Sequential Cross-Border Mergers in Models of Oligopoly*

Alberto Salvo (Northwestern University, KSM)†

May 2007; Revised: June 2008

Abstract

Oligopoly theory suggests that anti-competitive mergers may be held up because firms outside the merger stand to increase profits at the expense of the merging firms (Stigler 1950). Against this backdrop, I examine the profitability of cross-border mergers by embedding a class of oligopoly models – where mergers are anti-competitive and firms' actions are strategic substitutes – in the sequential merger game of Nilssen and Sørgard (1998), cast in a two-country setting. The solution to the cross-border merger game is robust across this class of oligopoly models and is such that (i) cross-border mergers are held up only when "international differences" tend to zero; (ii) cross-border mergers happen in clusters, not in isolation; and (iii) for certain parameterisations an equilibrium can be supported where cross-border mergers are interdependent. I provide two standard examples that fall in this class of oligopoly models: one based on Sutton (1991), where cross-border mergers are a means to transfer technology, and another based on Perry and Porter (1985), where cross-border mergers are a means to pool capital together. Interpreting international trade costs as a form of horizontal differentiation suggests that the hold-up of mergers may be less pervasive in an open-economy context. In a more abstract sense, the paper exploits commonalities across oligopoly models.

Keywords: Cross-border mergers; Sequential horizontal mergers; Anti-competitive mergers; Hold-up; Merger wave; International oligopoly; Market integration; Technology transfer

JEL classification: D43, F23, G34, L13

---

*This paper is based on a chapter of my Ph.D. thesis at the LSE. I am very grateful to my supervisors Peter Davis and John Sutton for their advice. An extended version of this paper circulated previously as LSE/STICERD Economics of Industry Working Paper 36, under the heading "A General Analysis of Sequential Merger Games, with an Application to Cross-Border Mergers". I thank Thomas Buettner, Roman Inderst, Massimo Motta, Tore Nilssen, Pierre Regibeau, Mark Schankerman, Margaret Slade, Tommaso Valletti and Helder Vasconcelos, as well as seminar participants, for comments on earlier versions. I also thank two referees and the editor for making this a better paper. Financial support from CAPES and from the LSE, and the provision of research facilities by STICERD, are gratefully acknowledged. The usual disclaimer applies.

†Author's correspondence details: Kellogg School of Management, Management and Strategy Department, 2001 Sheridan Road, Evanston, IL 60208, USA or email a-salvo@kellogg.northwestern.edu

1 Introduction

The "hold-up problem" has been a central theme in the Industrial Organisation literature on mergers. Early on, Stigler (1950) pointed out that mergers that raise industry profits may be held up because firms outside the merger stand to increase profits at the expense of the merging firms. Salant, Switzer and Reynolds (1983) formalised Stigler's insight, showing that in a benchmark Cournot oligopoly with identical firms, any standalone merger comprising less than 80% of the industry's firms is unprofitable. Intuitively, given that firms' actions in such a setting are strategic substitutes, the *pro-competitive free-riding* expansion of output by outside firms in response to the participating firms' output contraction in many cases undoes the profitability of the *anti-competitive* merger[1]. The private unprofitability of price-raising mergers in the Salant et al model suggested a lessened role for policy[2], triggering several studies which indicated that the result was not robust to changes in model specification. Perry and Porter (1985) objected to the notion of a merged firm being identical to any outside firm. While preserving the anti-competitive feature of mergers, they contain the magnitude of the pro-competitive outside response by introducing a factor (capital or capacity) whose supply to the industry is fixed, such that marginal cost is increasing in output (and decreasing in capital). Deneckere and Davidson (1985) modified the quantity-setting assumption by considering a symmetrically-differentiated Bertrand oligopoly. Again preserving the anti-competitive nature of mergers, the strategic complementarity of prices in Deneckere and Davidson now leads outside firms to respond anti-competitively, benefiting rather than hurting the merging firms. Adopting the stage game of Nilssen and Sørgard (1998), where exogenously-specified groups of firms sequentially decide whether to merge prior to a product-market competition stage, Fauli-Oller (2000) shows that sequential moves may facilitate anti-competitive mergers in a Cournot oligopoly not fundamentally different to that of Salant et al. By reducing the number of outside firms and thus the pro-competitive response, early mergers may induce subsequent mergers.

The hold-up problem has also been examined in games where mergers or merger participants are, to some extent, endogenously determined[3]. Kamien and Zang (1990) allow each firm in Salant et al's Cournot oligopoly to simultaneously post a vector of bids and an asking price. They find that hold-up prevails. Intuitively, on deciding whether to sell out as part of a single multilateral merger, each firm considers the profit it would earn

[1] Throughout, I refer to (i) a merger that imparts a positive externality on outside firms, through a reduction in output (increase in price), as *anti-competitive*; and (ii) an output-expanding response by outside firms, that hurts the participants to the merger, as *pro-competitive*, or *free-riding*.

[2] In the opposite case, that of a *pro-competitive merger* (where, say, a large marginal cost reduction for the merger participants lowers price and confers a negative externality on outside firms), there is naturally less of a concern for public policy.

[3] A benefit of this more recent strand is that it enables one to study the equilibrium response of firms to different forms of merger control, since firms endogenously select into their roles as participants (or non-participants) to a merger.

in a more concentrated industry should the merger go ahead absent its participation: this makes acquisitions costly. Gaudet and Salant (1992) show that exogenous mergers that are unprofitable in the Salant et al oligopoly do not occur in the endogenous Kamien and Zang (1990) game. Kamien and Zang (1993) allow mergers to form sequentially and find that the hold-up problem, though it persists, is less pervasive, in line with Fauli-Oller's (2000) result. Adding a time dimension to the game, Fridolfsson and Stennek (2005) also find that anti-competitive mergers are held up, in the form of a war of attrition: firms wait for others to merge since remaining independent is more profitable than merging. In contrast, Horn and Persson (2001a) find a way around the hold-up problem arguing that, in view of the large aggregate payoffs to merging in oligopolies, one might expect firms to (legally) communicate and sign binding agreements enabling contingent mergers. Borrowing from the literature on coalition formation, they show that through cooperation multiple mergers can be agreed on simultaneously.

Only in the past decade or so have oligopoly models in the IO vein been applied to study mergers in an international setting. There are at least two reasons why the study of international mergers is of interest in its own right, above and beyond the implicitly closed-economy (or non-spatial) context. First, as countries around the world have been liberalising their trade and investment regimes, with firms entering into global competition, cross-border mergers appear to be a prime channel for industry restructuring. UNCTAD (2000) reports that in 1999 cross-border mergers accounted for as much as 80% of global FDI. In a world where cross-country differences in technology and tastes are large and trade costs are present, when do mergers form? The second reason is normative: in view of the magnitude of cross-border merger activity in a world undergoing integration, is there a role for a supranational merger policy agency charged with making the "right" tradeoffs across countries and overseeing global welfare?[4] [5]

This paper contributes to the first positive question, on the private incentives for merger in an international setting. It examines whether cross-border mergers in a class of oligopoly models – where mergers are anti-competitive and non-merging firms react pro-competitively, à la Stigler (1950) – are held up in the presence of trade, and their possible interdependence over time. The setup is motivated by the following view of liberalisation. During a historical period of autarky, a concentrated industry has developed in each of

[4]Papers focusing primarily on the former positive question include Horn and Persson (2001b), Norbäck and Persson (2002) and Fumagalli and Vasconcelos (2006). Barros and Cabral (1994), Head and Ries (1997) and Norbäck and Persson (2005) contribute to the latter normative question.

[5]The trade literature has traditionally studied FDI in its greenfield form (see Markusen's 1995 survey). Only recently have general equilibrium (GE) trade models been used to analyse foreign entry via merger. Neary (2007) and Nocke and Yeaple (2007) address the private incentives for merger, Neary being the first to tackle oligopolistic (rather than perfect or monopolistic) competition. As for normative aspects, Francois and Horn (2006) argue that a GE framework – as opposed to IO's established partial equilibrium approach – is more adequate to analyse international merger policy that cuts across the general run of industries and sectors, much as has traditionally been the case with trade policy.

two countries. The two markets are then unexpectedly integrated, and firms can now export to the other market (due to trade integration) and/or can merge with a now rival (and possibly asymmetric) firm located in the other market (due to investment integration). Only cross-border mergers can occur: say that accompanying this process of reform, each country also strengthens antitrust oversight of its economy and that, given their typical focus on the concentration of ownership of domestic assets[6], (national) antitrust authorities would obstruct further consolidation of domestic assets. (I later provide some examples.) Relative to long-term autarky, one can interpret the short-run process of trade and investment liberalisation as downward shocks to both the variable trade cost of exporting and the fixed cost of implementing a cross-border merger, shifting from sufficiently high to lower – though (as I discuss below) non-trivial – values.

I specify a sequential merger game à la Nilssen and Sørgard (1998), but cast it in a two-country setting, allowing bilateral cross-border merger decisions to be undertaken in sequence. I show that the cross-border merger game displays a common solution across the class of *Stiglerian* oligopoly models, which I characterise by reference to two general conditions written in terms of firms' reduced-form payoffs[7]. The common features include (i) (the "all-or-none" bounds result) cross-border mergers happen in clusters, not in isolation; and (ii) ("interdependence of mergers") an equilibrium may obtain in which early mergers are undertaken only because the merging firms anticipate that their competitors will merge subsequently. The reason is that the pro-competitive outside response to an anti-competitive merger becomes smaller the fewer the number of competing firms. Thus, if two firms initially have incentives to merge, it must be that competitors' incentives to merge are even larger after the initial consolidation[8].

I illustrate by reference to two established oligopolies that are nested in the class of models. These oligopolies capture different and arguably realistic aspects of cross-border mergers. In a simple international variant of Sutton's (1991) vertically-differentiated oligopoly, cross-border mergers enable firms to transfer technology from a high-quality

[6] An alternative to using the national antitrust motivation to disallow domestic mergers (and thus simplify the cross-border merger game) would be to endogenously derive this via Stigler's hold-up mechanism (as, e.g., Neary 2007 does in his specific oligopoly where cross-border mergers obtain).

[7] For clarity, by *oligopoly model* I refer to demand- and supply-side primitives characterising the (international) oligopolistic product market, as well as how these change with concentration (i.e. the merger technology). The oligopoly model can thus be characterised by reference to the properties of reduced-form profit functions. I refer to the extensive form of the game as the *merger game*. The oligopoly model and the merger game are thus distinct objects. This paper is concerned with a specific type of merger game played across a class of oligopoly models.

[8] Nilssen and Sørgard (1998) provide a general discussion of sequential merger decisions. They model the merger technology in an unrestricted way (e.g. fixed costs can fall or rise), so that anything can happen. For certain parameters, they derive the interdependence equilibrium, which they associate with Fudenberg and Tirole's (1984) "fat cat strategy". My contribution is to place bounds on the set of equilibria for an appealing class of oligopoly models, thus explaining a regularity result not only in the oligopoly examples of my paper, but also in the oligopoly setups of, e.g., Fauli-Oller (2000), Matsushima (2001) and Motta and Vasconcelos (2005), who analyse similar sequential merger games.

rich-country facility to a low-quality poor-country facility (see Example 1). In Perry and Porter's (1985) fixed-stock-of-capital oligopoly, mergers enable firms (from now identical countries) to grow in "size" by pooling their holdings of capital (see Example 2). In both models, a horizontal trade cost parameter is introduced to capture international differences, or the effects of distance, broadly conceived. In addition to features (i) and (ii) above – the "all-or-none" result and the "interdependence" outcome – the trade cost highlights a third feature of the solution to the cross-border merger game across the class of oligopolies, that (iii) ("merger profitability") cross-border mergers are widespread: mergers are held up *only* when trade costs (and other forms of firm or product differentiation such as technology or quality differences) are "too close" to zero, or when the world is sufficiently "flat". Again, the reason is that the pro-competitive outside response to a merger is decreasing in the degree of international differences. Only when the international product market is excessively competitive, are cross-border mergers unprofitable: we are back in the atomistic market structure of Salant et al[9]. The "bumpiness" of the world[10] would suggest that in a cross-border setting the hold-up problem may be less pervasive compared to a closed-economy context. To fix the idea, suppose that free-riding were to hold anti-competitive mergers up in a certain six-firm oligopoly. Now add an international dimension to this oligopoly, locating three firms in each of two countries. In the presence of trade costs, it may be that mergers *can* be supported in the international oligopoly, in contrast to the non-spatial setting[11] [12].

In the remainder of the paper, Section 2 embeds a class of oligopoly models in a sequential cross-border merger game, Section 3 considers two standard oligopolies that are nested in the class of models, and Section 4 concludes.

---

[9] The notion that differentiation can restrain the free-riding response to a merger is intuitive and is present, in one horizontal form or another, in Lommerud and Sørgard (1997), Matsushima (2001), Inderst and Wey (2004), Bjorvatn (2004) and Qiu and Zhou (2006).

[10] This metaphor and the earlier one are used in the context of Thomas Friedman's controversial popular-business book, "The World is Flat", reviewed by Bhagwati (2005) and Leamer (2007). Leamer, for example, asserts: "Physically, culturally, and economically the world is not flat. Never has been, never will be." (p.123) See, also, Anderson and van Wincoop (2004) on (large) trade costs.

[11] My interpretation of market integration is not one where trade costs collapse to zero – in which case merger activity is absent and firms export – but rather a process by which the trade cost of exporting and the fixed cost of implementing cross-border mergers both shift to lower but still non-trivial levels, given that international differences remain. This unleashes a string of mergers. The examples also indicate that the presence of differentiation along other dimensions (say the vertical attribute quality of Example 1) can compensate for the absence of differentiation along the horizontal trade-cost dimension.

