of partial ownership arrangements when there is no policy intervention.

[10]Issues concerning how firm-level productivity affects trade have been systematically studied. Helpman et al. (2004) develop the firm-heterogeneity theory to characterize international commerce decisions of firms (export vs. FDI). The researchers find that the most productive firms in an industry choose to invest in foreign markets and that firms at the next high productivity level choose to export. Girma et al. (2005) present an empirical study to support the heterogeneous firm theory.

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$$\pi_{h2} = \left[1 - x_f - (y_{h1} + y_{h2}) + s - c\right] y_{h2}. \tag{3}$$

As in the literature, social welfare is taken as the sum of consumer surplus, producer surplus, and tariff revenue collected from the foreign firm, net of production subsidies to the domestic producers. That is,

$$\text{SW} = \text{CS} + \text{PS} + tx_f - s(y_{h1} + y_{h2}), \tag{4}$$

where $\text{CS} = \left(x_f + y_{h1} + y_{h2}\right)^2/2$, and PS is the sum of payoff that each domestic firm obtains.

In the analysis of an optimal policy mix, we define the government's net income (GNI) as tariff revenue minus production subsidies, that is, $\text{GNI} = tx_f - s(y_{h1} + y_{h2})$. There is a surplus (or deficit) when GNI is positive (or negative). We consider that the government provides a lump-sum transfer from outside of this market to guarantee a balanced budget. Such a transfer reflects a financial burden placed on the public to safeguard an industry vulnerable to import competition given that domestic production is at a cost disadvantage. Using this approach, we may look into how various circumstances—with or without cross-border ownership arrangements—affect the financial burden.

We adopt a two-stage game. In stage one, the home government commits to imposing a tariff t (or a subsidy for $t < 0$) on each unit of its imports and, in the meanwhile, offers a subsidy s (or a tax for $s < 0$) to each unit of the good domestically produced. In stage two, given the policy mix, $\{t, s\}$, the firms engage in Cournot competition by independently and simultaneously making their output decisions to maximize individual profits. We solve the two-stage game by backward induction to obtain a subgame-perfect Nash equilibrium.

2.1 | The benchmark case without cross-border ownership

We first examine the case where there are no ownership (NO) arrangements across international boundaries. Beginning with the second stage of the game, the competing firms independently make their output decisions to maximize respective profits. Using the profit functions in Equations (1)–(3), we derive the firms' first-order conditions (FOCs) and solve for their optimal output levels:

$$x_f^{\text{NO}} = \frac{(2c - 2s - 3t + 1)}{4} \text{ and } y_{hi}^{\text{NO}} = \frac{(1 + t + 2s - 2c)}{4} \text{ for } i = 1, 2. \tag{5}$$

In the first stage of the game, the importing country's government determines trade and industrial policies, $\left\{t^{\text{NO}}, s^{\text{NO}}\right\}$, to maximize its social welfare Equation (4), where $\text{PS} = \pi_{h1} + \pi_{h2}$. Substituting the output equations from Equation (5) back into the social welfare function in Equation (4) yields

$$\text{SW} = \frac{1}{32}\left[4c(5c - 2s + t - 7) - 4s(3s - 5t + 3) - 19t^2 + 10t + 13\right].$$

We derive the government's FOCs and find that the interior solution is unique since the Hessian matrix is negative definite (see Appendix A-1). Using the FOCs, we solve for the optimal policy mix of import tariff and domestic subsidy:

$$t^{\text{NO}} = \frac{c}{2} > 0 \text{ and } s^{NO} = \frac{2 - 3c}{4} > 0. \tag{6}$$

It follows straightforwardly from Equation (6) that an increase in the domestic cost disadvantage leads the government to (i) raise the optimal tariff for trade protection and (ii) lower the production

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subsidy to the domestic firms. Substituting the optimal policy mix from Equation (6) back into Equation (5) yields

$$x_f^{NO} = \frac{c}{2}, y_{h1}^{NO} = y_{h2}^{NO} = \frac{(2-3c)}{4} > 0, \text{and } p^{NO} = c. \tag{7}$$

We summarize the implications and the solutions for the benchmark case as follows:

Lemma 1. *In the benchmark scenario without cross-border ownership, an importing country's trade policy is an import tariff, and its industrial policy is a production subsidy. The equilibrium values of firm profits, producer surplus, consumer surplus, the government's net income (i.e., tariff revenue minus production subsidies), and domestic welfare are:*

$$\pi_{hi}^{NO} = \frac{(2-3c)^2}{16}, \pi_f^{NO} = \frac{c^2}{4}, PS^{NO} = \frac{(2-3c)^2}{8}, CS^{NO} = \frac{(1-c)^2}{2},$$

$$GNI^{NO} = -\frac{\left(7c^2-12c+4\right)}{8}, SW^{NO} = \frac{\left(3c^2-4c+2\right)}{4}. \tag{8}$$

The economic intuitions behind the optimal policy mix run as follows. An import tariff improves the importing country's terms of trade, and a production subsidy helps reduce the domestic producers' cost disadvantage (and hence improves their competitiveness) against the foreign firm, which indirectly improves the terms of trade.[11]

Having discussed the benchmark equilibrium, we analyze various changes in the production behavior of the competing firms when they may engage in partial ownership arrangements. We look at two scenarios: unilateral ownership by the foreign firm over a local producer and bilateral ownership between the two entities. We use the benchmark equilibrium, as shown in Lemma 1, to evaluate these two ownership arrangements, taking into account the conditions that all the firms produce positive outputs.

2.2 | Unilateral foreign ownership over a local producer

Under unilateral ownership, a foreign firm holds a stake in a local firm's stocks or profits. As in Ishikawa et al. (2011), we assume that an acquiring firm's equity share is not affected by changes in trade and industrial policies and that the cost of ownership, denoted as $k(>0)$, is a past sunk cost. That is, an acquiring firm's financial investment is undertaken. This assumption allows us to focus on market competition and its effects on product price, consumer benefits, firm profits, and domestic welfare. Also, we consider foreign ownership restrictions ($0 < k < 50\%$) and an ownership structure such that a firm's equity share does not affect its competitor's business operation or decision-making.[12] That is, there is no corporate control.

[11] An importing country's government has an incentive to assist its domestic firms by offering production subsidies, especially when they have cost disadvantages competing with foreign exporters without cross-border ownership. See Cheng (1988) for a more general analysis. Li and Wu (2022) empirically document that government subsidies play a vital role in improving the operating performance of state-owned enterprises by reducing financial constraints.

[12] We thank an anonymous referee for pointing out that a substantial (but $k < 50\%$) share of foreign ownership may imply a significant degree of control, depending on the ownership pattern.

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We continue to adopt a two-stage game in analyzing how the choice of trade and industrial policies is contingent upon different ownership arrangements. In stage one, the government determines an optimal policy mix, $\{t, s\}$, to maximize social welfare. In stage two, given the policy mix, the foreign and domestic firms adopt a Cournot strategy in determining output levels that maximize their ownership-adjusted profits for cross-border equity investments.

When cross-border ownership is unilateral, denoted by superscript U, the foreign firm acquires a fraction of the profit earned by a local producer (say, firm 1). The two firms' profit functions are given, respectively, as

$$\pi_f^U = \pi_f + k\pi_{h1} - \bar{r}, \tag{9}$$

$$\pi_{h1}^U = (1-k)\pi_{h1} + \bar{r}, \tag{10}$$

where π_f and π_{h1} are given in Equation (1) and (2), and $\bar{r}$ stands for the past sunk cost of the partial ownership transfers. The profit function of the other local producer (firm 2) is given in Equation (3).

In the second stage of the game, the foreign firm determines its output that maximizes π_f^U in Equation (9), the domestic firm 1 determines its output that maximizes π_{h1}^U in Equation (10), and the domestic firm 2 determines its output that maximize π_{h2}^U in Equation (3). Solving the firms' FOCs yields

$$x_f^U = \frac{(1-k) + c(2+k) - 3t - (2+k)s}{4-k}$$

and

$$y_{hi}^U = \frac{1 + t + 2s - 2c}{4-k} \text{ for } i = 1, 2. \tag{11}$$

Under the conditions that the values of t and s are positive under unilateral ownership, which will be verified in the subsequent analysis, we see from Equation (11) that an increase in the domestic cost disadvantage (c) causes the level of foreign exports to increase and the domestic production to decline, whereas an increase in the ownership share (k) leads the foreign exports to decline and the domestic production to increase.[13] In comparison to the benchmark equilibrium outputs, the increasing foreign export and the decreasing home production are greater, the higher the cost disadvantage of local firms. As such, when domestic firms' production inefficiency becomes more severe, their foreign competitor exports more of its product under unilateral ownership than it would in the benchmark case without ownership (see Section 2.1). The economic intuition is that there is an opportunity cost for the foreign firm to increase its sales under unilateral ownership. Note that in the benchmark equilibrium without foreign ownership, an increase in the domestic cost disadvantage (c) leads the foreign firm to sell more of its product. With unilateral ownership, the foreign firm's increase in sales causes the two domestic firms' output and revenue to decline.