[12] Alternatively, one might associate a downward *change* in merger profitability with a reduced likelihood that cross-border mergers are undertaken, regardless of the *level* (i.e. positive sign) of profitability. Again, a reduction in the variable trade cost of exporting lowers merger profitability only when the trade cost is low (intuitively, decreasing the trade cost from a high level would sharply increase pro-competitive exports, and this is avoided thanks to the anti-competitive cross-border merger). However, the (low trade cost) region for which merger profitability falls as the trade cost is reduced exceeds the region for which merger profitability is negative (see the Appendix). In contrast, merger profitability is everywhere increasing as the fixed cost of merger is reduced. In this sense, whether trade liberalization triggers mergers would depend on whether, empirically, the process mainly takes the form of a reduction in the fixed cost of merging or a reduction in the variable trade cost. (I thank a referee for this point.)

2 Embedding a class of oligopoly models in a sequential cross-border merger game

I specify a sequential merger game à la Nilssen and Sørgard (1998) in the context of cross-border mergers. I then describe a class of oligopoly models – where mergers are anti-competitive and outside firms free-ride – that exhibit a common solution to the merger game.

2.1 The cross-border merger game

Consider two countries, $l \in \{A, B\}$, and endow each country with $n_l \geq 2$ firms. Countries are initially closed to foreign trade and investment, i.e. historically, they are in autarky. Firms within each country are symmetric, but may be asymmetric across countries. For example, in the vertically-differentiated oligopoly of Example 1, I take firms in large (or rich) country A to produce high-quality goods and firms in small country B to produce low-quality goods.

The two economies are then unexpectedly integrated. Firms located in each country are now allowed to export to the other market (due to trade integration) and/or can merge with a (now) rival firm located in the other market (due to investment integration[13]). On its own, the process of market integration is clearly pro-competitive, with the number of firms selling in country l increasing from n_l to $\sum_l n_l$ potentially; the occurrence of cross-border mergers may now reverse these gains. The cross-border merger game is specified following Nilssen and Sørgard (1998), where disjoint and exogenously-given groups of firms make sequential merger decisions prior to a final market competition stage (to be defined by the oligopoly model). There are $T \leq \min(n_A, n_B)$ merger stages. In each merger stage, I pair a specific A-country firm with a specific B-country firm, allowing the pair to decide whether to merge.

Say that $T = n_A = n_B = 3$, as in Example 1. Without loss of generality, randomly label the three A-country firms a_1, a_2 and a_3, and the three B-country firms b_1, b_2 and b_3. The extensive form of the game is characterised as follows: in the first stage, firms a_1 and b_1 decide whether to merge (if formed, the merged firm is labelled m_1); in the second stage, firms a_2 and b_2 decide whether to merge (if formed, the merged firm is labelled m_2); in the third stage, firms a_3 and b_3 decide whether to merge (if formed, the merged firm is labelled m_3). Label the different market structures that may result

[13] I later formalise (and further motivate) this notion of investment integration, by reducing the fixed cost of implementing a cross-border merger, allowing for a flurry of cross-border merger activity. Neary (2007) cites empirical studies suggesting that such activity intensifies upon market integration, as well as empirical studies supporting some features of the type of game and class of oligopoly, such as bilateral mergers and mergers that do not realise cost savings.

out of the three merger stages as r_i, where $i \in \{0, 1, 2, 3\}$ denotes the number of cross-border mergers that are undertaken; for example, r_2 comprises market structures where two cross-border mergers are carried through, there being two merged (multinational) firms and one independent (domestic) firm producing in each country. (See Figure 1 for a depiction.) After the merger stages, in stage $T+1 = 4$, merged and/or independent firms compete in the integrated international product market according to the specification of the oligopoly model.

I argue that Nilssen and Sørgard's (1998) exogenous type of framework can be adequately motivated in the present institutional setting. My objective is to examine the prevalence and interdependence of cross-border mergers in an *oligopolistic* setting, where the concentration of assets located within each country is high[14]. Assume, by way of motivation, that during the historical period of autarky, Sutton's (1991, 1998) "escalation mechanism" has run its course and the industry in each autarkic country has already consolidated: each country has only a few firms[15]. At the moment in which both countries open up to cross-border trade and investment, domestic concentration of assets is such that each country's antitrust authorities would block any attempt to further consolidate domestic assets. However, given the typical focus on assets located within the country, an antitrust authority would approve any (purely) cross-border merger that were proposed[16]. This motivates the exogenous cross-border merger game. In view of my present purpose, the exclusion of domestic mergers is no less adequate than other exogenous assumptions typically made in the merger literature, such as the exclusion of entry (motivated via, say, the scarcity of critical resources), or the exclusion of merger to monopoly (usually motivated on antitrust grounds)[17]. In much the same way that the literature assumes that scarce resources create barriers to purely domestic entry, I assume these scarce resources (privileged access to distribution or ownership of land, say) also create barriers to greenfield entry. One can motivate this by reference to oligopolies where the mode of foreign entry boils down to a choice between M&A or export (and,

[14] I will show that the game highlights, in an analytically simple way, an alternative mechanism generating positive correlation between trade costs and foreign investment that is robust across different oligopoly models, as well as an equilibrium where investment decisions are sequentially interdependent.

[15] Say that, in line with Sutton's theory and empirics of different endogenous sunk cost industries, increased effectiveness of advertising or R&D in raising quality has led to greater concentration.

[16] Horn and Persson (2001b) allow merger to domestic monopoly in a two-country setting (though they exogenously rule out merger to international monopoly). Their objective, unlike mine, is to examine when two domestic monopolies form over two multinational firms. To the extent that firms would find domestic monopolies attractive in my oligopoly (bar note 6), I assume they would be blocked.

[17] As another point of comparison, in a model analysing the welfare ramifications of cross-border mergers as opposed to greenfield FDI, Norbäck and Persson (2005) specify a domestic industry to be not just concentrated but actually a monopoly, at the moment in which investment liberalisation occurs – their motivation is that domestic assets are in scarce supply. By the definition of their sequential game, only one cross-border merger may take place between the domestic firm and the winner of an auction among several symmetric foreign entrants into the domestic market. The authors do not allow mergers among foreign firms, motivating this by reference to antitrust oversight in the (unmodelled) foreign market. In the (final) product-market competition stage, exports are also assumed away.

as noted, cross-border M&A account for the lion's share of FDI flows).

Two features of the recent experience of certain Latin American and Southeast Asian countries come to mind. First, during the 1990s these regions underwent a relatively unplanned process of trade and investment liberalisation, and a high volume of cross-border merger activity was observed in its wake. Second, as countries began opening up, several domestic industries were already highly concentrated. Nascent antitrust oversight – typically operating at the domestic level only – was beginning to constrain further consolidation of domestic assets, while not viewing the merger of assets located in different countries as a threat to competition.

The Mexican cement industry provides an example. A string of domestic mergers starting in the 1960s culminated in the market leader Cemex acquiring, in 1989, the then number two producer, Cementos Tolteca, further raising the one-firm sales concentration ratio to 65%. Asked about such high concentration, the Mexican antitrust agency explained that much of the consolidation of the Mexican cement market had already taken place by the time the agency was set up in 1993 (Wall Street Journal, 2002). Around the late 1980s and early 1990s, Mexico was fast integrating with the world economy, adhering to GATT, joining the OECD and entering NAFTA. Recently, in 2004, Mexico's second largest cement producer, Apasco, was taken over by the Switzerland-based Holcim group. This cross-border merger was not blocked by the antitrust authorities on the grounds that it did not change the concentration of assets located in Mexico, representing only a change from domestic to foreign ownership[18] [19].

2.2 A class of oligopoly models

I consider a class of oligopoly models which satisfy two easily-interpretable properties written in terms of firms' reduced-form payoffs under the different market structures. As I explain, these properties are satisfied by oligopoly models à la Stigler (1950) in which (i) mergers are anti-competitive, and (ii) mergers elicit a pro-competitive response from

[18] Japan's steel industry offers a developed country example. Since the late 1990s, the Japanese antitrust authorities have allowed a fragmented industry to consolidate into five firms. More recently, the Economist (2006) reports that "the commission appears to think that concentration in the domestic market for steel has gone far enough". Yet, mindful of continued consolidation in the global steel industry (most notably the recent UK-based Mittal's hostile acquisition of Luxembourg-based Arcelor), "Japan's steelmakers are now wondering how vulnerable they are to foreign takeover".

[19] Horn and Levinsohn (2001) ask whether countries opening to trade may accept *further* concentration of domestic assets in the hope that a national champion might ward off foreign takeover of these assets. They cite the Kodak-Fuji trade dispute where Japan stood accused of "nullifying or impairing benefits accruing to the United States from the GATT by pursuing slack competition policies (widely interpreted.)" (p.245). (See, also, the political economy in Pearce and Sutton 1986.) Horn and Levinsohn "find no theoretical presumption that international trade liberalisation induces ... more lax competition policy" (p.245-6): rather, "in all the parametric cases examined, trade liberalisation results, in equilibrium, in a *stricter* standard for competition policy" (p.269; original emphasis).

non-participating firms. One can easily verify, through backward induction[20], that these properties restrict the (subgame perfect Nash) equilibria of the game to outcomes where a merger, when undertaken along the equilibrium path, occurs alongside other mergers. Outcomes where only some pairs of firms choose to merge while other pairs choose not to do not obtain in equilibrium. Figure 2 illustrates the "all-or-none" merger result for the case where there are two merger stages, $T = 2$, as in the fixed-stock-of-capital oligopoly of Example 2. Of the eight candidate equilibria ("strategy profiles"), only the three highlighted profiles can be supported as SPNE of the game. The equilibrium labelled "strategic sequential merger" (or "merger wave") is one where investment decisions are interdependent: the second pair of firms' strategy prescribes merger only if the first pair of firms merge, and the first pair of firms' strategy prescribes merger (also referred to as a "fat cat strategy" by Nilssen and Sørgard 1998[21]).

Let $\Pi_m(r_i)$, $i \in \{1, 2, ..., T\}$, denote the payoff to a merged (multinational) firm under market structure r_i (i.e. $i > 0$ cross-border mergers have occurred). Let $\Pi_a(r_i)$, $i \in \{0, 1, ..., T-1\}$, denote the payoff under market structure r_i to an A-country firm that has chosen to remain independent (i.e. $i < T$ mergers have occurred). Define $\Pi_b(r_i)$ similarly for an independent B-country firm.

Condition 1 *("The externality from merger is positive and increasing in concentration"): (1) The merger of a pair of firms has a positive externality on each pair of outside independent firms. That is*

$$\Pi_a(r_0) + \Pi_b(r_0) \leq \Pi_a(r_1) + \Pi_b(r_1) \leq ... \leq \Pi_a(r_{T-1}) + \Pi_b(r_{T-1}) \tag{1}$$

(2) Whenever the merger of a single pair of firms is profitable in isolation, the positive externality of the merger of a pair of firms on a pair of outside firms is greater when this pair of outside firms has merged. That is

$$\textit{Whenever } \Pi_m(r_1) \geq \Pi_a(r_0) + \Pi_b(r_0), \textit{ then}$$

$$\begin{cases} \Pi_m(r_2) - \Pi_m(r_1) \geq (\Pi_a(r_1) + \Pi_b(r_1)) - (\Pi_a(r_0) + \Pi_b(r_0)) \\ \Pi_m(r_3) - \Pi_m(r_2) \geq (\Pi_a(r_2) + \Pi_b(r_2)) - (\Pi_a(r_1) + \Pi_b(r_1)) \\ \vdots \\ \Pi_m(r_T) - \Pi_m(r_{T-1}) \geq (\Pi_a(r_{T-1}) + \Pi_b(r_{T-1})) - (\Pi_a(r_{T-2}) + \Pi_b(r_{T-2})) \end{cases} \tag{2}$$

Property (1) is related to the anti-competitive effect of a merger. By merging, each merger constituent now internalises the externality it confers upon the other constituent

[20] See Salvo (2006) for verification and further discussion. For brevity, I do not reproduce this here, though I later show that the properties are satisfied by the oligopolies of Examples 1 and 2.

[21] They refer to the case where "a merger that is unprofitable in isolation may be carried through if it encourages a subsequent merger that has a positive effect on the first group" (p.1684).

firm when making its output decision; thus, in the absence of (sufficiently large) merger efficiencies, a merged firm produces less than the pre-merger sum of outputs of its constituents. This benefits the outside independent firms.

Property (2) is implied by the pro-competitive free-riding response of outside firms, which has an adverse effect on the merger participants. To see this, rewrite the first inequality of (2) – which is expressed in terms of the *externality of a merger* – alternatively in terms of the *profitability of a merger*: $\Pi_m(r_2) - (\Pi_a(r_1) + \Pi_b(r_1)) \geq \Pi_m(r_1) - (\Pi_a(r_0) + \Pi_b(r_0))$. If a single merger is profitable in isolation (i.e. $\Pi_m(r_1) - (\Pi_a(r_0) + \Pi_b(r_0)) \geq 0$), then a second merger should be even more profitable, since the competitive response is dampened. Say that $T = n_A = n_B = 3$, as in Example 1: while an isolated single merger (of firms a_3 and b_3, say) has four other firms free-riding on it (firms a_1, b_1, a_2 and b_2), a second merger (of firms a_2 and b_2, say) will have only three free-riders (firms a_1, b_1 and m_3)[22]. Importantly, property (2) allows for combinations of parameter values where, say, the merger of a single pair of firms is unprofitable (due to an excessive number of free-riders) yet the merger of a second pair of firms, let alone the merger of a third pair of firms, are profitable (thanks to the lower number of free-riders), giving rise to a strategic wave of mergers. The reduction in competition brought about by each merger goes hand in hand with a reduction in the competitive response to other mergers in this string of mergers.