The declining output and revenue of the domestic firm 1 (an acquired firm) negatively affect the income of the foreign firm due to its unilateral ownership. This opportunity cost to the foreign firm is higher under unilateral ownership than in the benchmark case without ownership. When the domestic cost disadvantage is greater, the opportunity cost to the foreign firm becomes lower. This

[13]Taking the derivatives of the output equations in Equation (11) yields $\partial x_f^U/\partial k = -2[(1+t+2s)-2c]/(4-k)^2$ and $\partial y_{hi}^U/\partial k = (1+t+2s-2c)/(4-k)^2$. Under the assumption that each firm's output is positive, we have from Equation (11) that $\partial x_f^U/\partial k < 0$ and $\partial y_{hi}^U/\partial k > 0$.

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result emerges since outputs are strategic substitutes under Cournot, causing the two domestic firms to reduce more of their outputs.[14]

We move to the first stage of the game, where the importing country's government determines trade and industrial policies to maximize its social welfare in Equation (4). Note that producer surplus under unilateral ownership is $PS^U = (1-k)\pi_{h1}^U + \pi_{h2}^U$. Substituting the output equations from Equation (11) back into the social welfare function in Equation (4) yields

$$SW = \frac{\left\{\begin{array}{r} c^2(10-k)(2-k) - 2c\left[k^2(s+t+1) - k(8s+5t+9) + 4s - 2t + 14\right] + k^2(1+s)(1+2t+s) \\ -2k\left(2s^2+3st+7s-2t^2+6t+4\right) - 12s^2 - 20st + 12s - 19t^2 + 10t + 13 \end{array}\right\}}{2(4-k)^2}.$$

We derive the government's FOCs and find that the interior solution is unique since the Hessian matrix is negative definite (see Appendix A-2). Using FOCs, we solve for the optimal policy mix of import tariff and domestic subsidy as follows:

$$t^U = \frac{2c}{4-k} > 0 \text{ and } s^U = \frac{(1-k)(4-k) - c\left(6+4k-k^2\right)}{(k+2)(4-k)} > 0. \tag{13}$$

From Equation (13), we see that the values of t^U and s^U are all positive. Thus, the importing country's trade policy is an import tariff, and its industrial policy is a production subsidy. It is easy to verify that the tariff rate increases with the parameters c and k, and the subsidy rate decreases with the parameter c, respectively.

Other things being equal, an increase in the domestic cost disadvantage, c, leads to a greater increase in the optimal tariff and a less reduction in the optimal subsidy under unilateral ownership ($k > 0$) than in the benchmark case without ownership ($k = 0$).[15] The economic intuitions are as follows. The foreign firm behaves more aggressively by increasing its exports under unilateral ownership ($k > 0$) than under the benchmark case ($k = 0$) without ownership due to a higher level of domestic cost disadvantage. In response, the importing country's government raises the tariff rate for protecting domestic industry, thereby shifting the rent earned by the foreign firm. Given that the shifted rent is from the foreign firm's relative efficiency in production, the importing government's industrial strategy is an increase the subsidy rate to lower the production costs for its domestic firms.

Substituting the optimal policy mix, $\{t^U, s^U\}$, from Equation (13) back into Equation (11), we calculate the optimal levels of outputs produced by the firms as follows:

$$x_f^U = \frac{2c}{4-k} > 0 \text{ and } y_{\text{hi}}^U = \frac{(4-k)-6c}{(2+k)(4-k)} \text{ for } i = 1, 2. \tag{14}$$

We see from Equation (14) that each domestic firm's output is strictly positive when the equity share, k, and the domestic cost disadvantage, c, satisfy the following conditions:

$$c < \frac{4-k}{6} < \frac{2}{3} \text{ for } k > 0. \tag{15}$$

[14]In the benchmark case, we have from Equation (6) that $\partial x_f^{\text{NO}}/\partial c = 1/2$ and $\partial y_{hi}^{\text{NO}}/\partial c = -1/2$. By comparison, we have from Equation (13) that $\partial x_f^U/\partial c = [(2+k)/(4-k)] > 1/2$ and $\partial y_{hi}^U/\partial c = -[2/(4-k)] < -1/2$. These results further imply that $\partial x_f^U/\partial c > \partial x_f^{NO}/\partial c$ and $\partial y_{hi}^{NO}/\partial c < \partial y_{hi}^U/\partial c$.

[15]See Appendix A-3 for the detailed calculations.

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The inequality in Equation (15) is satisfied under the conditions that $c < 0.5$ and $k < 0.5$.

We summarize the economic implications and the reduced-form solutions under unilateral foreign ownership in the second lemma:

Lemma 2. *Under unilateral foreign ownership over a local firm, the optimal trade policy is an import tariff, and the optimal industrial policy is a production subsidy. The equilibrium values of firm profits, consumer surplus, producer surplus, the government's net income, and domestic welfare are:*

$$\pi_f^U = \frac{4c^2(1+2k)+k[k(8c-1)+4(1-2c)]}{(2+k)^2(4-k)}, \pi_{h1}^U = \pi_{h2}^U = \frac{[(4-k)-6c)]^2}{(2+k)^2(4-k)^2},$$

$$\mathrm{CS}^U = \frac{2(1-c)^2}{(2+k)^2}, \mathrm{PS}^U = \frac{(2-k)[(4-k)-6c)]^2}{(2+k)^2(4-k)^2},$$

$$\mathrm{GNI}^U = -\frac{2(4-k)^2(1-k)+8c^2\left(k^2-8k+7\right)+2c\left(k^3-14k^2+52k-48\right)}{(4-k)^2(2+k)^2},$$

$$\mathrm{SW}^U = \frac{4+6c^2-2c(4-k)-k}{(2+k)(4-k)}. \tag{16}$$

2.3 | Bilateral foreign ownership with a local producer

We proceed to analyze the bilateral ownership arrangement, (denoted by the superscript B), under which foreign firm and a local producer (firm 1) acquire $k(>0)$ fraction of each other's profits. The profit functions of these two acquiring firms are:

$$\pi_f^B = (1-k)\pi_f + k\pi_{h1} \tag{17}$$

$$\pi_{h1}^B = (1-k)\pi_{h1} + k\pi_f, \tag{18}$$

where π_f and π_{h1} are given by Equations (1) and (2), respectively. The profit function of the other domestic firm (i.e., firm 2) outside the arrangement is:

$$\pi_{h2}^B = \left[1 - x_f - (y_{h1}+y_{h2}) + s - c\right]y_{h2}, \tag{19}$$

which is the same as the function in Equation (3).

In the second stage of the game where the three firms engage in Cournt competition, their FOCs imply the optimal output levels as follows:

$$x_f^B = \frac{(1-k)[-3(1-k)t-(2-k)s+c(2-k)+(1-2k)]}{2(1-2k)(2-k)},$$

$$y_{h1}^B = \frac{(1-k)[(2-k)s+(1+k)t+(1-2k)-(2-k)c]}{2(1-2k)(2-k)},$$

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$$y_{h2}^{B} = \frac{[(2-k)s + (1-k)t + ck - 2c + 1]}{4 - 2k}. \tag{20}$$

Analogous to the case under unilateral ownership, we see from Equation (20) that an increase in the cost disadvantage in domestic production (c) causes the level of foreign exports to increase and domestic firm 1's production to decline. Nonetheless, the foreign firm's output-increasing effect and the domestic firm 1's output-reducing effect are stronger under bilateral ownership than under unilateral ownership.[16] In the meanwhile, an increase in the domestic cost disadvantage has an output-reducing effect on firm 2, which is identical to that in the benchmark case without ownership. This result implies that the output-reducing effect on firm 2 under bilateral ownership is less than that under unilateral ownership.

One interesting observation from Equation (20) is that whether the competing firms' outputs will increase or decrease with k depends on the values of c, s and t.