3 Cross-border mergers in two standard oligopolies

I consider two standard (Cournot) oligopolies that are nested in the class of models spanned by properties (1) and (2): Sutton's (1991) vertically-differentiated oligopoly and Perry and Porter's (1985) fixed-stock-of-capital oligopoly. For each international oligopoly, I complete the specification and consider the solution to the cross-border merger game (keeping the second example very brief, given the commonality).

3.1 Example 1: A vertically-differentiated oligopoly

3.1.1 Specification

There are m_l consumers in each country $l \in \{A, B\}$, with identical Cobb-Douglas preferences defined over a quality (differentiated) good and an outside good, indexed by quantities x and y respectively:

$$U = (ux)^{\beta} y^{1-\beta} \qquad 0 < \beta < 1$$

[22] As pointed out by a referee, property (2) is very reminiscent of Proposition 3 of Neary (2007) (in a Cournot oligopoly – with linear demand and flat, though asymmetric, marginal cost – which also falls in the class of oligopolies I consider).

where u denotes the quality level of the quality good. Economy l's total expenditure on the quality good, S_l, is:

$$S_l = \sum_{i=1}^{n_l} p_i x_i = \sum_{k=1}^{m_l} \beta z_k \tag{3}$$

recalling that n_l is the number of firms producing and selling in initially autarkic country l, and where x_i and p_i are respectively the quantity and price of firm i's (single) quality good (referred to as variety i), and z_k is consumer k's income. Assume $S_A \geq S_B$ due either to a larger population or a higher per capita income in (large) country A relative to (small) country B.

Given any vector of qualities and associated prices, the consumer chooses a variety i that maximises the quality/price ratio $\frac{u_i}{p_i}$[23]. All varieties that command positive sales at equilibrium must therefore have prices proportional to qualities:

$$\frac{p_i}{u_i} = \lambda \quad \forall i$$

where λ is a constant. From (3), one can then write $S = \sum_{i=1}^{n} p_i x_i = \lambda \sum_{i=1}^{n} u_i x_i$ (momentarily dropping the country subscript l for simplicity), expressing the price-to-quality ratio λ as:

$$\lambda = \frac{S}{\sum_{i=1}^{n} u_i x_i} \tag{4}$$

The inverse demand function for variety i is thus:

$$p_i = \lambda u_i = \frac{S}{\sum_{j=1}^{n} \frac{u_j}{u_i} x_j} = \frac{S}{\sum_{j=1}^{n} \frac{p_j}{p_i} x_j} \tag{5}$$

(By assumption, each variety $i = 1, ..., n$ is sold to the (i/n)th part of the population.)

In the example, I endow each country with three firms, $n_A = n_B = 3$. Firms located within a same country produce goods of common quality, but this quality differs across the two countries. Goods produced by the three firms in large country A have high quality u_A, while goods produced by the three firms in small country B have low quality u_B, where $1 \leq u_B \leq u_A$. Define the quality gap v as the ratio of the (common) quality offered by the large-country firms to that offered by their small-country counterparts, $v := \frac{u_A}{u_B} (\geq 1)$. Firms everywhere have the same constant marginal cost of production $c > 0$, and compete à la Cournot.

In the Appendix, I motivate this oligopolistic market structure as the equilibrium outcome to the following long-term entry and investment game (Motta 1992). During

[23] Consumer k chooses to consume quantity x_{ik} of variety i such that $u_i x_{ik}$ is maximised subject to her budget constraint $p_i x_{ik} = \beta z_k$; i.e. she solves $\max_i \beta z_k \frac{u_i}{p_i}$ by selecting a variety i such that $\frac{u_i}{p_i}$ is maximised across i.

a historical period of autarky, without foreseeing any changes, entrants in each country separately play a two-stage game. In a first stage, firms simultaneously decide whether to enter and, if so, at what level of quality. In a second stage, they engage in Cournot competition. In order to produce a good of quality u, a firm must incur a fixed and sunk cost $F(u) = u^{\gamma}$, $u \geq 1$. In equilibrium, an equal number of firms enters in each country, with the large-country firms making larger investments in quality than the small-country firms. The convexity of the fixed cost function, parameterised by γ, is chosen so that three firms enter in each country. That the margin of adjustment to variation in market size ($S_A \geq S_B$) is quality ($u_A \geq u_B$) rather than the number of entrants ($n_A = n_B$) is consistent with the "non-convergence" (or finiteness) property of many oligopoly models of vertical product differentiation (Shaked and Sutton 1983, Sutton 1991).

Consistent with the historical context in which the cross-border merger game is set, as market integration unexpectedly occurs firms are "locked in" with their previous (autarky-based) quality levels, reflecting the long-term nature of entry and investment decisions ("capability-building") as opposed to the short-run process of market integration and market competition. Should firms now choose to export, there is a unit trade cost $t \geq 0$. Should firms now choose to merge, a merged firm can fully transfer technology across borders, being able to produce at the high level of quality u_A not only at its A-country facilities but also at its B-country facilities[24]. Finally, the cross-border merger game is specified with three merger stages, $T = 3$ (recall Figure 1).

3.1.2 Cross-border mergers in equilibrium

The merger game is easily solved by backward induction, once the equilibrium payoffs for the merged and independent firms in each of the different market structures have been derived, as a function of the parameters of the model. (See the Appendix.) These reduced-form payoffs can be expressed as a function of the quality gap v, the trade cost (normalised by the marginal cost of production) $\tilde{t} := \frac{t}{c}$, and the market sizes S_A and S_B. Since I am interested in analysing cross-border mergers in the presence of trade, I restrict the space of parameters such that, in equilibrium, independent (low-quality) B-country firms command positive sales in both countries, i.e. there is two-way trade between countries under any market structure where at least two firms remain independent (since trade ceases if all firms merge across borders). This requires that (i) $(1 \leq) v \leq \frac{3}{2}$ (i.e. the quality gap be low enough) and (ii) $(0 \leq) \tilde{t} \leq \frac{3-2v}{2v}$ (i.e. the trade cost be low enough)[25].

[24] I could have assumed an intermediate merger technology, where the B-country facility of the multinational firm produces at the "average" quality level $\delta u_A + (1-\delta) u_B$, where $0 \leq \delta \leq 1$ is a technology-transfer coefficient. In any case, I next consider the comparative statics of equilibrium to the quality gap v. I later also introduce a fixed cost of implementing a cross-border merger.

[25] Extending the space of parameters beyond $\{(v, \tilde{t}) \in \mathcal{R}^2 \mid 1 \leq v \leq \frac{3}{2} \text{ and } 0 \leq \tilde{t} \leq \frac{3-2v}{2v}\}$ does not add any insight to the results. This would only enlarge the zone where mergers are always profitable,

The solution to the cross-border merger game is depicted in Figures 3 and 4, and is stated in the following proposition[26].

Proposition 1 *("All-or-none" merger result, with interdependent-investment equilibrium, in the vertically-differentiated oligopoly) When a merger occurs along the equilibrium path of the game, it occurs alongside other mergers: either all the pairs of firms that are allowed to merge choose to do so, or none of the pairs of firms choose to merge. Only when both the values of the (normalised) trade cost $\tilde{t}$ and the quality gap v are low, are cross-border mergers held up (zone 4). Higher values for the trade cost or the quality gap are associated with all possible mergers taking place along the equilibrium path of the game (zones 3, 2 and 1). For intermediate values for the trade cost or the quality gap, mergers take place along the equilibrium path, but earlier mergers trigger subsequent mergers (zones 3 and 2).*

The set of equilibria is reminiscent of the "all-or-none" result for the class of oligopoly models seen earlier (recall Figure 2 for two merger stages). This should come as no surprise. In the present oligopoly model, mergers are anti-competitive: despite the transfer of technology (i.e. the quality jump from u_B to u_A enjoyed by the B-country constituent to a cross-border merger), a merged multinational firm always produces less than the pre-merger sum of outputs of its domestic constituents[27]. Since quantities are strategic substitutes, the merger participants' "reduced aggression" is met with "increased aggression" on the part of non-participants: outside firms respond pro-competitively to an anti-competitive merger by increasing output. This free-riding response by outside firms reduces the profitability of a merger for its participants, and may even reverse it, à la Salant, Switzer and Reynolds (1983). The Appendix shows that the model exhibits properties (1) and (2) for all combinations of parameter values.

As for the comparative statics of equilibrium, when differentiation is low along both a horizontal dimension (i.e. low $\tilde{t}$) and a vertical dimension (i.e. low v), the output expansion by outside firms is large. As a result, at any node of the game tree, a decision

both along and off the equilibrium path (zone 1 in Figures 3 and 4). See the Appendix.

[26] See the Appendix for a proof. Salvo (2004) provides a decomposition analysis of the profitability of a cross-border merger, and discusses the robustness of the result to changes in the extensive form of the merger game (i.e. specifying a different number of stages, or specifying simultaneous rather than sequential decisions).

[27] Farrell and Shapiro (1990) refer to this as the "no synergies" case: in their Cournot model, rationalisation of production among the merging parties, from inefficient to efficient plants, does not suffice to expand output and lower prices. More generally, note that if a quality increase (or a marginal cost reduction) through merger were very large, participants to the merger might actually expand output, i.e. merger efficiencies would then lead to a *pro-competitive* merger. In the model at hand, for example, were I to consider $\tilde{t}$ high enough (and $v > 1$) such that not even high-quality A-country firms were able to sell in country B (i.e. trade flows in neither direction), a merger would have a detrimental effect on outside firms selling in country B.

to merge would be unprofitable – this is the case for parameters values in zone 4. In zones 3 and 2, where $\tilde{t}$ or v are intermediate and thus the outside firms' output expansion is lower, a single merger is still not profitable in isolation. To see this, note that firms a_3 and b_3 will not merge in the third stage if the two pairs of firms deciding whether to merge ahead of them were to deviate from the equilibrium path by not merging. Here, however, the more moderate outside output expansion means that subsequent mergers will take place contingent on earlier mergers, as well as earlier mergers will take place anticipating subsequent mergers, since when the market competition stage is reached there are less outside firms to free ride on each merger. Thus, in zones 3 and 2, mergers are sequentially interdependent. Finally, in zone 1, either $\tilde{t}$ or v are high enough (and thus the free riding by outside firms is low enough) that mergers are profitable everywhere, both along the equilibrium path of the game as well as at nodes off the equilibrium path. Figure 4 indicates that the presence of trade costs can compensate for the absence of a quality gap, and vice versa, in ensuring that mergers are undertaken.

The pattern of equilibria is such that either *all* the pairs of firms that are allowed to merge choose to do so, or that *none* of the pairs of firms choose to merge. In particular, outcomes where only some pairs of firms choose to merge while other pairs choose not to are not supported in equilibrium.

Specifically, the analysis highlights a different theoretical mechanism to the trade literature's classic explanation for why foreign investment (FDI) may not occur when trade costs are "too close" to zero (and quality differences are small enough). By the classic "tariff-jumping" story, firms expanding into international markets face a choice between exporting and investing, trading off variable trade costs (e.g. tariffs, transport, etc) against fixed costs of investing in facilities abroad. All else equal, the likelihood that exporting is chosen is high when the trade cost is low[28]. For example, higher trade barriers in the U.S. in the late 1980s and early 1990s – a weakened U.S. dollar in the aftermath of the "New York Plaza Accord", or the imposition of countervailing duties on alleged dumping – would have prompted domestic investments by foreign producers in industries such as cars and cement (e.g. Toyota, Cemex), a move Bhagwati (1985) labelled "quid pro quo FDI". In the present analysis, a different *oligopolistic* mechanism generates the positive correlation between trade costs and foreign investment, hinging on the pro-competitive response of rivals to an anti-competitive merger. Cross-border mergers are held up only when trade costs (and other forms of differentiation)

[28]Motta (1994), for example, studies greenfield investment in a similar vertically-differentiated oligopoly. He finds that reducing trade costs results, ceteris paribus, "in an enlargement of the regions (in parameter space) where exports, rather than investments, prevail" (p.191). His finding is consistent with my Proposition 1 – i.e. in Figure 4, the boundary between zones 4 (exports) and 3 (mergers) slopes downward – yet Motta's result owes to the classic mechanism: a lower trade cost reduces the incentive to invest. Other papers exploring this classic tradeoff between trade costs and fixed costs include Markusen (1984), Horstmann and Markusen (1992) and Markusen and Venables (2000).

are "minimal", since only then would a merger be met with a fierce outside response which would undo the profitability of the merger. Clearly, such a theoretical mechanism may be empirically relevant to the extent that the international industry is oligopolistic, substantial merger efficiencies are absent, and firms' actions are strategic substitutes. Other than low differentiation, industry characteristics in which free-riding may hold mergers up include slack capacity (or, similarly, marginal costs that do not rise steeply in output – see the oligopoly of Example 2), and the presence of several producers that are not party to the merger. As Stigler (1950) observed with respect to anti-competitive mergers, it may be "more profitable to be outside a merger than to be a participant" (p.25).

3.1.3 Investment liberalisation and cross-border "merger waves"

The solution to the cross-border merger game is such that mergers are undertaken and "bunch" together for a "large" region of parameter space (bar when there are "minimal international differences"). This result may seem consistent with bursts of investment activity being observed as countries open up their borders – witness the EEC (EU) from the 1980s, or several emerging markets over the 1990s.[29] However, the prevalence of mergers begs the question: if the all-merger outcome indeed occurs *along* (rather than as a deviation from) the equilibrium path, why were these mergers not undertaken earlier? In light of the historical motivation, cross-border mergers in the vertically-differentiated oligopoly *would* be profitable in trade autarky: intuitively, for $\tilde{t}$ high enough (outside the restricted space of parameters) such that trade does not flow between countries, technology transfer would make cross-border mergers profitable (see the Appendix).

A simple way to formalise the notion of investment integration prompting a wave of cross-border mergers is to introduce a fixed cost G associated with implementing a cross-border merger. Say that, initially, each country's industry is closed to foreign investment, through curbs on the right of foreign firms to acquire shares in domestic firms. In this initial setting, the fixed cost $G = G_0$ of merging across borders is very high, rendering mergers unprofitable, and no merger occurs along the equilibrium path. Then, as countries undergo reform and the cost of doing business in a new environment declines, G drops. UNCTAD (2000) reports that "over the period 1991-1999, 94% of the 1,035 changes worldwide in the laws governing FDI created a more favourable framework for FDI. Complementing the more welcoming national FDI regimes, the number of bilateral investment treaties ... has risen from 181 at the end of 1980 to 1,856 at the end of 1999. Double taxation treaties have also increased, from 719 in 1980 to 1,982 at the end of

[29] Besides intensifying during episodes of market integration (recall note 13), empirical studies document that merger activity more generally also appears to cluster over time, or display wave-like behaviour, including Mueller (1989), Town (1992), Golbe and White (1993), Barkoulas et al (2001) and Andrade et al (2001), using either aggregate or within industry data.

1999. At the regional and interregional levels, an increasing number of agreements ... are helping create an investment environment more conducive to international investment flows" (p.xv). (See also Caves 1991.)

Suppose that the magnitude of the change in G is unforeseen, or that firms are sufficiently impatient. (As pointed out by a referee, interesting dynamics such as pre-emptively merging – to acquire scarce assets – or waiting for G to fall further – to increase the surplus from merger – might arise were firms to anticipate the future time path of G.) The following proposition states that if G drops to the upper threshold at which mergers are (barely) profitable, denoted $\underline{G}$ (see Figure 5), the equilibrium that supports this "all-merger" outcome corresponds to the "merger wave" equilibrium of zone 3 in Figure 3, where mergers are interdependent (i.e. *even* when the trade cost and quality gap parameters lie in zones 1 or 2 of Figure 4).

Proposition 2 *("Merger wave" in the vertically-differentiated oligopoly with a downward shock to the fixed cost of merger) When the fixed cost G of implementing a cross-border merger lies above a certain threshold $\underline{G}$, cross-border mergers are not undertaken in any zone of Figure 4, thus replicating the equilibrium for zone 4 in the absence of fixed costs (recall Figure 3). At the fixed cost threshold $\underline{G}$, for any combination of trade cost $\tilde{t}$ and quality gap v in either of zones 3, 2 or 1, the "all-merger" outcome is reestablished. In particular, at this threshold $\underline{G}$, a "merger wave" equilibrium – where earlier mergers induce subsequent mergers – is supported not only for parameter values $\tilde{t}$ and v in zone 3, but also in zones 2 and 1 (this merger wave equilibrium then replicates the equilibrium of zone 3 in the absence of fixed costs).*

To illustrate, consider a specific combination of parameters $(v, \tilde{t})$ such that, in the absence of fixed costs, mergers are profitable everywhere (i.e. at all nodes of the game tree) and are thus non-strategic: $(v, \tilde{t})$ lies in zone 1 of Figure 4. Now introduce a shock that lowers the fixed cost to $\underline{G}$, the threshold at which mergers only just occur. The equilibrium that supports this outcome, even for $(v, \tilde{t})$ in zone 1, is one where earlier mergers now induce subsequent merger activity.

The intuition for this result again hinges on properties (1) and (2) which the vertically-differentiated oligopoly satisfies. Introducing a fixed cost to merge lowers its profitability: at the threshold $\underline{G}$,[30] anti-competitive mergers are only just profitable because they dampen the pro-competitive outside response. That is, mergers are undertaken because along the equilibrium path merging parties observe or anticipate the reduction in the

[30] $\underline{G}$ is given by $\Pi_m(r_3) - (\Pi_a(r_2) + \Pi_b(r_2))$. Proof of this and of the proposition is again provided in the Appendix.

number of competitors in the international product market. Rival mergers do not lessen and can increase incentives to merge oneself.

The predominance of an equilibrium where merger decisions are interdependent is of particular interest. While a merger would not be profitable in isolation, sequential interdependence of merger activity ensures that mergers take place.

3.2 Example 2: A fixed-stock-of-capital oligopoly

3.2.1 Specification

Let $k > 0$ index the amount of a fixed factor of production (say capital) whose total supply is fixed to an international homogeneous-good industry. Firm i's cost function is given by $C(x_i, k_i)$, where x_i denotes its output and k_i is the amount of the fixed factor it owns. The cost function is taken to be homogeneous of degree one in output and capital, implying constant returns to scale and that the marginal cost function, $C_1(x, k) := \frac{\partial C(x,k)}{\partial x}$, is homogeneous of degree zero in x and k. Because of the presence of a fixed factor of production, it is assumed that marginal costs are decreasing in k, $C_{12}(x, k) := \frac{\partial^2 C(x,k)}{\partial k \partial x} < 0$ and hence, by Euler's theorem, marginal costs are increasing in output, $C_{11}(x, k) := \frac{\partial^2 C(x,k)}{\partial x^2} > 0$.

In the example, I endow each of two identical countries, $l \in \{A, B\}$, with two firms, $n_A = n_B = 2$, each firm owning $k_i = k$. Technology is common across countries and firms: as in Perry and Porter (1985), a firm's cost function is quadratic (and convex) in output, $C(x, k) = gk + dx + \frac{e}{2k}x^2$, where industry fixed costs $g \sum_i k_i = 4gk$ are distributed in proportion to capital ownership, and coefficients d, e and g are (weakly) positive. Also as in Perry and Porter (1985), demand is linear: inverse demand functions are given by $P^l(X^l) = a - X^l$, where P^l and X^l are respectively the price and quantity sold in country l (i.e. $X^l := \sum_i x_i^l$), and $a > d$. Firms compete à la Cournot. The international oligopoly thus initially consists of four symmetric firms.

Once countries are unexpectedly integrated, the cross-border merger game is played with two merger stages, $T = 2$. Should firms choose to merge, the merger technology is such that the capital stock of a merged (multinational) firm is the sum of its constituent firms' capital. What distinguishes one firm from another here is not the quality of the firm's offering, but how much capital it owns. Thus, a "larger" multinational firm arising from the merger of two domestic firms has a lower marginal cost than either constituent at a given level of output. Notice, however, that the assumptions rule out economies of scale as a motive for merger. Should firms choose to export, the trade technology is again linear, with unit trade cost $t \geq 0$.

3.2.2 Cross-border mergers in equilibrium

The merger game is again solved by backward induction, once the equilibrium payoffs have been derived as a function of the parameters of the model. (See the Appendix.) These reduced-form payoffs can be expressed as a function of (i) the demand intercept less the marginal cost intercept, $(a-d)$, (ii) the trade cost t, and (iii) the rate of change of the marginal cost of a firm with capital stock k, $C_{11}(x,k) = \frac{e}{k}$. Let $\tilde{t} := \frac{t}{a-d}$ and $\tilde{e} := \frac{e}{k}$. As in the vertically-differentiated oligopoly, the space of parameter values that is of interest is that where trade between countries is feasible. (Otherwise there is zero surplus from merger.) This requires that $(0 \leq)\tilde{t} \leq \frac{1}{3+\tilde{e}}$, i.e. the (normalised) trade cost be low enough. The solution to the cross-border merger game is depicted in Figure 6 and is stated in the following proposition.

Proposition 3 *("All-or-none" merger result, with interdependent-investment equilibrium, in the fixed-stock-of-capital oligopoly) When a merger occurs along the equilibrium path of the game, it occurs alongside another merger: either both pairs of firms that are allowed to merge choose to do so, or none of the pairs of firms choose to merge. Only when both the values of the (normalised) trade cost $\tilde{t}$ and the rate of change of the marginal cost $\tilde{e}$ are low, are cross-border mergers held up (zone 3). Higher values for the trade cost or the rate of change of the marginal cost are associated with both possible mergers taking place along the equilibrium path of the game (zones 2 and 1). For intermediate values for the trade cost or the rate of change of the marginal cost, mergers take place along the equilibrium path, but the earlier merger triggers the subsequent merger (zone 2).*

The common solution to the merger game, despite the present motive for merger differing in kind, follows from verifying that the oligopoly satisfies properties (1) and (2). Intuitively, the comparative statics again hinge on the magnitude of the pro-competitive response to an anti-competitive merger. When the trade cost and the rate of change of the marginal cost are both low, outside firms react to the merging firms' output reduction by expanding output to such a large extent that cross-border mergers are not profitable (zone 3). As frictions on this free riding response increase, either through greater trade costs (horizontal differentiation) or through marginal costs that rise sufficiently fast in output, this disincentive to merger is contained, and cross-border mergers occur in equilibrium (zones 2 and 1). In zone 2 in particular, the "merger wave" equilibrium, this effect is only just contained thanks to the reduced number of firms competing in the final-stage international product market.

In particular, the result that cross-border investments do not occur only when trade costs (and other frictions on the outside response) are "minimal" owes again to the oligopolistic pro-competitive-response-meets-anti-competitive-merger mechanism à la Stigler (1950), not to the classic "tariff-jumping" mechanism.

4 Concluding remarks

This paper has examined a sequential cross-border merger game across two archetypal oligopoly settings. In the vertically-differentiated international oligopoly à la Sutton (1991), cross-border mergers are a means to transfer technology (in addition, of course, to jumping tariffs and concentrating the industry). In the fixed-stock-of-capital international oligopoly à la Perry and Porter (1985), cross-border mergers are a means to pool capital together. In both oligopolies, the solution to the game is such that (i) cross-border mergers are widespread, being held up only when rival products and firms serving any one market are "too similar"; (ii) cross-border mergers happen in clusters, not in isolation; and (iii) for certain parameterisations, an equilibrium can be supported where cross-border mergers are sequentially interdependent.

More generally, this pattern of equilibria to the sequential cross-border merger game can be generalised to a class of oligopoly models of product-market interaction where participants to a merger become "less aggressive" (i.e. mergers are anti-competitive) and firms outside the merger respond by becoming "more aggressive" (i.e. outside firms respond pro-competitively), à la Stigler (1950). To the extent that this pro-competitive outside response can be restrained, say via horizontal product differentiation, vertical product differentiation, or marginal costs that rise in output (or capacity utilisation), the much-studied merger hold-up problem can be overcome. The analysis also generalises the (strategic) "merger wave" equilibrium of Nilssen and Sørgard (1998) where, by reducing competition, each merger concomitantly reduces the competitive response to other mergers, thus allowing a string of mergers to be supported.

Importantly, interpreting international trade costs as a form of horizontal differentiation suggests that the hold-up of anti-competitive mergers may be less pervasive in an open-economy context relative to a non-spatial atomistic market structure.

Unlike much of the (small but growing) literature studying international mergers, my aim has not been to provide one or another explanation for their occurrence. Rather, the emphasis has been to explore commonalities across oligopoly models in the presence of trade. To provide an example, in the oligopoly model specified by Qiu and Zhou (2006), cross-border mergers are a means for sharing private information. To the extent that their oligopoly model is embedded in the sequential cross-border merger game and parameterised such that cross-border mergers are anti-competitive and outside firms free-ride, the all-or-none merger result will obtain, as in Propositions 1, 2 and 3 above.

References

[1] Anderson, J. and E. van Wincoop (2004). Trade costs. *Journal of Economic Literature* 42(3), 691-751

[2] Andrade, G., M. Mitchell and E. Stafford (2001). New evidence and perspectives on mergers. *Journal of Economic Perspectives* 15(2), 103-120

[3] Barkoulas, J., C. Baum and A. Chakraborty (2001). Waves and persistence in merger and acquisition activity. *Economic Journal* 70, 237-243

[4] Barros, P. P. and L. Cabral (1994). Merger policy in open economies. *European Economic Review* 38, 1041-1055

[5] Bhagwati, J. (1985). Protectionism: Old wine in new bottles. *Journal of Policy Modeling* 7, 23-34

[6] Bhagwati, J. (2005). A new vocabulary for trade. In *The Wall Street Journal*, August 4

[7] Bjorvatn, K. (2004). Economic integration and the profitability of cross-border mergers and acquisitions. *European Economic Review* 48, 1211-1226

[8] Caves, R. (1991). Corporate mergers in international economic integration. In Alberto Giovannini and Colin Mayer (Eds.), *European Financial Integration*, 136-160. Cambridge: Cambridge University Press.