Moving to the second stage of the game, the importing country's government determines its trade and industrial policies that maximize domestic welfare in Equation (4), where producer surplus under bilateral ownership is $\mathrm{PS}^{B} = \left[(1-k)\pi_{h1}^{B} + k\pi_{f}^{B}\right] + \pi_{h2}^{B}$, with the firms' outputs and profits being given in Equations (17)–(20). Substituting the output equations from Equation (20) back into the social welfare function in Equation (4) yields

$$\mathrm{SW} = \frac{\left\{\begin{array}{r} c^2(2-k)^2(5-8k) - 2c(2-k)(1-2k)[k(2kt-2k+s-3t+6) - 2s + t - 7] - 8k^4(1-t)(s+t) \\ -4k^3\left[s^2 - 9s(1-t) - t(9-10t) - 2\right] + k^2\left[19s^2 - s(60-62t) - 15t(4-5t) - 32\right] \\ -k\left[28s^2 - s(46-54t) + 62t^2 - 42t - 40\right] + 20st - 12(1-s)s + 19t^2 - 10t - 13 \end{array}\right\}}{8(2-k)^2(1-2k)}.$$

We derive the government's FOCs and find that the Hessian matrix is negative definite (see Appendix A-4). The FOCs imply that the optimal trade and industrial policies are:

$$t^{B} = \frac{c(2-k)\left(2-4k+3k^2\right) - k^2\left(4-5k+2k^2\right)}{(1-k)(2+k)\left(4-5k+2k^2\right)} \tag{21}$$

and

$$s^{B} = \frac{(1-k)\left[-c\left(6-4k+2k^2\right) + \left(4-5k+2k^2\right)\right]}{(2+k)\left(4-5k+2k^2\right)}. \tag{22}$$

These results in Equations (21) and (22) imply that as the domestic cost disadvantage, c, rises, the government responds by increasing the tariff rate for more protection and decreasing the subsidy rate for domestic firms. Note that under bilateral ownership, the rate of increase in the tariff is less than in the benchmark case, which is less than under unilateral ownership. Furthermore, under bilateral ownership, the decrease in the domestic subsidy rate is lower than under unilateral ownership, which, in turn, is less than that in the benchmark case. Based on the policy mix in Equations (21) and (22), when the equity share, k, increases, the government reacts by lowering both the tariff and subsidy rates.

[16]We have from Equation (20) the derivatives that $\partial x_{f}^{B}/\partial c = (1-k)/[2(1-2k)]$ and $\partial y_{h1}^{B}/\partial c = -(1-k)/(1-2k)$. The statement in the text comes from comparing these results to those in Equation (11).

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The tariff rate is reduced more under bilateral ownership than under unilateral ownership. However, under bilateral ownership as opposed to unilateral ownership, the subsidy rate is reduced less.[17]

Substituting the policy mix $\{t^B, s^B\}$ from Equations (21)–(22) back into Equation (20), we calculate the reduced-form solutions for the optimal levels of outputs by the three firms:

$$x_f^B = \frac{2c(1-k)^2}{(1-2k)\left(4-5k+2k^2\right)} > 0 \text{ for } k < 0.5, \tag{23a}$$

$$y_{h1}^B = \frac{4-k\left(13-12k+4k^2\right)-c\,(3-4k)\left(2-2k+k^2\right)}{(1-2k)(k+2)\left(4-5k+2k^2\right)}, \tag{23b}$$

$$y_{h2}^B = \frac{\left(4-5k+2k^2\right)-c\left(6-6k+k^2\right)}{(k+2)\left(4-5k+2k^2\right)}. \tag{23c}$$

Note that the two domestic firms no longer produce an identical level of output.[18] It follows from Equation (23a) that the level of foreign exports is positive under the foreign ownership restrictions with the equity share (k) being less than 50%. Also, we have from y_{h1}^B in Equation (23b) that for firm 1's output to be positive, the production subsidy rate s^B as shown in Equation (22) must be positive. That is

$$s^B > 0 \text{ when } y_{h1}^B > 0.$$

Moreover, we find that $t^B > 0$ when the domestic cost disadvantage is critically high. Otherwise, we have the opposite result that $t^B < 0$, implying that the trade policy becomes an import subsidy. To see these, we first calculate the critical value of c(denoted as $\hat{c}$) such that the value of t^B equals zero. That is, $t^B = 0$ when $\hat{c} \equiv \frac{k^2\left(4-5k+2k^2\right)}{(2-k)\left(2-4k+3k^2\right)}$, which is strictly positive. There are two possible outcomes:

$$\text{(i) } t^B < 0 \text{ when } 0 < c < \hat{c}; \tag{24a}$$

$$\text{(ii) } t^B > 0 \text{ when } c > \hat{c}. \tag{24b}$$

We have from Equation (23b) that for positive output, ${y_{h1}}^B > 0$, the domestic cost disadvantage in production must be sufficiently low. That is,

$${y_{h1}}^B > 0 \text{ when } c < \tilde{c}_1, \text{ where } \tilde{c}_1 \equiv \frac{(2k-1)\left(4-5k+2k^2\right)}{(4k-3)\left(2-2k+k^2\right)}.$$

We have from Equation (23c) that for ${y_{h2}}^B > 0$, the domestic cost disadvantage must also be sufficiently low. That is,

$$y_{h2}^B > 0 \text{ when } c < \tilde{c}_2, \text{ where } \tilde{c}_2 \equiv \frac{4-5k+2k^2}{6-6k+k^2}.$$

It is easy to verify that $\tilde{c}_1 < \tilde{c}_2$, which implies that

[17]See A-3 and A-5 in the Appendix for detailed calculations and comparisons.

[18]The two domestic firms produce an identical level of output either when foreign ownership is unilateral (see Equation (7)) or in the benchmark case without ownership (see Equation (11)).

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$$y_{h1}{}^{B} > 0 \text{ when } c < \tilde{c}_1.$$

Based on this inequality condition, we find that either $t^B < 0$ or $t^B > 0$, depending on whether $0 < c < \hat{c}$ or $c > \hat{c}$, as shown in Equation (24a) and (24b).

Under bilateral ownership, we have the policy implications and the reduced-form solutions as summarized in Lemma 3 (see Appendix A-6).

3 | EQUILIBRIUM COMPARISONS ACROSS DIFFERENT OWNERSHIP ARRANGEMENTS

In this section, we compare the equilibrium results for unilateral and bilateral cross-border ownership (described in Section 2) and analyze their differences in economic implications for trade and industrial policies implemented by the government of an importing country.

3.1 | The choice of an optimal policy mix

For the case of foreign ownership being unilateral, we have the results that

$$s^U > 0 \text{ and } t^U > 0.$$

When foreign ownership is bilateral, the industrial policy is a production subsidy since

$$s^B > 0.$$

As for the trade policy under bilateral ownership, there are two possibilities:

$$\text{(i) } t^B > 0 \text{ for } c > \hat{c};$$

$$\text{(ii) } t^B < 0 \text{ for } c < \hat{c}, \text{ where } \hat{c} \equiv \frac{k^2\left(4 - 5k + 2k^2\right)}{(2-k)\left(2 - 4k + 3k^2\right)}.$$

For the benchmark case without foreign ownership, the optimal policy mix is straightforward:

$$s^{NO} > 0 \text{ and } t^{NO} > 0.$$

These results allow us to establish the first proposition:

Proposition 1. *Under unilateral foreign ownership, the optimal trade and industrial policies are an import tariff and a production subsidy, respectively. When foreign ownership is bilateral, industrial policy remains a production subsidy while trade policy may become an import subsidy.*

These different combinations of policies contrast with the traditional case without foreign ownership, under which a specific tariff on imports is the optimal trade policy and a unit subsidy to domestic production is the optimal industrial policy. The results in Proposition 1 suggest the possibilities for policy changes under different ownership arrangements. Specifically, bilateral ownership between

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foreign and domestic firms may lead to a switch in trade policy from an import tariff to an import subsidy, depending on the degree of domestic cost disadvantage.[19]

3.2 | The ranking of trade policies

With foreign ownership, there are sufficient conditions (in terms of c and k) under which the optimal trade policy requires import tariffs to protect domestic firms. The issue comes down to comparing tariff rates when foreign ownership is unilateral or bilateral, relative to the benchmark case without ownership. We have from Equations (6), (13), and (21) that

$$t^U > t^{\mathrm{NO}} > t^B.$$

This ranking leads to the following proposition (see the proof in Appendix 7):

Proposition 2. *The optimal tariff rate is at its highest under unilateral foreign ownership but is at its lowest under bilateral foreign ownership.*

As we consider two different types of foreign ownership structures, we compare how they alter the standard welfare implications of trade and industrial policies under imperfect competition. When an import-competing market changes from no foreign ownership (the benchmark case) to one with foreign ownership being unilateral, the foreign firm becomes a *less* aggressive exporter as it holds the equity share of a domestic firm. In response, the importing country's government raises the optimal tariff rate for rent-shifting to maximize domestic welfare. This explains the result that $t^U > t^{\mathrm{NO}}$. When an import-competing market changes from no foreign ownership to one with foreign ownership being bilateral, it reduces (or softens) the rent-shifting incentive of an importing country government due to the partial ownership owned by a domestic firm. As such, the optimal tariff decreases. That is, $t^B < t^{\mathrm{NO}}$.