[9] Deneckere, R. and C. Davidson (1985). Incentives to form coalitions with Bertrand competition. *Rand Journal of Economics* 16, 473-486

[10] Economist (2006). Japan's steel industry: A changed game, July 15

[11] Farrell, J. and C. Shapiro (1990). Horizontal mergers: An equilibrium analysis. *American Economic Review* 80, 107-126

[12] Fauli-Oller, R. (2000). Takeover waves. *Journal of Economics & Management Strategy* 9(2), 189-210

[13] Francois, J. and H. Horn (2006). Antitrust in open economies. Mimeo, Tinbergen Institute and IUI Research Institute of Industrial Economics

[14] Fridolfsson, S.-O. and J. Stennek (2005). Hold-up of anti-competitive mergers. *International Journal of Industrial Organization* 23(9-10), 753-775

[15] Fudenberg, D. and J. Tirole (1984). The fat cat effect, the puppy dog ploy and the lean and hungry look. *American Economic Review*, *Papers and Proceedings* 74, 361-368

[16] Fumagalli, E. and H. Vasconcelos (2006). Cross-border merger waves. CEPR Discussion Paper 5601, London

[17] Gaudet, G. and S. Salant (1992). Mergers of producers of perfect complements competing in price. *Economics Letters* 39, 359-364

[18] Golbe, D. and L. White (1993). Catch a wave: The time series behaviour of mergers. *Review of Economics and Statistics* 75(3), 493-499

[19] Head, K. and J. Ries (1997). International mergers and welfare under decentralized competition policy. *Canadian Journal of Economics* 30(4), 1104-23

[20] Horn, H. and J. Levinsohn (2001). Merger policies and trade liberalisation. *Economic Journal* 111(470), 244-76

[21] Horn, H. and L. Persson (2001a). Endogenous mergers in concentrated markets. *International Journal of Industrial Organization* 19, 1213-1244

[22] Horn, H. and L. Persson (2001b). The equilibrium ownership of an international oligopoly. *Journal of International Economics* 53(2), 307-333

[23] Horstmann, I. and J. R. Markusen (1992). Endogenous market structures in international trade. *Journal of International Economics* 32, 109-129

[24] Inderst, R. and C. Wey (2004). The incentives for takeover in oligopoly. *International Journal of Industrial Organization* 22, 1067-1089

[25] Kamien, M. and I. Zang (1990). The limits of monopolization through acquisition. *Quarterly Journal of Economics* 105, 465-499

[26] Kamien, M. and I. Zang (1993). Monopolization by sequential acquisition. *Journal of Law, Economics & Organization* 9, 205-229

[27] Leamer, E. E. (2007). A flat world, a level playing field, a small world after all, or none of the above? A review of Thomas L. Friedman's *The World is Flat. Journal of Economic Literature* 45, 83-126

[28] Lommerud, K. E. and L. Sørgard (1997). Merger and product range rivalry. *International Journal of Industrial Organization* 16, 21-42

[29] Markusen, J. R. (1984). Multinationals, multi-plant economies, and the gains from trade. *Journal of International Economics* 16, 205-226

[30] Markusen, J. R. and A. Venables (2000). The theory of endowment, intra-industry, and multinational trade. *Journal of International Economics* 52, 209-234

[31] Matsushima, N. (2001). Horizontal mergers and merger waves in a location model. *Australian Economic Papers* 40(3), 263-286

[32] Motta, M. (1992). Sunk costs and trade liberalisation. *Economic Journal* 102(412), 578-587

[33] Motta, M. (1994). International trade and investments in a vertically differentiated industry. *International Journal of Industrial Organization* 12, 179-196

[34] Motta, M. and H. Vasconcelos (2005). Efficiency gains and myopic Antitrust Authority in a dynamic merger game. *International Journal of Industrial Organization* 23(9-10), 777-801

[35] Mueller, D. (1989). Mergers: Causes, Effects and Policies. *International Journal of Industrial Organization* 7 (special issue on mergers), 1-10.

[36] Neary, P. J. (2007). Cross-border mergers as instruments of comparative advantage. *Review of Economic Studies*, 1229-1257

[37] Nilssen, T. and L. Sørgard (1998). Sequential horizontal mergers. *European Economic Review* 42, 1683-1702

[38] Nocke, V. and S. Yeaple (2007). Cross-border mergers and acquisitions versus greenfield foreign direct investment: The role of firm heterogeneity. *Journal of International Economics* 72(2), 336-365

[39] Norbäck, P.-J. and L. Persson (2002). Cross-border acquisitions and greenfield entry. IUI Research Institute of Industrial Economics Working Paper 570

[40] Norbäck, P.-J. and L. Persson (2005). Investment liberalization – Why a restrictive cross-border merger policy can be counterproductive. IUI Research Institute of Industrial Economics Working Paper 644

[41] Pearce, J. and J. Sutton (1986) (with R. Batchelor). *Protection and Industrial Policy in Europe*. London: The Royal Institute of International Affairs

[42] Perry, M. and R. Porter (1985). Oligopoly and the incentive for horizontal merger. *American Economic Review* 75, 219-227

[43] Qiu, L. D. and W. Zhou (2006). International mergers: Incentives and welfare. *Journal of International Economics* 68(1), 38-58

[44] Salant, S., S. Switzer and R. Reynolds (1983). Losses from horizontal merger: The effects of an exogenous change in industry structure on Cournot-Nash equilibrium. *Quarterly Journal of Economics* 98, 185-199

[45] Salvo, A. (2004). A general analysis of sequential merger games, with an application to cross-border mergers. STICERD Economics of Industry Working Paper EI 36, London School of Economics

[46] Salvo, A. (2006). Explaining the pattern of equilibria in a symmetric sequential horizontal merger game. Mimeo, Northwestern University

[47] Shaked, A. and J. Sutton (1983). Natural oligopolies. *Econometrica* 51, 1469-1484

[48] Stigler, G. J. (1950). Monopoly and oligopoly by merger. *American Economic Review* 40(2), 23-34

[49] Sutton, J. (1991). *Sunk Costs and Market Structure: Price Competition, Advertising and the Evolution of Concentration.* Cambridge, MA: The MIT Press.

[50] Sutton, J. (1998). *Technology and Market Structure: Theory and History.* Cambridge, MA: The MIT Press.

[51] Town, R. (1992). Merger waves and the structure of merger and acquisition time-series. *Journal of Applied Econometrics* 7 (supplement), 83-100

[52] UNCTAD (2000). Cross-border mergers and acquisitions and development. *World Investment Report.* New York and Geneva: United Nations

[53] Wall Street Journal (2002). Selling cement to Mexico's poor, April 22

A Appendix: A vertically-differentiated oligopoly

A.1 Historical motivation: Derivation of the autarky equilibrium

In order to motivate the number of firms located in each country (three) and their respective qualities (high quality u_A for firms located in country A and low quality u_B for firms located in country B, such that $v = \frac{u_A}{u_B} \geq 1$), the equilibrium to the autarkic (long-term) entry and investment game is derived[31]. In each country, in a first stage firms simultaneously make entry and quality investment decisions; in a second stage, firms that have entered engage in Cournot competition.

In the second (market) stage, given that n firms have entered in the first (entry and investment) stage with qualities $u = (u_j)$, $j = 1, ..., n$, the gross profit of firm i (recalling the price-to-quality ratio λ) is

[31] The specification here closely resembles Motta (1992) and the derivation follows Sutton (1998, Appendix 15.1).

$$\Pi_i = p_i x_i - c x_i = \lambda u_i x_i - c x_i$$

Firm i maximises Π_i taking the vector of qualities u from the earlier stage and x_j, $j \neq i$, as given. The first order condition is $\lambda u_i + u_i x_i \frac{d\lambda}{dx_i} - c = 0$, where from (4) we have $\frac{d\lambda}{dx_i} = -\frac{S}{(\sum_{j=1}^n u_j x_j)^2} u_i = -\frac{u_i}{S}\lambda^2$, or

$$u_i x_i = \frac{c - \lambda u_i}{\frac{d\lambda}{dx_i}} = \frac{S}{\lambda} - \frac{cS}{\lambda^2}\frac{1}{u_i} \tag{6}$$

Summing over j, we obtain $\sum_{j=1}^n u_j x_j = n\frac{S}{\lambda} - \frac{cS}{\lambda^2}\sum_{j=1}^n(\frac{1}{u_j})$. Using (4), we can solve for the price-to-quality ratio, $\lambda = \frac{c}{n-1}\sum_{j=1}^n(\frac{1}{u_j})$. Substituting for λ in FOC (6), we find the output of firm (variety) i:

$$x_i = \frac{S}{\lambda u_i}(1 - \frac{c}{\lambda}\frac{1}{u_i}) = \frac{S}{c}\frac{n-1}{u_i \sum_{j=1}^n(\frac{1}{u_j})}(1 - \frac{n-1}{u_i \sum_{j=1}^n(\frac{1}{u_j})}) \tag{7}$$

Labelling the firm offering the lowest quality as firm 1, a necessary and sufficient condition for all n firms to command positive sales in equilibrium is $u_1 \sum_{j=1}^n(\frac{1}{u_j}) > n - 1$. We can further solve for the price and gross profit:

$$p_i = \lambda u_i = c\frac{u_i}{n-1}\sum_{j=1}^n(\frac{1}{u_j}) \tag{8}$$

$$\Pi_i = (p_i - c)x_i = (1 - \frac{n-1}{u_i \sum_{j=1}^n(\frac{1}{u_j})})^2 S \tag{9}$$

At the equilibrium, prices do not depend on market size, and profits are increasing in quality and do not depend on marginal cost.

We now turn to the entry and investment stage. Sutton (1991, c.3) proves that at the unique Nash equilibrium, firms choose the same quality level u. In this case, $u_i \sum_{j=1}^n(\frac{1}{u_j}) = n$, and for every firm choosing to enter, output, price and gross profit collapse to:

$$x_i = x = \frac{S}{c}\frac{n-1}{n^2} \tag{10}$$

$$p_i = p = c\frac{n}{n-1} \tag{11}$$

$$\Pi_i = \Pi = \frac{S}{n^2} \tag{12}$$

We wish to set the convexity of the fixed cost function $F(u) = u^\gamma$ so that, in equilibrium, $n = 3$ firms find it profitable to enter each country. This is the case when $\gamma = 3$. (Making the cost function more convex – reflecting a reduction in the effectiveness of, say, R&D spending in raising quality – increases the number of entrants; e.g. 4 firms enter when $\gamma = 5$.) To see this, write the net profit per firm as $\pi(n,u) = \Pi(n) - F(u) = \frac{S}{n^2} - u^3$. The industry equilibrium, where n firms enter with quality u, is characterised by two conditions:

(I) (Free entry) $\pi(n,u) \geq 0$ (viability) and $\pi(n+1,u) < 0$ (stability)

(II) (Optimal quality[32]) $\frac{d\Pi}{du} = \frac{dF}{du}$

By considering a deviant firm i offering quality u_i when all its rivals $j \neq i$ offer a common quality u, condition (II) becomes[33]:

$$\frac{d\pi_i}{du_i} |_{u_i=u} = \frac{d\Pi_i}{du_i} |_{u_i=u} - \frac{dF_i}{du_i} |_{u_i=u} = \frac{2S(n-1)^2}{un^3} - 3u^2 = 0$$

which can be rearranged to

$$u^3 = \frac{2S(n-1)^2}{3n^3} \tag{13}$$

Given $u = u(n)$ by condition (II), and that condition (I) can be expressed as $\sqrt{\frac{S}{[u(n+1)]^3}} - 1 < n \leq \sqrt{\frac{S}{[u(n)]^3}}$, condition (I) may then be rewritten as

$$\sqrt{\frac{3(n+1)^3}{2n^2}} - 1 < n \leq \sqrt{\frac{3n^3}{2(n-1)^2}}$$

The only possible solution to this inequality is $n = 3$ and this does not depend on S. This "non-convergence" result is common to many vertical product differentiation models; less common is the result that firms choose the same quality in equilibrium, which hinges on the symmetry of consumer preferences and the assumption of quantity as opposed to price competition (Sutton 1991, Motta 1992).

The autarky equilibrium is then given by equations (10) to (13), where $n = n_l = 3$ firms enter in each country $l \in \{A, B\}$ and the common quality, price, firm output and firm (gross and net) profits are given by:

$$\begin{aligned} u_l &= \frac{2}{3}\sqrt[3]{\frac{S_l}{3}}, \quad p_l = \frac{3}{2}c, \quad x_l = \frac{2}{9}\frac{S_l}{c}, \\ \Pi_l &= \frac{S_l}{9}, \quad \pi_l = \frac{S_l}{9} - (u_l)^3 = \frac{S_l}{81} \end{aligned} \tag{14}$$

Given the assumption $u_l \geq 1$, I further assume that $S_l > \frac{81}{8}$. Quality is an increasing function of market size so the assumption that $S_A \geq S_B (> \frac{81}{8})$ implies that the

[32] As in Motta (1992), I consider only internal solutions.

[33] From equation (9), when all firm i's rivals offer a common quality u, we obtain $\Pi_i = (1 - \frac{1}{\frac{1}{n-1} + \frac{u_i}{u}})^2 S$. Then $\frac{d\Pi_i}{du_i} = \frac{2S}{u} \frac{\frac{1}{n-1} + \frac{u_i}{u} - 1}{(\frac{1}{n-1} + \frac{u_i}{u})^3}$, and by evaluating this expression at $u_i = u$ the marginal benefit for the deviant firm i of increasing quality when all firms choose a common quality u is $\frac{d\Pi_i}{du_i} |_{u_i=u} = \frac{2S(n-1)^2}{un^3}$. The SOC is satisfied at the solution $n = 3$ (see below).

quality offered by A-country firms is at least equal to that offered by their B-country counterparts, i.e. $u_A \geq u_B (\geq 1)$.

A.2 Reduced-form profit functions in game with T merger stages and $n_A = n_B = T$ firms

Endow each country initially with T independent firms, equal to the number of merger stages. (The setup in Example 1 refers to the case $T = 3$.) Recall that firms located in country A (producing with quality u_A) are labelled $a_1, a_2, a_3, ..., a_T$ and firms located in country B (quality u_B) are labelled $b_1, b_2, b_3, ..., b_T$. In the first stage firms a_1 and b_1 decide whether to merge (if formed, the merged firm is labelled m_1), in the second stage firms a_2 and b_2 decide whether to merge (if formed, the merged firm is labelled b_2), and so on, in sequence until stage T, where firms a_T and b_T are the last pair of firms to undertake a merger decision (if formed, the merged firm is labelled m_T). The game ends at stage $T + 1$, the market competition stage. The $T + 1$ possible market structures coming out of the T merger stages are labelled $r_0, r_1, r_2, ..., r_T$ where the subscript denotes the number of cross-border mergers undertaken.

To solve for market competition equilibrium outcomes as a function of market structure, begin by considering market structure r_i, where $i = 1, 2, 3, ..., T - 1$, i.e. both independent (domestic) and merged (multinational) firms exist (I will return to the "corner" structures r_0 and r_T shortly). Specifically, under market structure r_i there are i multinational firms, $T - i$ independent A-country firms and $T - i$ independent B-country firms.

By the merger-technology assumption, a multinational firm produces at quality level $\max(u_A, u_B) = u_A$ not only in country A but also in country B. Clearly, given the unit trade cost $t \geq 0$, it will no longer trade between countries, meeting the demand for its (high-quality) product in each country through domestic production[34].

From the demand setup, in equilibrium consumer prices in country $l \in \{A, B\}$ are such that $\frac{p_m^l}{u_A} = \frac{p_a^l}{u_A} = \frac{p_b^l}{u_B}$, where p_j^l denotes the price of the good produced by firm j and sold in country l. This may be written in terms of the quality gap $v = \frac{u_A}{u_B} \geq 1$:

$$p_m^l = p_a^l = v p_b^l \qquad l \in \{A, B\} \tag{15}$$

[34]This would not necessarily be the case were a merger *not* to lead to a quality upgrade in the production facilities in country B. For a large enough quality gap relative to the trade cost, it can be shown that a multinational firm would then continue exporting high-quality product produced by its A-country plant to country B, discontinuing production operations in country B. For example, when $T = 3$ under market structure r_1 (one multinational firm and two independent firms in each country), this would happen if $v > 1 + \tilde{t}$. Otherwise, for $v \leq 1 + \tilde{t}$, the multinational firm would produce high-quality product in country A for consumption in country A and produce low-quality product in country B for consumption in country B.

To illustrate, prices in country B are given by p_m^B, p_a^B and p_b^B, where high-quality goods (produced by multinational firms and independent A-country firms) command a price premium relative to low-quality goods (produced by independent B-country firms).

With no loss of generality (solely for the purpose of labelling firms), assume that the i multinational firms in market structure r_i were formed in the first i merger stages. Similar to equation (5), the inverse demand functions for low-quality product offered in country A and country B are, respectively:

$$p_b^A = \frac{S_A}{v\sum_{j=m_1}^{m_i} x_j^A + v\sum_{j=a_{i+1}}^{a_T} x_j^A + \sum_{j=b_{i+1}}^{b_T} x_j^A}$$

$$p_b^B = \frac{S_B}{v\sum_{j=m_1}^{m_i} x_j^B + v\sum_{j=a_{i+1}}^{a_T} x_j^B + \sum_{j=b_{i+1}}^{b_T} x_j^B}$$

The first term in the denominator corresponding to each market is the quality-adjusted sales of the i multinational firms in that market; the second and third terms respectively refer to the quality-adjusted sales of the $T-i$ independent A-country firms and the $T-i$ independent B-country firms in that market. The inverse demand functions for high-quality product offered in both countries, $p_m^l = p_a^l$, $l \in \{A, B\}$, can then be obtained from equation (15).

Each firm's optimisation problem can now be written. A merged multinational firm m, $m = m_1, m_2, ..., m_i$, maximises profits by setting x_m^A and x_m^B to solve

$$\max_{x_m^A \geq 0, x_m^B \geq 0} \; p_m^A x_m^A + p_m^B x_m^B - c(x_m^A + x_m^B)$$

taking all other firms' outputs as given. As in equation (4), writing the price-to-quality ratio in country A as $\lambda^A = \frac{S_A}{v\sum_{j=m_1}^{m_i} x_j^A + v\sum_{j=a_{i+1}}^{a_T} x_j^A + \sum_{j=b_{i+1}}^{b_T} x_j^A}$, and the price-to-quality ratio in country B as $\lambda^B = \frac{S_B}{v\sum_{j=m_1}^{m_i} x_j^B + v\sum_{j=a_{i+1}}^{a_T} x_j^B + \sum_{j=b_{i+1}}^{b_T} x_j^B}$, the optimisation problem for the multinational firm may be rewritten

$$\max_{x_m^A \geq 0, x_m^B \geq 0} \; v(\lambda^A x_m^A + \lambda^B x_m^B) - c(x_m^A + x_m^B)$$

Since $\frac{d\lambda^l}{dx_m^l} = -v\frac{(\lambda^l)^2}{S_l}$, $l \in \{A, B\}$, the two FOCs are

$$vx_m^A = \frac{S_A}{\lambda^A}\left(1 - \frac{1}{\lambda^A}\frac{c}{v}\right) \tag{16}$$

$$vx_m^B = \frac{S_B}{\lambda^B}\left(1 - \frac{1}{\lambda^B}\frac{c}{v}\right) \tag{17}$$

An independent A-country firm a, $a = a_{i+1}, a_{i+2}, ..., a_T$, located in country A, sets

x_a^A and x_a^B to solve

$$\max_{x_a^A \geq 0, x_a^B \geq 0} \; p_a^A x_a^A + (p_a^B - t)x_a^B - c(x_a^A + x_a^B)$$

where sales in country B are subject to the unit trade cost. This may be rewritten in terms of the price-to-quality ratios in each market:

$$\max_{x_a^A \geq 0, x_a^B \geq 0} \; v(\lambda^A x_a^A + \lambda^B x_a^B) - c x_a^A - (c+t)x_a^B$$

Since $\frac{d\lambda^l}{dx_a^l} = -v\frac{(\lambda^l)^2}{S_l}$, $l \in \{A, B\}$, the two FOCs are

$$v x_a^A = \frac{S_A}{\lambda^A}\left(1 - \frac{1}{\lambda^A}\frac{c}{v}\right) \tag{18}$$

$$v x_a^B = \frac{S_B}{\lambda^B}\left(1 - \frac{1}{\lambda^B}\frac{c+t}{v}\right) \tag{19}$$

Similarly, an independent B-country firm b, $b = b_{i+1}, b_{i+2}, ..., b_T$, located in country B, solves

$$\max_{x_b^A \geq 0, x_b^B \geq 0} \; (p_b^A - t)x_b^A + p_b^B x_b^B - c(x_b^A + x_b^B)$$

or,

$$\max_{x_b^A \geq 0, x_b^B \geq 0} \lambda^A x_b^A + \lambda^B x_b^B - (c+t)x_b^A - c x_b^B$$

Now $\frac{d\lambda^l}{dx_b^l} = -\frac{(\lambda^l)^2}{S_l}$, $l \in \{A, B\}$, and the two FOCs are

$$x_b^A = \frac{S_A}{\lambda^A}\left(1 - \frac{1}{\lambda^A}(c+t)\right) \tag{20}$$

$$x_b^B = \frac{S_B}{\lambda^B}\left(1 - \frac{1}{\lambda^B}c\right) \tag{21}$$

Adding across all FOCs pertaining to market A (i FOCs (16) for the multinational firms, $T-i$ FOCs (18) for the independent A-country firms and $T-i$ FOCs (20) for the independent B-country firms), we obtain:

$$v\sum_{j=m_1}^{m_i} x_j^A + v\sum_{j=a_{i+1}}^{a_T} x_j^A + \sum_{j=b_{i+1}}^{b_T} x_j^A = \frac{S_A}{\lambda^A}\left(2T - i - \frac{1}{\lambda^A}\left(c\frac{T + (T-i)v}{v} + (T-i)t\right)\right)$$

and, noting that the LHS is simply $\frac{S_A}{\lambda^A}$, we can solve for λ^A:

$$\lambda^A = \frac{1}{2T - (i+1)}\left(\frac{c(T + (T-i)v) + (T-i)tv}{v}\right)$$

Similarly adding across all FOCs pertaining to market B (i FOCs (17), $T-i$ FOCs (19) and $T-i$ FOCs (21), λ^B can be obtained:

$$\lambda^B = \frac{1}{2T-(i+1)}\left(\frac{c(T+(T-i)v)+(T-i)t}{v}\right)$$

Substituting for the price-to-quality ratios in FOCs (16) through (21), sales per firm in each market are obtained:

$$\begin{aligned}
x_m^A &= (2T-(i+1))\,S_A\frac{c((T-i)v-(T-i-1))+(T-i)tv}{\left(c\,(T+(T-i)\,v)+(T-i)tv\right)^2}\\
x_a^A &= x_m^A\\
x_b^A &= (2T-(i+1))\,S_A v\frac{c(T-(T-1)v)-(T-1)tv}{\left(c\,(T+(T-i)\,v)+(T-i)tv\right)^2}\\
x_m^B &= (2T-(i+1))\,S_B\frac{c((T-i)v-(T-i-1))+(T-i)t}{\left(c\,(T+(T-i)\,v)+(T-i)t\right)^2}\\
x_a^B &= (2T-(i+1))\,S_B\frac{c((T-i)v-(T-i-1))-(T-1)t}{\left(c\,(T+(T-i)\,v)+(T-i)t\right)^2}\\
x_b^B &= (2T-(i+1))\,S_B v\frac{c(T-(T-1)v)+(T-i)t}{\left(c\,(T+(T-i)\,v)+(T-i)t\right)^2}
\end{aligned}$$

Non-negativity constraints – ensuring that despite trade costs $t \geq 0$ and quality asymmetries $v \geq 1$, all firms command positive sales in both countries – can be summarised as two parameter restrictions. The "low-enough-quality-gap" restriction follows from requiring that low-quality B-country firms are still able to sell in their home country when imports are most competitive ($\tilde{t} = \frac{t}{c} = 0$): $x_b^B \geq 0 \iff v \leq \frac{T}{T-1} + \frac{T-i}{T-1}\tilde{t}$ which implies $v \leq \frac{T}{T-1}$ when $\tilde{t} = 0$. The "low-enough-trade-cost" restriction ensures that low-quality B-country firms' exports to country A are not priced out of the market: $x_b^A \geq 0 \iff \tilde{t} \leq \frac{T-(T-1)v}{(T-1)v}$. Denote by $\mathcal{P}$ the set of parameter values $(v, \tilde{t})$ satisfying these two conditions[35].

[35] Formally, space $\mathcal{P}$ is defined as $\{(v,\tilde{t}) \in \mathfrak{R}^2 \mid 1 \leq v \leq \frac{T}{T-1} \text{ and } 0 \leq \tilde{t} \leq \frac{T-(T-1)v}{(T-1)v}\}$. Alternatively, $\mathcal{P}$ can be defined by the restrictions $0 \leq \tilde{t} \leq \frac{1}{T-1}$ and $1 \leq v \leq \frac{T}{T-1}\frac{1}{1+\tilde{t}}$.

The reason why I confine the analysis to $\mathcal{P}$ is simplicity. Lifting these parameter restrictions adds little insight: extending the space of parameter values to $\{(v,\tilde{t}) \in \mathfrak{R}^2 \mid v \geq 1 \text{ and } \tilde{t} \geq 0\}$ would enlarge the zone where mergers are always profitable, both along and off the equilibrium path of the game.

Proof of this claim is available from the author, but headway can be made by noting that, say, for the case $T = 3$ considered: (i) independent B-country firms do not command positive sales *even* in their home country, let alone the foreign country, i.e. $x_b^B = x_b^A = 0$, when $v \geq \frac{3}{2} + \frac{3}{2}\tilde{t}$ and $\tilde{t} \geq 0$ under market structure r_0, or when $v \geq \frac{3}{2} + \tilde{t}$ and $\tilde{t} \geq 0$ under r_1, or when $v \geq \frac{3}{2} + \frac{1}{2}\tilde{t}$ and $\tilde{t} \geq 0$ under r_2; (ii) trade is too expensive *even* for A-country firms, let alone for B-country firms, i.e. $x_a^B = x_b^A = 0$, when $1 \leq v \leq \frac{2}{3} + \frac{2}{3}\tilde{t}$ under r_0, or when $1 \leq v \leq \frac{1}{2} + \tilde{t}$ under r_1, or when $1 \leq v \leq 2\tilde{t}$ under r_2. Note that for $\frac{3}{2} + \frac{1}{2}\tilde{t} \leq v \leq 2\tilde{t}$ under r_2, only two (multinational) firms command positive sales in country B, unlike all other parameter combinations and market structures where the number of firms selling into each country is at least three.

Prices are obtained noting that $p_b^l = \lambda^l$, and from equation (15), $p_m^l = p_a^l = v\lambda^l$, $l \in \{A, B\}$. Finally, evaluating the objective functions at these sales and prices, profits per firm in each market are obtained:

$$\begin{array}{ll} \Pi_m^A(r_i) = \left(\frac{(T-i)v-(T-i-1)+(T-i)\tilde{t}v}{T+(T-i)v+(T-i)\tilde{t}v}\right)^2 S_A & \Pi_m^B(r_i) = \left(\frac{(T-i)v-(T-i-1)+(T-i)\tilde{t}}{T+(T-i)v+(T-i)\tilde{t}}\right)^2 S_B \\ \Pi_a^A(r_i) = \Pi_m^A(r_i) & \Pi_a^B(r_i) = \left(\frac{(T-i)v-(T-i-1)-(T-1)\tilde{t}}{T+(T-i)v+(T-i)\tilde{t}}\right)^2 S_B \\ \Pi_b^A(r_i) = \left(\frac{T-(T-1)v-(T-1)\tilde{t}v}{T+(T-i)v+(T-i)\tilde{t}v}\right)^2 S_A & \Pi_b^B(r_i) = \left(\frac{T-(T-1)v+(T-i)\tilde{t}}{T+(T-i)v+(T-i)\tilde{t}}\right)^2 S_B \end{array} \quad (22)$$

The reduced-form profit functions per firm are thus the sum of the profit components in the two markets, e.g. for a multinational firm, $\Pi_m(r_i) = \Pi_m^A(r_i) + \Pi_m^B(r_i)$.

While the derivation above was carried out for "intermediate" market structures where both independent and multinational firms exist, it similarly applies to structures r_0 (where there are no multinational firms) and r_T (where there are no independent firms). It is easy to see that the reduced-form profit functions (22) – as well as the outputs and prices derived above) – also hold where applicable. In other words, $\Pi_m(r_i)$ calculated from (22) holds for $i = 1, 2, ..., T$, while $\Pi_a(r_i)$ and $\Pi_b(r_i)$ hold for $i = 0, 1, ..., T-1$.