Interestingly, the optimal trade policy may switch from an import tariff to an import subsidy, depending on (i) the type of cross-border ownership (unilateral or bilateral) and (ii) the relative cost disadvantage of domestic production. When cross-border ownership is bilateral and the domestic cost disadvantage is sufficiently low, the optimal trade policy switches from an import tariff to an *import subsidy* (see Equation (24a)). A shift in ownership from unilateral to bilateral (see Equation (24b)), or from the benchmark equilibrium without foreign ownership to the case with unilateral ownership, may also result in a shift in policy toward import subsidy.

3.3 | The ranking of industrial policies

With the presence of cross-border ownership, there are conditions (in terms of c and k) such that the optimal industrial policy requires a domestic subsidy. Note that in conducting a comparison across

[19]We thank an anonymous for pointing out an important behavioral difference between (i) ownership of a domestic firm by unspecified foreign investors and (ii) ownership by a clearly identifiable foreign firm (as examined in this paper). For case (i), there are two possibilities. The first possibility is when those unspecified foreign investors do not have any equity stakes in the foreign firm. Methodologically, at the stage where two competing firms (domestic and foreign) make their output decisions, they do so independently without considering the rival's profit. This stage is similar to the benchmark situation without ownership. However, when the domestic government sets import tariffs and domestic subsidies, the social welfare function changes since parts of the producer surplus (i.e., domestic profits) will go to those unspecified foreign investors. Consequently, the equilibrium results will differ from those in Lemma 1 or 2. The second possibility is when those unspecified foreign investors also have partial ownership stakes in the foreign firm. This turns out to be an example of common ownership. These two possibilities for case (i) are beyond the scope of the present study and constitute interesting topics for future research.

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the three scenarios, we consider the constraints that the output levels of the firms are all positive. As shown in Appendix A-8, we have from equations in Equations (6), (13), and (22) the ranking of production subsides as[20]

$$s^{\mathrm{NO}} > s^{B} > s^{U} > 0.$$

We thus have the following implications for industrial policies:

Proposition 3. *The optimal subsidy rate for domestic output is at its highest without foreign ownership. However, when foreign ownership is unilateral, the subsidy rate is at its lowest.*

The results in Proposition 3 have policy implications. The government of an importing country has less incentive to subsidize domestic production when there is a switch from no ownership (the benchmark scenario) to a bilateral ownership (two-sided). As for a change in foreign ownership to unilateral (one-sided), production subsidies are positive but at a lower rate.

3.4 | Effects on domestic consumers

To see how domestic consumers are affected in the presence or absence of foreign ownership arrangements, we first look at the total industrial output under the three scenarios. As shown in Appendix A-9, we have from the equations in (7), (14), and (20) that

$$\left(x_f^{\mathrm{NO}} + y_{h1}^{\mathrm{NO}} + y_{h2}^{\mathrm{NO}}\right) > \left(x_f^{B} + y_{h1}^{B} + y_{h2}^{B}\right) > 0,$$

$$\left(x_f^{B} + y_{h1}^{B} + y_{h2}^{B}\right) = \left(x_f^{U} + y_{h1}^{U} + y_{h2}^{U}\right) > 0.$$

These results imply that $Q^{\mathrm{NO}} > Q^{B} = Q^{U}$. Moreover, the consumer surplus measures as shown in Lemmas 1-3 imply that

$$\mathrm{CS}^{\mathrm{NO}} > \mathrm{CS}^{B} > 0.$$

The ranking of consumer surplus is then given as

$$\mathrm{CS}^{\mathrm{NO}} > \mathrm{CS}^{U} = \mathrm{CS}^{B},$$

and the economic implications are summarized in the following:

Proposition 4. *Consumer surplus is higher when there is no foreign ownership than when foreign ownership is unilateral or bilateral.*

3.5 | Effects on the aggregate producer surplus of domestic firms

Note that the equilibrium results for producer surplus under the different modes of cross-border ownership (see Lemmas 2 and 3) are much more complicated than that without ownership (see Lemma 1).

[20]When $c = 0$, we have $s^{\mathrm{NO}} > s^{B} = s^{U} > 0$, where $s^{\mathrm{NO}} = 1/2$ and $s^{B} = s^{U} = (1-k)/(2+k) > 0$.

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We show in Appendix A-10 the detailed calculations for the differences in producer surplus across the three cases. First, let c_3 represent the critical value of the domestic firms' cost disadvantage such that $PS^B = PS^{NO}$. Solving for c_3, we have two possibilities:

$$PS^{NO} > PS^B \text{ if } c < c_3 \text{ and } PS^B > PS^{NO} \text{ if } c > c_3. \tag{26a}$$

Second, let c_4 denote the critical value of the domestic cost disadvantage such that $PS^U = PS^B$. Solving for c_4, we also have two possibilities:

$$PS^U > PS^B \text{ if } c < c_4 \text{ and } PS^B > PS^U \text{ if } c > c_4. \tag{26b}$$

Note that $c_3 > c_4$. Finally, we use a simulation approach to verify that

$$PS^{NO} > PS^U. \tag{26c}$$

Considering all the inequality results in Equations (26a)–(26c) yields the following:

$$\text{(i) } PS^{NO} > PS^U > PS^B \text{ if } 0 < c < c_4;$$

$$\text{(ii) } PS^{NO} > PS^B > PS^U \text{ if } c_4 < c < c_3;$$

$$\text{(iii) } PS^B > PS^{NO} > PS^U \text{ if } c > c_3.$$

We summarize the economic implications of these results in the next proposition:

Proposition 5. *If domestic producers' cost disadvantages are low enough ($0 < c < c_4$), their aggregate surplus is the highest when there is no foreign ownership. If the cost disadvantages are critically high ($c > c_3$), instead, the surplus of domestic producers is at its highest when there is bilateral foreign ownership.*

3.6 | Effects on domestic welfare

For comparing social welfare, it is necessary to place restrictions on the range of the parameters, $\{k,c\}$, to ensure that all firms produce positive outputs. According to the equilibrium levels of social welfare in Lemmas 1-3, we present detailed computations for the comparisons in Appendix A-11 and summarize the results as follows:

$$SW^B > SW^U, SW^{NO} > SW^U,$$

$$SW^B < SW^{NO} \text{ if } c < c_5 \text{ and } SW^B > SW^{NO} \text{ if } c > c_5,$$

where

$$c_5 = \frac{26k - 24k^2 + 8k^3 - 8 + \left[2\left(40 - 174k + 263k^2 - 156k^3 - 8k^4 + 48k^5 - 16k^6\right)\right]^{\frac{1}{2}}}{2 + 15k - 24k^2 + 12k^3}.$$

It can be verified that $k^2 < c_5 < \frac{2 - 7k + 4k^2}{(1-k)(3-4k)}$, which implies that $SW^B > SW^U$. Thus, depending on the degree of domestic cost disadvantage, there are two possible outcomes:

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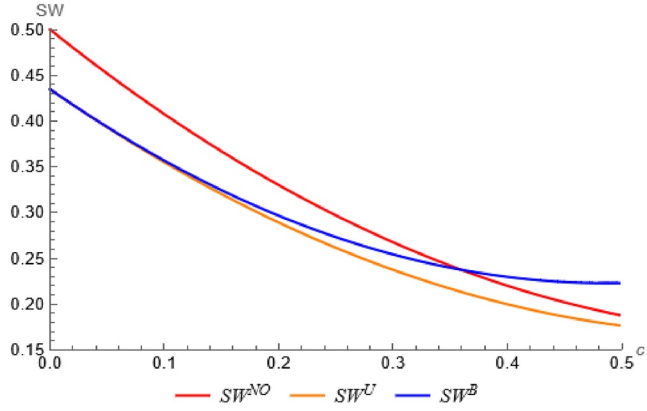

FIGURE 1 Welfare levels as functions of c (given $k = 0.3$).

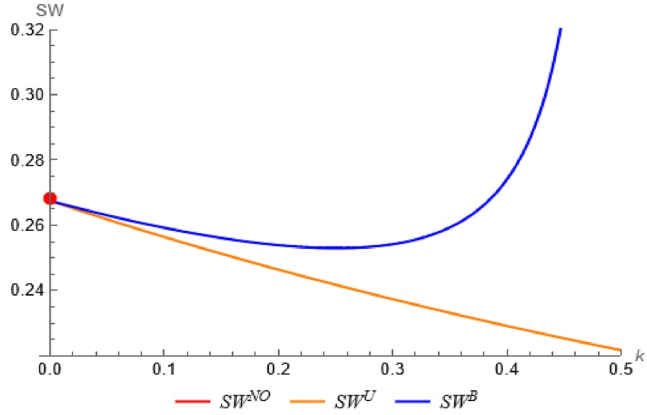

FIGURE 2 Welfare levels as functions of k (given $c = 0.3$).

$$\text{(i)}\ \mathrm{SW}^{\mathrm{NO}} > \mathrm{SW}^{B} > \mathrm{SW}^{U}\ \text{for}\ 0 < c < c_5;$$

$$\text{(ii)}\ \mathrm{SW}^{B} > \mathrm{SW}^{\mathrm{NO}} > \mathrm{SW}^{U}\ \text{for}\ c > c_5.$$

Figure 1 presents a graphical illustration that SW^{U} is always less than $\mathrm{SW}^{\mathrm{NO}}$ over the entire range of the domestic cost disadvantage (c) for a given vale of k (say, 0.3). However, the comparison between SW^{B} and $\mathrm{SW}^{\mathrm{NO}}$ is indeterminate. Two possibilities are: (i) $\mathrm{SW}^{B} < \mathrm{SW}^{\mathrm{NO}}$ when the domestic cost disadvantage is low, and (ii) $\mathrm{SW}^{B} > \mathrm{SW}^{\mathrm{NO}}$ when the cost disadvantage is sufficiently high.