For the particular case considered in Example 1, equilibrium payoffs follow simply from plugging $T = 3$ in (22).

A.3 Proof of Proposition 1 (and the equilibria depicted in Figures 3 and 4)

The proof follows from numerical verification of selected combinations of the reduced-form payoffs, based on backward induction of the game's extensive form (Figure 1).

Definition of merger surplus functions To simplify exposition, I define certain "merger surplus" functions Ψ in terms of reduced-form payoffs. For simplicity I omit the functions' arguments v, $\tilde{t}$, S_A and S_B.

Definition 1 *(Merger surplus functions) Define six Ψ functions as follows:*

$$\begin{array}{ll} \Psi_I := \Pi_m(r_1) - \Pi_a(r_0) - \Pi_b(r_0) & \Psi_{IV} := \Pi_m(r_2) - \Pi_a(r_0) - \Pi_b(r_0) \\ \Psi_{II} := \Pi_m(r_2) - \Pi_a(r_1) - \Pi_b(r_1) & \Psi_V := \Pi_m(r_3) - \Pi_a(r_1) - \Pi_b(r_1) \\ \Psi_{III} := \Pi_m(r_3) - \Pi_a(r_2) - \Pi_b(r_2) & \Psi_{VI} := \Pi_m(r_3) - \Pi_a(r_0) - \Pi_b(r_0) \end{array}$$

To illustrate, Ψ_V captures the surplus behind a merger decision which, if favourable, results in a total of three mergers being undertaken in the industry along the equilibrium path of the game (i.e. market structure r_3 results) and, if unfavourable, results in a total of one merger being undertaken (market structure r_1).

Verification of the positive externality of merger on outside independent firms (property (1) of the class of oligopoly models) It is easy to verify that (for $(v, \tilde{t}) \in \mathcal{P}$) $\Pi_a(r_1) + \Pi_b(r_1) \geq \Pi_a(r_0) + \Pi_b(r_0)$ (i.e. outside independent firms gain from a first stand-alone merger). This is equivalent to

$$\Psi_{IV} \geq \Psi_{II} \quad \forall (v, \tilde{t}) \in \mathcal{P} \tag{23}$$

and

$$\Psi_{VI} \geq \Psi_{V} \quad \forall (v, \tilde{t}) \in \mathcal{P} \tag{24}$$

It is also easy to verify that (for $(v, \tilde{t}) \in \mathcal{P}$) $\Pi_a(r_2) + \Pi_b(r_2) \geq \Pi_a(r_1) + \Pi_b(r_1)$ (i.e. outside independent firms gain from a second stand-alone merger). This is equivalent to

$$\Psi_{V} \geq \Psi_{III} \quad \forall (v, \tilde{t}) \in \mathcal{P} \tag{25}$$

Definition of zones 1, 2, 3 and 4 (Figure 3) In view of (23), (24) and (25), each of the four strategy profiles depicted in Figure 3, labelled as zones 1 to 4, can be supported as a subgame-perfect Nash equilibrium of the game if a specific set of conditions based only on the signs of merger surplus functions Ψ_I, Ψ_{II} and Ψ_{III} holds, as follows:

Definition 2 *(Equilibrium support of the strategy profiles of Figure 3) Define zones 1 to 4 as follows:*

Zone 1 $:= \left\{(v, \tilde{t}) \in \mathcal{P} \mid \Psi_I \geq 0,\ \Psi_{II} \geq 0,\ \Psi_{III} \geq 0\right\}$
Zone 2 $:= \left\{(v, \tilde{t}) \in \mathcal{P} \mid \Psi_I < 0,\ \Psi_{II} \geq 0,\ \Psi_{III} \geq 0\right\}$
Zone 3 $:= \left\{(v, \tilde{t}) \in \mathcal{P} \mid \Psi_I < 0,\ \Psi_{II} < 0,\ \Psi_{III} \geq 0\right\}$
Zone 4 $:= \left\{(v, \tilde{t}) \in \mathcal{P} \mid \Psi_I < 0,\ \Psi_{II} < 0,\ \Psi_{III} < 0\right\}$

This follows simply by backward induction. To see this consider, by way of illustration, the strategy profile labelled as zone 2 in Figure 3. This profile can be characterised by the following triple of strategies, one strategy for each of the three pairs of firms deciding, in sequence, whether to merge: (i) Firms a_1 and b_1 (stage 1): 'merge'; (ii) Firms a_2 and b_2 (stage 2): 'merge'; and (iii) Firms a_3 and b_3 (stage 3): 'merge' if at least one of the two earlier pairs of firms has merged, otherwise 'don't merge'. To verify that each of the three strategies is optimal given the strategies of the other players, begin by analysing the subgames hanging from the four stage 3 nodes (right to left). For strategy (iii) to be optimal requires that $\Psi_I < 0$, $\Psi_{II} \geq 0$, $\Psi_{II} \geq 0$ and $\Psi_{III} \geq 0$, which is consistent with the definition of zone 2. Now analyse the subgames hanging from the two stage 2 nodes (right to left). For strategy (ii) to be optimal requires that $\Psi_{IV} \geq 0$ and $\Psi_{III} \geq 0$, which is again consistent with the definition of zone 2, recalling that by

(23) it follows that $\Psi_{IV} \geq \Psi_{II} \geq 0$. Finally, analyse the game hanging from the stage 1 node. For strategy (i) to be optimal requires that $\Psi_{III} \geq 0$, which is again consistent with the definition of zone 2. The definition of zones 1, 3 and 4 follow likewise.

How Ψ_I, Ψ_{II} and Ψ_{III} vary in $\mathcal{P}$ To complete the proof that each of the four, and only the four, strategy profiles depicted in Figure 3 obtain in $\mathcal{P}$ in equilibrium, we must further verify that (i) the corresponding zones 1 through 4 are not empty; and (ii) the three boundaries that separate the four zones, as shown in Figure 4, are downward-sloping, do not cross one another, nor do they cross the locus given by $\tilde{t} = \frac{3-2v}{2v}$ (i.e. the boundary of $\mathcal{P}$ where the "low-enough-trade-cost" restriction binds, i.e. $x_b^A = 0$). We also verify that

$$\forall (v, \tilde{t}) \in \mathcal{P} \text{ such that } \Psi_I \geq 0, \text{ it is also the case that } \Psi_{III} \geq \Psi_{II} \geq \Psi_I \qquad (26)$$

By backward induction, one can readily see that condition (26), combined with conditions (23), (24) and (25), exclude any other strategy profile apart from the four depicted in Figure 3.

With regard to the class of oligopoly models considered in the paper, while (23), (24) and (25) are equivalent to property (1), (26) is equivalent to property (2).

Statements (i) and (ii) (that the four zones are non-empty, and that their boundaries slope downward and do not cross), as well as condition (26), can be verified numerically. In what follows, I provide a way of doing this in a simple stepwise fashion. Notice that each merger surplus function is the sum of profit terms which correspond to country A and profit terms which correspond to country B. Thus write $\Psi_X = \Psi_X^A + \Psi_X^B$, $X \in \{I, II, III\}$, where the respective A-country profit terms are grouped into Ψ_X^A and the the respective B-country profit terms are grouped into Ψ_X^B. To illustrate, it follows that $\Psi_I^A = \Pi_m^A(r_1) - \Pi_a^A(r_0) - \Pi_b^A(r_0) = \left[\left(\frac{2v-1+2\tilde{t}v}{3+2v+2\tilde{t}v} \right)^2 - \frac{\left(3v-2+3\tilde{t}v\right)^2 + \left(3-2v-2\tilde{t}v\right)^2}{9\left(1+v+\tilde{t}v\right)^2} \right] S_A$. Notice also that the corresponding market size S enters multiplicatively in each of these by-country merger surplus functions, since S enters the payoffs (22) multiplicatively.

Begin by considering how Ψ_I^A, Ψ_{II}^A and Ψ_{III}^A vary in $\mathcal{P}$. To simplify, consider a straight line segment going from $(v, \tilde{t}) = (1, 0)$ to any point on $\tilde{t} = \frac{3-2v}{2v}$. By writing this line segment as $\tilde{t} = \rho(v-1)$, where $0 \leq \rho \leq \infty$ and $0 \leq \rho(v-1) \leq \frac{3-2v}{2v}$, changes in v and $\tilde{t}$ along this line segment parameterised by ρ may be referred to simply as changes in v. (For $\rho = 0$ the line segment lies on the v-axis; for $\rho \to \infty$ the line segment lies on the $\tilde{t}$-axis.) We wish to determine how Ψ_I^A, Ψ_{II}^A and Ψ_{III}^A change as we increase v along line segment ρ (i.e. jointly increasing $\tilde{t}$ such that $\tilde{t} = \rho(v-1)$) from the lower end $v = 1$ (i.e. $(v, \tilde{t}) = (1, 0)$) to the upper end defined implicitly by $\rho(v-1) = \frac{3-2v}{2v}$ (label this value $v = \bar{v}$; formally this label should carry the parameter ρ, omitted for simplicity). At the lower end of the line segment, when $v = 1$, all three functions are negative[36]. At the upper endpoint of the line segment, when $v = \bar{v}$, all three functions are equal to zero[37]. Now, starting at $v = 1$ and increasing v along the line segment, Ψ_I^A, Ψ_{II}^A and Ψ_{III}^A each increase continuously from negative values toward positive values, reaching a maximum, then decreasing continuously toward zero when $v = \bar{v}$. Label the lowest value of v at which Ψ_I^A is zero as v_A', the lowest value of v at which Ψ_{II}^A is zero as v_A'', and the lowest value of v at which Ψ_{III}^A is zero as v_A''' (again the labels omit the reference to ρ for simplicity). One can verify that $1 < v_A''' < v_A'' < v_A' < \bar{v}$. It may also be verified that, in addition to intersecting at $v = \bar{v}$, Ψ_{II}^A and Ψ_I^A cross as they slope upwards at a point, labelled $v_A^{\prime\prime-\prime}$, which lies between 1 and v_A''. In other words, $\Psi_{II}^A = \Psi_I^A$ at $v = v_A^{\prime\prime-\prime}$, where $1 < v_A^{\prime\prime-\prime} < v_A''$. To the right of this point, for v such that $v_A^{\prime\prime-\prime} < v < \bar{v}$, one verifies that $\Psi_{II}^A > \Psi_I^A$, whereas to its left, for v such that $1 \leq v < v_A^{\prime\prime-\prime}$, one verifies that $\Psi_{II}^A < \Psi_I^A$. Since $1 < v_A^{\prime\prime-\prime} < v_A'' < v_A' < \bar{v}$ along any line segment parameterised by ρ, $0 \leq \rho \leq \infty$, the following result holds:

$$\forall (v, \tilde{t}) \in \mathcal{P} \text{ such that } \Psi_I^A \geq 0, \text{ it is also the case that } \Psi_{II}^A \geq \Psi_I^A \tag{27}$$

It can further be verified that $\Psi_{III}^A > \Psi_{II}^A$ for v such that $1 \leq v < \bar{v}$ (recall that $\Psi_{III}^A = \Psi_{II}^A$ when $v = \bar{v}$) and thus

$$\forall\ (v, \tilde{t}) \in \mathcal{P},\ \Psi_{III}^A \geq \Psi_{II}^A \tag{28}$$

Turning now to the merger surplus terms in market B, similar results come through, with one exception: the values of the functions Ψ_I^B, Ψ_{II}^B and Ψ_{III}^B do not necessarily fall to zero for *all* $(v, \tilde{t})$ along the border of $\mathcal{P}$ for which the "low-enough-trade-cost" restriction binds[38]. Now, starting at $v = 1$ and increasing v along any line segment parameterised by ρ, Ψ_I^B, Ψ_{II}^B and Ψ_{III}^B each increase continuously from negative values toward positive values (to then possibly reach a maximum and return in the direction of zero). Similar to before, labelling the lower and possibly only value of v at which Ψ_I^B (Ψ_{II}^B, Ψ_{III}^B) is zero as v_B' (v_B'', v_B''' respectively), one verifies that $1 < v_B''' < v_B'' < v_B' < \bar{v}$.

[36] Intuitively, at low v and $\tilde{t}$, the output expansion of outside firms is so high as to render any stand-alone merger unprofitable.

[37] Intuitively, since $x_b^A = 0$, there is no surplus to be enjoyed on sales in country A from cross-border mergers when B-country firms' exports to country A are (just) priced out of the market. Prior to any merger, there are three firms offering quality v commanding positive sales in country A; after a merger, this is unchanged.

[38] Intuitively, and unlike in country A, for parameters along $\tilde{t} = \frac{3-2v}{2v}$ B-country firms still command positive sales in their home country and hence there is surplus from merger to be made on sales in country B. The surplus functions are equal to zero only when (i) $(v, \tilde{t}) = (\frac{3}{2}, 0)$, since here imports are at their most competitive and thus B-country firms command zero sales in their home country, as they do abroad; and (ii) when $(v, \tilde{t}) = (1, \frac{1}{2})$, since here quality is symmetric and markets are effectively autarkic: a cross-border merger does not change the (effective) number of competitors in each market.