Figure 2 illustrates graphically that SW^{U} is always less than $\mathrm{SW}^{\mathrm{NO}}$ over the entire range of the ownership share (k) for a given vale of c (say, 0.3). When foreign ownership is bilateral, Two possibilities of interest are: (i) $\mathrm{SW}^{B} < \mathrm{SW}^{\mathrm{NO}}$ when the ownership share is low, and (ii) $\mathrm{SW}^{B} > \mathrm{SW}^{\mathrm{NO}}$ when the ownership share is high (noting the foreign ownership restrictions that $k < 50\%$ for the level of foreign exports to be positive).

Figure 3 presents the welfare comparisons in 3D space, with both k and c as variables in their appropriate ranges.[21] We see that social welfare under unilateral foreign ownership, SW^{U}, is always

[21]We thank an anonymous referee for suggesting that we include the welfare comparisons in 3D space.

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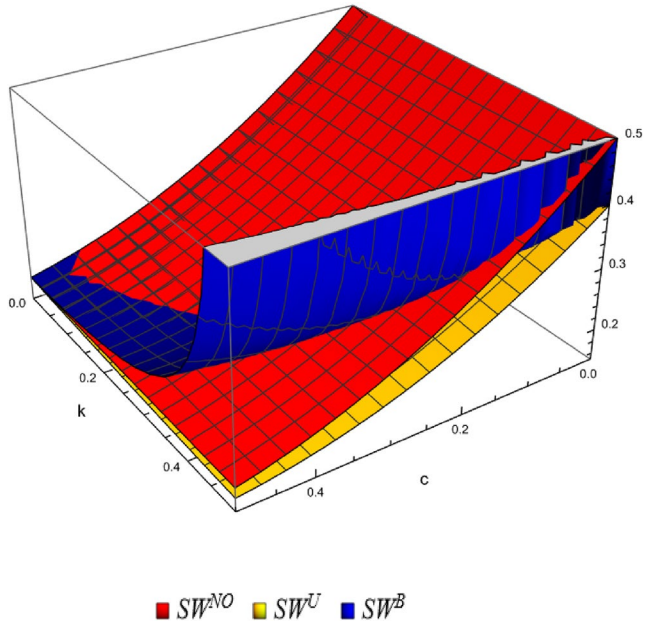

FIGURE 3 Welfare levels with both k and c as variables.

the lowest among the three different scenarios. The ranking between SW^B and SW^{NO} depends on the ownership share and the domestic cost disadvantage. When k and c are low, SW^B is less than SW^{NO}. When k and c are sufficiently high, SW^B is greater than SW^{NO}.

The results of the welfare analyses lead to the following proposition:

Proposition 6. *Unilateral foreign ownership always reduces domestic welfare. Domestic welfare is at its highest without foreign ownership, provided domestic producers' cost disadvantages are low enough ($0 < c < c_5$). If cost disadvantages are substantially high ($c > c_5$), domestic welfare can be at its highest under bilateral foreign ownership.*

Proposition 6 implies that the lower the domestic cost disadvantage, the higher the aggregate welfare for an importing country without foreign ownership. Moreover, Propositions 3 and 4 indicate that consumer surplus and producer surplus are at their highest levels. When the domestic cost disadvantage is high, domestic welfare may increase at the expense of consumer surplus. However, the foreign firm acts more aggressively under bilateral ownership than the benchmark equilibrium without ownership. Moreover, as shown in Equation (11), the tariff rate is positive under bilateral ownership when the cost difference is high enough. As the foreign firm sells more outputs, the domestic government receives more tariff revenues than the benchmark case.

One case of interest is when the cost difference between domestic producers and foreign firm is zero ($c = 0$).[22] The foreign firm's export becomes zero and the optimal tariff is zero (i.e., free trade) in the benchmark case without cross-border ownership (see Equations (5) and (6)). If foreign ownership is unilateral, the foreign firm's export and the optimal tariff continue to be zero (see Equations (13) and (14)). However, if foreign ownership is bilateral, the optimal trade policy is an *import subsidy* and the optimal industrial policy is a production subsidy. These results follow directly from setting the cost difference to be zero in Equations (21)–(22). That is,

[22]We thank an anonymous referee for suggesting that we include this interesting case of zero cost difference in the analysis.

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$$t^B = -\frac{k^2}{(1-k)(2+k)} < 0 \text{ and } s^B = \frac{(1-k)}{(2+k)} > 0.$$

As for welfare comparisons, we have from Lemmas 1–3 the following ranking:

$$\text{SW}^{\text{NO}} > \text{SW}^B = \text{SW}^U.$$

Figure 1 presents a graphical illustration of this welfare ranking when the cost difference is zero. We thus have the following proposition:

Proposition 7. *In an import-competing industry where domestic and foreign firms are equally efficient in production (i.e., c = 0), the level of foreign exports and the optimal tariff rate are equal to zero in the benchmark situation without foreign ownership or when the ownership is unilateral. Under bilateral foreign ownership, the optimal trade and industrial policies are import and production subsidies, respectively. From the welfare perspective, the benchmark equilibrium without ownership leads to the highest domestic welfare.*

3.7 | Effects of trade and industrial policies on the public finances

Finally, from the public policy perspective, we discuss the following issue: What is the impact of those optimal policies on public finances? In other words, do the optimal policies in the three different scenarios generate a surplus or are they financed in deficit (with the usual lump-sum transfer to guarantee a balanced budget)? Based on our setting, we compare the equilibrium levels of the government's net revenue (GNI) with or without foreign ownership arrangements, as shown in Lemmas 1–3.[23]

When there is no cost disadvantage in domestic production ($c = 0$), the government's net income, measured by its tariff revenues net of domestic subsidies, is negative for the three arrangements. These results follow from letting $c = 0$ for the *GNI* measures (see Lemmas 1–3). That is,

$$\text{GNI}^B = \text{GNI}^U = \text{GNI}^{\text{NO}} = -\frac{2(1-k)}{(2+k)^2} < 0.$$

When domestic firms are at a cost disadvantage ($c > 0$), foreign ownership arrangements (unilateral and bilateral) result in financial deficit even when c is low enough. Otherwise, there is financial surplus. In the benchmark case without ownership, there is budget deficit. Moreover, we have from Lemmas 1–3 the following results:

$$\text{GNI}^B - \text{GNI}^U = \frac{2ck\left[\left(64-208k+252k^2-147k^3+40k^4-4k^5\right)-c\left(96-256k+266k^2-138k^3+35k^4-3k^5\right)\right]}{(4-k)^2(2+k)(4-5k+2k^2)} > 0,$$

$$\text{GNI}^U - \text{GNI}^{\text{NO}} = \frac{k\left[c^2\left(7k^3-28k^2-148k+736\right)-4c\left(3k^3-8k^2-92k+304\right)+4(k-4)^2(k+8)\right]}{(4-k)^2(2+k)(4-5k+2k^2)} > 0,$$

noting the conditions that the levels of outputs produced by the firms are positive. These two inequalities imply that

$$\text{GNI}^B > \text{GNI}^U > \text{GNI}^{\text{NO}}.$$

[23]This section is due to an anonymous referee who suggests that we examine the effect of trade and industrial policies on public finances.

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The policy implications of the analyses are as follows: If domestic and foreign firms are equally efficient in production ($c = 0$), the optimal trade and industrial policies generate the same deficit for the government. Regardless of the types of foreign ownership or in its absence, the lump-sum transfer to assure a balanced budget will be identical. If there is a domestic cost disadvantage ($c > 0$), the government's net income (measured by tariff revenue net of domestic subsidies) is the *highest* under bilateral foreign ownership compared to two other scenarios. This suggests that the lump-sum transfer to guarantee a balanced budget is the *lowest* under bilateral foreign ownership. For $c > 0$, we have the last proposition:

Proposition 8. *Bilateral foreign ownership entails the lowest public burden for an importing country's government to finance its strategic use of trade and industrial policies compared to unilateral foreign ownership or the benchmark scenario without ownership.*

4 | CONCLUDING REMARKS

In markets where import competition is intense, multinational corporations compete fiercely with local firms while holding equity shares in their stocks as "silent investments." In this study, we examine how such cross-border partial ownership affects trade and industrial policies optimally chosen by the government of an importing country. In the analysis, domestic consumers purchase parts of their products imported from abroad due to the relative inefficiency of home production. We look at bilateral ownership between a foreign firm and a local producer, as well as unilateral ownership by the foreign exporter over a local producer. We find that when foreign ownership is unilateral (i.e., one-sided), the optimal trade policy is an import tariff, and the optimal industrial policy is a production subsidy. In contrast, when foreign ownership is bilateral (i.e., two-sided), the trade policy can become an import subsidy, and the industrial policy is a production subsidy. As opposed to the case without ownership, where the policy mix consists of an import tax and a production subsidy, the trade policy under bilateral ownership may differ. The underlying economic premise of this outcome is that home and foreign firms have partial equity holdings in each other's profits.

Under unilateral foreign ownership over a local producer, the foreign firm becomes a less aggressive exporter compared to the situation without ownership. In response, the importing country's government raises its tariff rate for trade protection and profit-shifting. If foreign ownership is bilateral, it reduces (or softens) the rent-shifting incentive of the importing country's government. The government may reduce the tariff rate or, on the contrary, switch the trade policy to an import subsidy. This policy switch arises when (i) the cost disadvantage of domestic production is sufficiently low and (ii) the equity stakes are high (despite foreign ownership restrictions). Our analysis has welfare implications for the three different scenarios, depending upon various economic factors such as the cost disadvantage of domestic production, ownership types (unilateral or bilateral), and equity stakes. Remarkably, from the public finance perspective, bilateral ownership entails a lower burden for an importing country's government to finance its optimal trade and industrial policies.

It is necessary to mention the limitations of the current study and, consequently, potential model extensions. We impose the restrictions that all firms produce positive outputs when conducting the welfare comparisons over the different scenarios. Analyzing the endogeneity of the ownership share through negotiating appears to be challenging.[24] It is possible to relax the positive output restrictions. In this case, a local firm without an ownership arrangement could exit the market because of its cost disadvantage. Second, we abstract our analysis from cost-reducing R&D investments. Third, as firms may compete on prices in the presence of cross-border ownership, one may relax the homogenous

[24]See the detailed explanations in Appendix A-12.

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good assumption and replace it with the differentiation of competing products. These are potentially interesting topics for future research.

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CONFLICTS OF INTERESTS STATEMENT

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APPENDIX

A-1 | The Hessian matrix for the benchmark case

Totally differentiating the government's FOCs yields the Hessian matrix:

$$H_2^{NO} = \begin{bmatrix} \frac{\partial^2 SW^{NO}}{\partial t^2} & \frac{\partial^2 SW^{NO}}{\partial t \partial s} \\ \frac{\partial^2 SW^{NO}}{\partial s \partial t} & \frac{\partial^2 SW^{NO}}{\partial s^2} \end{bmatrix} = \begin{bmatrix} -\frac{19}{16} & -\frac{5}{8} \\ -\frac{5}{8} & -\frac{3}{4} \end{bmatrix},$$

where the principal minors alternate in sign beginning with a negative sign since

$$\left|H_1^{NO}\right| = -\frac{19}{16} < 0 \text{ and } \left|H_2^{NO}\right| = \frac{1}{2} > 0.$$

The Hessian matrix is negative definite so that the solution is interior and unique.

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A-2 | The Hessian matrix under unilateral ownership

Totally differentiating the government's FOCs yields the Hessian matrix:

$$H_2^U = \begin{bmatrix} \frac{\partial^2 \mathrm{SW}^U}{\partial t^2} & \frac{\partial^2 \mathrm{SW}^U}{\partial t \partial s} \\ \frac{\partial^2 \mathrm{SW}^U}{\partial s \partial t} & \frac{\partial^2 \mathrm{SW}^U}{\partial s^2} \end{bmatrix} = \begin{bmatrix} -\frac{19-4k}{(4-k)^2} & -\frac{10+3k-k^2}{(4-k)^2} \\ -\frac{10+3k-k^2}{(4-k)^2} & -\frac{12+4k-k^2}{(4-k)^2} \end{bmatrix},$$

where the principal minors alternate in sign beginning with a negative sign since

$$\left|H_1^U\right| = -\frac{(19-4k)}{(4-k)^2} < 0 \text{ and } \left|H_2^U\right| = \frac{2+k}{4-k} > 0.$$

The Hessian matrix is negative definite so that the solution is interior and unique.

A-3

Note that in the benchmark case, we have from Equation (5) that

$$\frac{\partial t^{\mathrm{NO}}}{\partial c} = \frac{1}{2} \text{ and } \frac{\partial s^{\mathrm{NO}}}{\partial c} = -\frac{3}{4}.$$

In contrast, we have from Equation (11) that

$$\frac{\partial t^U}{\partial c} = \frac{2}{4-k} > \frac{1}{2} \text{ and } \frac{\partial s^U}{\partial c} = -\frac{\left(6-4k+k^2\right)}{(4-k)(2+k)} > -\frac{3}{4}.$$

It follows that

$$\frac{\partial t^U}{\partial c} > \frac{\partial t^{\mathrm{NO}}}{\partial c} \text{ and } \frac{\partial s^U}{\partial c} > \frac{\partial s^{\mathrm{NO}}}{\partial c}.$$

Moreover, we see that the effect of an exogenous change in k on s^U is negative since

$$\frac{\partial s^U}{\partial k} = \frac{-3(4-k)^2 + 2c\left(22-14+k^2\right)}{(4-k)^2(2+k)^2} < 0.$$

A-4 | The Hessian matrix under bilateral ownership

Totally differentiating the government's FOCs yields the Hessian matrix:

$$H_2^B = \begin{bmatrix} \frac{\partial^2 \mathrm{SW}^B}{\partial t^2} & \frac{\partial^2 \mathrm{SW}^B}{\partial t \partial s} \\ \frac{\partial^2 \mathrm{SW}^B}{\partial s \partial t} & \frac{\partial^2 \mathrm{SW}^B}{\partial s^2} \end{bmatrix} = \begin{bmatrix} -\frac{(1-k)^2\left(19-24k+8k^2\right)}{4(1-2k)(2-k)^2} & \frac{\left(4k^3-10k^2+11k-5\right)}{4(1-2k)(2-k)} \\ \frac{\left(4k^3-10k^2+11k-5\right)}{4(1-2k)(2-k)} & -\frac{3-4k}{4(1-2k)} \end{bmatrix},$$

where the principal minors alternate in sign beginning with a negative sign since

$$|H_1^B| = -\frac{(1-k)^2\left(19-24k+8k^2\right)}{4(1-2k)(2-k)^2} < 0 \text{ and } |H_2^B| \frac{(2-k)\left(4-5k+2k^2\right)(1-k)^2}{4(1-2k)(2-k)^2}$$

The Hessian matrix is negative definite so that the solution is interior and unique.

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A-5

From Equations (21) and (22) we have

$$\frac{\partial t^B}{\partial c} = \frac{(2-k)[4+(3k-4)k]}{(1-k)(2+k)[4+(2k-5)k]} \text{ and } \frac{\partial s^B}{\partial c} = -\frac{(1-k)\left(3-2k+k^2\right)}{(2+k)\left(4-5k+2k^2\right)}.$$

Moreover, we find that

$$\frac{\partial t^B}{\partial k} = -\frac{(4-k)k[4+(2k-5)k]^2 + \left(24-120k+198k^2-176k^3+105k^4-40k^5+6k^6\right)}{(1-k)^2(2+k)^2[4+(2k-5)k]^2} < 0,$$

$$\frac{\partial s^B}{\partial k} = -\frac{3[4+(2k-5)k]^2 - 2c\left(22-54k+65k^2-32k^3+5k^4\right)}{(2+k)^2[4+(2k-5)k]^2} < 0.$$

Comparing these results to those in footnotes 10 and 11, we have

$$\frac{\partial t^B}{\partial c} - \frac{\partial t^U}{\partial c} = \frac{-k\left(16-40k+28k^2-7k^3\right)}{(1-k)(4-k)(2+k)\left(4-5k+2k^2\right)} < 0,$$

$$\frac{\partial t^B}{\partial k} - \frac{\partial t^U}{\partial k} = -\frac{(4-k)^3k[4-k(5-2k)]^2 + cH}{[(1-k)(4-k)(2+k)(4-k(5-2k)]^2} < 0,$$

where $H = 512 - 2560k + 4704k^2 - 4704k^3 + 3104k^4 - 1484k^5 + 499k^6 - 112k^7 + 14k^8$. Also, we see that

$$\left|\frac{\partial s^B}{\partial c}\right| - \left|\frac{\partial s^U}{\partial c}\right| = -\frac{k^2}{(4-k)\left(4-5k+2k^2\right)} < 0,$$

$$\frac{\partial s^B}{\partial k} - \frac{\partial s^U}{\partial k} = \frac{2c\left(224-720k+1150k^2-886k^3+328k^4-52k^5+k^6\right)}{(4-k)^2(2+k)^2[4+(2k-5)k]^2} > 0.$$

A-6

Lemma 3. *When foreign ownership is bilateral, the optimal trade policy can be an import subsidy or tariff, depending on the degree of the domestic cost disadvantage in production. With the plausible conditions that all the firms' outputs are positive, the optimal industrial policy is a production subsidy. In equilibrium, the optimal levels of profits, consumer surplus, the government's net income, and domestic welfare are:*

$$\pi_f^B = \frac{c^2\left(4-3k^4+14k^3-16k^2\right)+2ck\left(4k^3-12k^2+13k-4\right)-k\left(4k^3-12k^2+13k-4\right)}{(k+2)^2(1-2k)\left(2k^2-5k+4\right)},$$

$$\pi_{h1}^B = \frac{(1-k)\begin{pmatrix} c^2\left(36-104k+132k^2-104k^3+39k^4-6k^5\right)-4c(12 \\ -47k+66k^2-49k^3+20k^4-4k^5)+(1-2k)\left(4-5k+2k^2\right)^2 \end{pmatrix}}{(k+2)^2(1-2k)\left(4-5k+2k^2\right)^2},$$

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$$\pi_{h2}^{B}=\frac{\left(6c+5k-ck^2-6c+2k^2+4\right)^2}{\left(2k^3-k^2-5k+8\right)^2},CS^{B}=\frac{2(1-c)^2}{(2+k)^2},$$

$$\mathrm{PS}^{B}=\frac{\begin{pmatrix}c^2\left(6k^6-47k^5+168k^4-344k^3+428k^2-284k+72\right)-2c(8k^6-52k^5\\+174k^4-339k^3+380k^2-220k+48)+\left(2k^2-5k+2\right)\left(2k^2-5k+4\right)^2\end{pmatrix}}{(k+2)^2(1-2k)\left(2k^2-5k+4\right)^2},$$

$$\mathrm{GNI}^{B}=-\frac{2(1-k)\left[c^2\left(3k\left(k^3-6k^2+14k-16\right)+28\right)-4c\left(k^2-2k+3\right)\left(2k^2-5k+4\right)+\left(2k^2-5k+4\right)^2\right]}{\left[8-k^2(6+k-2k^2)\right]^2},$$

$$\mathrm{SW}^{B}=\frac{c^2\left(6-3k^3+12k^2-16k\right)-c\left(8-8k^3+24k^2-26k\right)-4k^3+12k^2-13k+4}{(k+2)(2k-1)\left(2k^2-5k+4\right)}.$$

A-7 | Proof of Proposition 2

Making use of Equations (6), (13) and (21), we calculate the following:

$$t^{\mathrm{NO}}-t^{U}=-\frac{ck}{2(4-k)}<0,$$

$$t^{\mathrm{NO}}-t^{B}=\frac{k\left[2k\left(4-5k+2k^2\right)+c\left(6-15k+9k^2-2k^3\right)\right]}{2(1-k)(k+2)\left(4-5k+2k^2\right)}>0,$$

$$t^{B}-t^{U}=\frac{k\left[c\left(40k-28k^2+7k^3-16\right)-k(4-k)\left(4-5k+2k^2\right)\right]}{(1-k)(2+k)(4-k)\left(4-5k+2k^2\right)}<0.$$

We thus have the following:

$$t^{U}>t^{\mathrm{NO}}>t^{B}.$$

A-8 | Proof of Proposition 3

We see that $s^{U}>0$ if $c<\frac{(4-k)(1-k)}{6-k(4-k)}$. Otherwise, we have $s^{U}<0$.

Since $\frac{(4-k)(1-k)}{6-k(4-k)}>\tilde{c}_1$, where $\tilde{c}_1$ is defined in Equation (23b), we have the result that $s^{U}>0$.

Moreover, we have $s^{B}>0$ since $y_{h1}^{B}>0$. Also, we have

$$s^{B}>s^{U}>0,$$

$$s^{\mathrm{NO}}>s^{B}=\frac{k\left[6\left(4-5k+2k^2\right)-c\left(22-27k+14k^2\right)^3\right]}{4(2+k)\left(4-5k+2k^2\right)}>0.$$

These inequality conditions then imply that

$$s^{\mathrm{NO}}>s^{B}>s^{U}.$$

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A-9 | Proof of Proposition 4

By comparing total outputs directly in the three cases, we have from Equations (7), (14), and (20) that

$$\left(x_f^{\mathrm{NO}} + y_{h1}^{\mathrm{NO}} + y_{h2}^{\mathrm{NO}}\right) - \left(x_f^{B} + y_{h1}^{B} + y_{h2}^{B}\right) = \frac{k(1-c)}{2+k} > 0,$$

$$\left(x_f^{B} + y_{h1}^{B} + y_{h2}^{B}\right) = \left(x_f^{U} + y_{h1}^{U} + y_{h2}^{U}\right) = \frac{2(1-c)}{2+k}.$$

Therefore, we have $Q^{\mathrm{NO}} > Q^B = Q^U$. It follows that the ranking of consumer surplus is:

$$\mathrm{CS}^{\mathrm{NO}} > \mathrm{CS}^B = \mathrm{CS}^U \text{ since } \mathrm{CS}^{\mathrm{NO}} - \mathrm{CS}^B = \frac{(1-c)^2 k(4+k)}{2(2+k)^2} > 0.$$

A-10 | Proof of Proposition 5

Next, we focus on producer surplus. As expressions are complicated we omit the detailed calculations here. Instead, we briefly provide the results of comparison of producer surplus for the three cases. First, denote the following values of parameter c such that:

$$\mathrm{PS}^{\mathrm{NO}} - \mathrm{PS}^B = 0 \text{ when } c = c_3,$$

$$\mathrm{PS}^{\mathrm{NO}} - \mathrm{PS}^B > 0 (< 0) \text{ if } c < c_3 (c > c_3),$$

where

$$c_3 = \frac{2\left\{\begin{array}{l}(1-2k)[4-k(5-2k)]\left[52(1-k)+k^2(17+6k)\right] \\ -(2+k)[4-k(5-2k)]\sqrt{2(1-2k)\left(146-393k+366k^2-120k^3\right)}\end{array}\right\}}{\left(256-1516k+2788k^2-2343k^3+754k^4+60k^5-72k^6\right)}.$$

Moreover, we find that

$$\mathrm{PS}^B - \mathrm{PS}^U = 0 \text{ when } c = c_4 \text{ and } PS^B - PS^U < 0 (> 0) \text{ if } c < c_4 (c > c_4),$$

where

$$c_4 = \frac{2(4-k)(1-2k)[4-k(7-2k)][4-k(5-2k)]}{320-1216k+1852k^2-1412k^3+566k^4-107k^5+6k^6}.$$

Note that $c_4 < c_3$. With simulation, it can be verified that $\mathrm{PS}^{\mathrm{NO}} > \mathrm{PS}^U$. Therefore, we have the following possibilities:

$$\mathrm{PS}^{\mathrm{NO}} > \mathrm{PS}^U > \mathrm{PS}^B \text{ if } c < c_4;$$

$$\mathrm{PS}^{\mathrm{NO}} > \mathrm{PS}^B > \mathrm{PS}^U \text{ if } c_4 < c < c_3;$$

$$\mathrm{PS}^B > \mathrm{PS}^{\mathrm{NO}} > \mathrm{PS}^U \text{ if } c > c_3.$$

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A-11 | Proof of Proposition 6

Given the optimal levels of social welfare for the three scenarios,

$$SW^{NO} = \frac{3c^2 - 4c + 2}{4}, SW^{U} = \frac{4 + 6c^2 - 2c(4-k) - k}{(2+k)(4-k)},$$

$$SW^{B} = \frac{-2c^2k^3 + 12c^2k^2 + 16c^2k + 6c^2 + 8ck^3 - 24ck^2 + 26ck - 8c - 4k^3 + 12k^2 - 13k + 4}{2(k+2)(1-2k)\left(4 - 5k + 2k^2\right)}.$$

We find that

$$SW^{B} - SW^{U} = \frac{c^2k\left(3k^2 - 6k + 4\right)}{(k-4)(2k-1)\left(4 - 5k + 2k^2\right)} > 0,$$

$$SW^{NO} - SW^{U} = \frac{k\left[2(4-k) - 4c(4-k) + 3c^2(2-k)\right]}{4(4-k)(2+k)} > 0.$$

We thus have $\min\{SW^{B}, SW^{NO}\} > SW^{U}$. Calculating the critical value of c (denoted by c_5) such that $SW^{NO} = SW^{B}$ yields

$$c_5 = \frac{2(1-2k)[k(5-2k)-4])] + [2(2+k)(1-2k)[4-k(5-2k)][5-4k(2-k)]^{\frac{1}{2}}}{2 + 15k - 24k^2 + 12k^3}.$$

It follows that

$$SW^{NO} > SW^{B} \text{ if } 0 < c < c_5; SW^{B} > SW^{NO} \text{ if } c > c_5.$$

We, therefore, have two possibilities:

$$\text{(i) } SW^{NO} > SW^{B} > SW^{U} \text{ if } 0 < c < c_5;$$

$$\text{(ii) } SW^{B} > SW^{NO} > SW^{U} \text{ if } c > c_5.$$

A-12 | Notes on the Bargaining Analysis

One potentially interesting question is whether we can endogenously determine the equity share of partial ownership through bargaining between the acquiring and acquired firms. In our model with one foreign exporter and two local firms, it seems untraceable. This is because we impose the assumption that all competing firms (one foreign and two domestic) produce positive outputs when comparing policy implications under difficult ownership structures. Note that the status quo for a domestic firm is that its profit is higher under no foreign ownership than under unilateral ownership. That is why we add the past sunk costs of partial ownership transfers (see Equations (8) and (9)). This implies that the partial ownership share cannot be very low (or close to zero); otherwise, the ownership arrangement is not profitable to the foreign firm. Besides, the variation of the equity share from zero to a positive value leads to discontinuous changes in profits and outputs in our model, making the bargaining analysis and solution analytically intractable. In what follows, we present the explanations in detail.

Under unilateral ownership, before solving k, we have $(\pi_f + \pi_{h1})$ as a convex function of k.

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$$\frac{d\left(\pi_f+\pi_{h1}\right)}{dk} = \frac{8c^2\left(2k^3-3k^2\text{–}12\text{k}+34\right)+2c\left(k^4-2k^3-18k^2+92k-208\right)-2(k-4)^3}{(k-4)^4(2+k)^3},$$

$$\frac{d^2\left(\pi_f+\pi_{h1}\right)}{dk^2} = \frac{6(k-4)^4+48c^2\left(50-50k+3k^2-2k^3-k^4\right)-4c\left(k^5-2k^4-20k^3+224k^2-952k+992\right)}{(k-4)^4(2+k)^4}>0.$$

Thus the value of k for the joint profit is either 0 or 0.5. By comparing the joint profit when $k=0.5$ to the case when $k=0$ (the benchmark result), we have:

$$\left(\pi_f+\pi_{h1}\right)>\left(\pi_f^{\text{NO}}+\pi_{h1}^{\text{NO}}\right) \text{ if } c>0.387\text{; otherwise } \left(\pi_f+\pi_{h1}\right)\le\left(\pi_f^{\text{NO}}+\pi_{h1}^{\text{NO}}\right).$$

Thus, when k is high enough *joint profit* may be higher under unilateral ownership than in the benchmark case. Moreover, when $k=0.5$ and $c>0.387$, we have $\pi_f>\pi_f^{NO}$ and $\pi_{h1}<\pi_{h1}^{\text{NO}}$. So, by making a side payment by the foreign firm, there is a scope to improve the joint profit of the two firms. Also, it can be verified that

$$\frac{d^2\left(\pi_f+\pi_{h1}\right)}{dkdc}=\frac{2[8c\left(2k^3+3k^2-12k+34\right)+k^4-2k^3-18k^2+92k-208)}{(k-4)^3(2+k)^3}>0.$$

Given that $(\pi_f+\pi_{h1})$ is co*nvex* in k, the minimum requirement for c is $c>0.387$.

Next, we look at the question of bargaining. As we have shown above, without making a side payment to firm 1, the firm is worse off *ex-post* compared to the benchmark equilibrium. This indicates that bargaining solution does not apply if we take benchmark case as the status quo. Alternatively, we try zero profit as relevant point and find that

$$\left[\left(k\pi_{h1}+\pi_f\right)-0\right]\left[(1-k)\pi_1-0\right]=\frac{(1-k)(4-6c-k)^2\left[c^2(8k+4)+(1-2c)(4-k)k\right]}{(4-k)^3(2+k)^3}>0.$$

It can be checked that the solution is $k=4-6c$ when $c>0.38$. This means that when the value of k is solved by bargaining solution, local firms will not produce (see Equation (14) in the text). Alternatively, note that for $k<0.5$ we have $4-6c<0.5$, meaning that $c>0.5$. This implies that for $c>0.38$, the solution does not satisfy the requirement. Along with the comparison made with the benchmark case, we find that positive output requirements in the model do not suit for the bargaining solution. The above analysis justifies the modeling strategy we have in the text. That is, focusing our analysis on the issues of optimal policy mix of trade and industrial policies under unilateral ownership, avoiding working out the endogeneity of k through bargaining.

We now look at bilateral ownership. To facilitate the comparison with the unilateral case, we require that the three firms' outputs be positive. That is, we impose the restriction that $c>0.387$ (see the unilateral case). We have the profit, $(\pi_f+\pi_{h1})$, to be co*nvex* in k.

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$$\frac{d(\pi_1+\pi_f)}{dk}=\frac{2}{(8-8k-21k^2+10k^3-k^4)^3}\Big[-160+1256k-3972k^2+6625k^3-6215k^4+2961k^5-727k^6+594k^7-126k^8+4k^9+c(560-4400k+13074k^2-19300k^3+15837k^4-14044k^3-7482k^5+2082k^6-670k^7+111k^8-4k^9)+c^2(-448+3784k-10764k^2+9960k^4+4164k^5-1057k^6+215k^7-27k^8+k^9)\Big]>0,$$

$$\frac{\partial^2(\pi_1+\pi_f)}{\partial k^2}=\frac{2}{(8-8k-21k^2+10k^3-k^4)^4}\Big[6208-63616k+273504k^2-634928k^3+877391k^4-780522k^5+483268k^6-195232k^7+35391k^8-11142k^9+3978k^{10}-504k^{11}+12k^{12}+c^2(19520-168128k+688584k^2-1530992k^3+1926116k^4-1485960k^5+749248k^6-254848k^7+57495k^8-9556k^9+1282k^{10}-108k^{11}+3k^{12})-2c(10880-104672k+435504k^2-981860k^3+1302728k^4-1086771k^5+605080k^6-227260k^7+52746k^8-10711k^9+2104k^{10}-222k^{11}+6k^{12})\Big]>0.$$

Also,

$$\frac{\partial^2(\pi_1+\pi_f)}{\partial k\partial c}=\frac{2}{(8-8k-21k^2+10k^3-k^4)^3}\Big[560-4400k+13074k^2-19300k^3+15837k^4-7482k^5+2082k^6-670k^7+111k^8-4k^9-2c(448-3784k+10764k^2-14044k^3+9960k^4-4164k^5+1057k^6-215k^7+27k^8-k^9)\Big]>0.$$

For $k=1/2$, we have that $\pi_f<\pi_f^{NO}$ if $c>0.124$ and $\pi_1>\pi_1^{NO}$ if $c>0.15$. Moreover, we find that

$$(\pi_f+\pi_1)>\left(\pi_f^{NO}+\pi_1^{NO}\right) \text{ if } c>0.18, \text{ otherwise, } (\pi_f+\pi_1)\le\left(\pi_f^{NO}+\pi_1^{NO}\right).$$

Therefore, domestic firm 1 can make a side payment to compensate the foreign firm for the loss of forming bilateral ownership if $c>0.18$. This condition is satisfied since we restrict to the situation where $c<0.387$.

Next, we examine bargaining under bilateral ownership. Since for $c>0.387>0.18$, we have that $\pi_f<\pi_f^{NO}$ land $\pi_1>\pi_1^{NO}$. If we consider a bargaining solution, the benchmark should not be set as the status quo. Take zero profit instead, we have

$$\left[k\pi_f+(1-k)\pi_1-0\right]\left[(1-k)\pi_f+k\pi_1-0\right] \text{ is convex when } c>0.387.$$

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This means that we have $k = 1/2$ when considering a bargaining solution under bilateral ownership. However, this cannot work since it implies that the foreign firm does not produce (see Equation (23a) in the text). Again, the bargaining solution does not satisfy the relevant conditions of the model. One possibility is to calculate the joint profit of the three firms (one foreign and two domestic) to see whether there exists an optimal k, between the foreign firm and the domestic firm 1. Since firms may be worse off without side payments, a bargaining solution is analytically intractable in the model with three firms and the cost disadvantage of domestic production.

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