Similar to their country A counterparts, Ψ_{II}^B and Ψ_I^B cross as they slope upwards at a point, labelled $v_B^{''-'}$, which lies between 1 and v_B''. To the right of this point, for v such that $v_B^{''-'} < v < \bar{v}$, one verifies that $\Psi_{II}^B > \Psi_I^B$, whereas to its left, for $1 \leq v < v_B^{''-'}$, one verifies that $\Psi_{II}^B < \Psi_I^B$. Since $1 < v_B^{''-'} < v_B'' < v_B' < \bar{v}$ along any line segment parameterised by ρ, $0 \leq \rho \leq \infty$, a result analogous to (27) holds:

$$\forall (v, \tilde{t}) \in \mathcal{P} \text{ such that } \Psi_I^B \geq 0, \text{ it is also the case that } \Psi_{II}^B \geq \Psi_I^B \tag{29}$$

It can further be verified that $\Psi_{III}^B > \Psi_{II}^B$ for v such that $1 \leq v < \bar{v}$ (recall that $\Psi_{III}^B \geq \Psi_{II}^B$ when $v = \bar{v}$) and thus

$$\forall\ (v, \tilde{t}) \in \mathcal{P},\ \Psi_{III}^B \geq \Psi_{II}^B \tag{30}$$

We must now combine the by-country merger surplus functions. It may be verified that $v_B''' \leq v_A''' < v_B'' \leq v_A''$ along any line segment parameterised by ρ. From this, it follows that, starting at $v = 1$ and increasing v along line segment ρ, the function $\Psi_{III} = \Psi_{III}^A + \Psi_{III}^B$ turns positive before the function $\Psi_{II} = \Psi_{II}^A + \Psi_{II}^B$ does so too, i.e. the root of Ψ_{III}, denoted v''', which lies in between v_B''' and v_A''' (depending on the slopes of Ψ_{III}^B and Ψ_{III}^A, and the market sizes S_A and S_B), is lower than the root of Ψ_{II}, denoted v'', which lies in between v_B'' and v_A''. Thus we have that along any line segment parameterised by ρ, $0 \leq \rho \leq \infty$,

$$1 < v''' < v'' < \bar{v} \tag{31}$$

(This result also follows from (28), $1 < v_A''' < v_A'' < \bar{v}$, (30), and $1 < v_B''' < v_B'' < \bar{v}$.) It may also be verified that along any line segment parameterised by ρ, $v_A^{''-'} < v_B''$ and $v_B^{''-'} < v_B''$. (Recall that for v such that $v_A^{''-'} < v < \bar{v}$, we have $\Psi_{II}^A > \Psi_I^A$, and for v such that $v_B^{''-'} < v < \bar{v}$, we have $\Psi_{II}^B > \Psi_I^B$.) Combined with $v_B'' \leq v_A''$ as noted earlier, this implies that for v such that $v'' \leq v < \bar{v}$, it will be the case that $\Psi_{II} = \Psi_{II}^A + \Psi_{II}^B > \Psi_I = \Psi_I^A + \Psi_I^B$. From this, it follows that, starting at $v = 1$ and increasing v along line segment ρ, the function Ψ_{II} turns positive before the function Ψ_I does so too, i.e. the root of Ψ_{II}, defined above as v'', is lower than the root of Ψ_I, denoted v', which lies in between v_B' and v_A'. Thus we have that along any line segment parameterised by ρ, $0 \leq \rho \leq \infty$,

$$1 < v'' < v' < \bar{v} \tag{32}$$

(31) and (32) combine to prove that zones 1 through 4 are not empty, noting that the boundary between zone 4 and zone 3 is defined by v''', the boundary between zone 3 and zone 2 is defined by v'', and the boundary between zone 2 and zone 1 is defined by v'. They also demonstrate that as the parameter of the straight line segment ρ spans $0 \leq \rho \leq \infty$, these boundaries do not cross one another nor do they cross the boundary of $\mathcal{P}$ where the "low-enough-trade-cost" restriction binds.

Finally, it may be verified that v_A''', v_A'', v_A', v_B''', v_B'', v_B' and $\bar{v}$ are all decreasing in the line segment parameter ρ, as this increases from 0 (line segment lies on top of the v-axis) to ∞ (line segment lies on top of the $\tilde{t}$-axis). It then follows that the three boundaries that separate the four zones are downward-sloping, completing the proof. *Q.E.D.*

A.4 Proof of Proposition 2

I consider the equilibrium in each of zones 1, 2 and 3 of parameter space $\mathcal{P}$ in turn, starting from a fixed cost G associated with implementing a cross-border merger equal to zero (equilibria as in Figures 3 and 4, in the absence of fixed costs). I analyse how these equilibria change as G increases from zero. Clearly, the introduction of a fixed cost does not change the equilibrium in zone 4: if no cross-border merger is profitable when $G = 0$, this remains the case when $G > 0$.

Notice that the fixed cost G of implementing a merger changes the conditions for any merger to be profitable: whereas in the absence of the fixed cost this was given by $\Psi_X \geq 0$, for $X \in \{I, II, III, IV, V, VI\}$, where X represents the relevant merger surplus function, the introduction of the fixed cost changes this condition to $\Psi_X - G \geq 0$. I now introduce the notation $\mathbf{m}_i$ and $\overline{\mathbf{m}_i}$, $i \in \{1, 2\}$, to denote, respectively, a favourable and an unfavourable merger decision in the first and second merger stages.

I begin with $(v, \tilde{t})$ in zone 1. From Definition 2 and (26) – or, equivalently, property (2) – in this zone $\Psi_{III} \geq \Psi_{II} \geq \Psi_I \geq 0$. For:

1. $G \leq \Psi_I$: the equilibrium (solved-out game tree) replicates the equilibrium for zone 1 in the absence of fixed costs (Figure 3), where firms choose to merge from all nodes in the game tree.

2. $\Psi_I < G \leq \Psi_{II}$: we have that $\Psi_I - G < 0$ and thus firms a_3 and b_3 will now choose not to merge conditional on $\overline{\mathbf{m}_1}$ and $\overline{\mathbf{m}_2}$. By $\Psi_{II} - G \geq 0$, $\Psi_{III} \geq \Psi_{II}$ and – from (23) – $\Psi_{IV} \geq \Psi_{II}$, firms continue choosing to merge from all other nodes in the game tree. For this range of values of G, the equilibrium then replicates the equilibrium for zone 2 in the absence of fixed costs (Figure 3).

3. $\Psi_{II} < G \leq \Psi_{III}$: $\Psi_{II} - G < 0$ implies that firms a_3 and b_3 will now choose not to merge conditional on either $\mathbf{m}_1$ and $\overline{\mathbf{m}_2}$, or $\overline{\mathbf{m}_1}$ and $\mathbf{m}_2$. Since $\Psi_I - G < 0$, firms a_3 and b_3 will still choose not to merge conditional on $\overline{\mathbf{m}_1}$ and $\overline{\mathbf{m}_2}$, and firms a_2 and b_2 will now choose not to merge conditional on $\overline{\mathbf{m}_1}$. By $\Psi_{III} - G \geq 0$ and – from (25) and (24) – $\Psi_V \geq \Psi_{III}$ and $\Psi_{VI} \geq \Psi_{III}$, firms continue choosing to merge from all other nodes in the game tree. For this range of values of G, the equilibrium then replicates the equilibrium for zone 3 in the absence of fixed costs (Figure 3).

4. $G > \Psi_{III}$: firms a_3 and b_3 will now choose not to merge conditional on $\mathbf{m}_1$ and $\mathbf{m}_2$. Since $\Psi_{II} - G < 0$, firms a_3 and b_3 will still choose not to merge conditional on either $\mathbf{m}_1$ and $\overline{\mathbf{m}_2}$, or $\overline{\mathbf{m}_1}$ and $\mathbf{m}_2$, and firms a_2 and b_2 will now choose not to merge conditional on $\mathbf{m}_1$. Since $\Psi_I - G < 0$, firms a_3 and b_3 will still choose not to merge conditional on $\overline{\mathbf{m}_1}$ and $\overline{\mathbf{m}_2}$, firms a_2 and b_2 will still choose not to merge conditional on $\overline{\mathbf{m}_1}$, and firms a_1 and b_1 will now choose not to merge. For this range of values of G, along the equilibrium path no mergers occur and the equilibrium then replicates the equilibrium for zone 4 in the absence of fixed costs (Figure 3).

The proofs of the equilibria for $(v, \tilde{t})$ in zones 2 and 3 follow from that of zone 1. In zone 2, by definition, $\Psi_I < 0 \leq \Psi_{II}$, and only the equilibria for zones 2, 3 and 4 in the absence of fixed costs can be replicated as G increases from zero, as analysed for zone 1. In zone 3, by definition, $\Psi_{III} \geq 0$ and $\Psi_I, \Psi_{II} < 0$, and only the equilibria for zones 3 and 4 in the absence of fixed costs can be replicated as G increases from zero, as analysed for zone 1. *Q.E.D.*

B Appendix: A fixed-stock-of-capital oligopoly

Derivation of the reduced-form profit functions Coming out of the (two) merger stages, there are three possible market structures: (i) r_0, where no cross-border merger is undertaken; (ii) r_1, where one merger decision is favourable but the other is not; and (iii) r_2, where both mergers take place. I now derive the reduced-form profit functions under each.

(i) Under r_0, independent A-country firm a, $a = a_1, a_2$, owning capital stock k, sets quantity in each country A and B, respectively x_a^A and x_a^B, to solve

$$\max_{x_a^A \geq 0, x_a^B \geq 0} P^A(X^A)x_a^A + \left(P^B(X^B) - t\right) x_a^B - C(x_a^A + x_a^B, k)$$

where its exports to country B are subject to the unit trade cost t. Given the functional forms specified earlier for the inverse demand functions and the cost function, the FOCs may be written:

$$a - X^A - x_a^A - \left(d + \frac{e}{k}(x_a^A + x_a^B)\right) = 0 \tag{33}$$

$$a - X^B - t - x_a^B - \left(d + \frac{e}{k}(x_a^A + x_a^B)\right) = 0 \tag{34}$$

The FOCs for the independent B-country firms $b = b_1, b_2$ can be similarly written, adjusting for the trade cost being incurred on exports to country A. Solving the system of FOCs, and recalling $\tilde{e} = \frac{e}{k}$ (the rate of change of marginal cost) and $\tilde{t} = \frac{t}{a-d}$ (the normalised trade cost), one obtains $X^A = X^B = \frac{(a-d)(4-2\tilde{t})}{5+2\tilde{e}}$. From FOCs (33) and (34), it follows that $\left|x_i^A - x_i^B\right| = t$ (firm i's sales in its home market exceed its foreign-market sales by t, where $i = a_1, a_2, b_1, b_2$) and each firm's foreign-market sales are $x_a^B = x_b^A = \frac{(a-d)\left(1-\tilde{t}(3+\tilde{e})\right)}{5+2\tilde{e}}$. Clearly, for trade between countries to be feasible, the parameter restriction $\tilde{t} \leq \frac{1}{3+\tilde{e}}$ must be satisfied. Denote by $\mathcal{P}$ the set of parameter values $(\tilde{e}, \tilde{t})$ satisfying this non-negativity constraint, in addition to satisfying conditions $\tilde{e} \geq 0$ and $\tilde{t} \geq 0$. Equilibrium prices in both countries are $p^A = p^B = \frac{a(1+2\tilde{e})+4d+2t}{5+2\tilde{e}}$. The reduced-form profit function follows from evaluating each firm's objective function:

$$\Pi_a(r_0) = \Pi_b(r_0) = \frac{(a-d)^2}{(5+2\tilde{e})^2}\left(2(1+\tilde{e})(1-\tilde{t}) + \frac{\tilde{t}^2}{2}(2+\tilde{e})(13+4\tilde{e})\right) - gk$$

(ii) Under r_1, each of the two independent firms a and b solves the same problem as in (i) (i.e. FOCs given by (33) and (34)). The multinational firm m, formed from the merger of an independent A-country firm and an independent B-country firm, owns capital stock $2k$ and is twice as "large" as either of its independent rivals. Clearly, given the unit trade cost $t \geq 0$ and the cost function $C(x_m^A + x_m^B, 2k)$, it will no longer trade between countries, supplying each country through domestic production; it solves

$$\max_{x_m^A \geq 0, x_m^B \geq 0} P^A(X^A)x_m^A + P^B(X^B)x_m^B - C(x_m^A + x_m^B, 2k)$$

The FOCs become

$$a - X^A - x_m^A - \left(d + \frac{e}{2k}(x_m^A + x_m^B)\right) = 0 \tag{35}$$

$$a - X^B - x_m^B - \left(d + \frac{e}{2k}(x_m^A + x_m^B)\right) = 0 \tag{36}$$

Solving the system of FOCs, one obtains aggregate sales in each country, $X^A = X^B = \frac{(a-d)(3+4\tilde{e})-\tilde{t}(1+\tilde{e})}{4+7\tilde{e}+2\tilde{e}^2}$. The multinational firm's sales in each country are $x_m^A = x_m^B = \frac{(a-d)(1+2\tilde{e})+\tilde{t}}{4+7\tilde{e}+2\tilde{e}^2}$. Independent firms' home-market sales exceed foreign-market sales by t, i.e. $\left|x_i^A - x_i^B\right| = t$, $i \in \{a, b\}$, where foreign-market sales $x_a^B = x_b^A = \frac{(a-d)(1+\tilde{e})\left(1-\tilde{t}(3+\tilde{e})\right)}{4+7\tilde{e}+2\tilde{e}^2}$. Equilibrium prices are $p^A = p^B = \frac{a(1+\tilde{e})(1+2\tilde{e})+d(3+4\tilde{e})+t(1+\tilde{e})}{4+7\tilde{e}+2\tilde{e}^2}$. Finally, the reduced-form profit functions are given by:

$$\Pi_m(r_1) = \frac{(a-d)^2}{(4+7\tilde{e}+2\tilde{e}^2)^2}\left((1+2\tilde{e})^2(2+\tilde{e}) + 2\tilde{t}(1+2\tilde{e})(2+\tilde{e}) + \tilde{t}^2(2+\tilde{e})\right) - 2gk$$

$$\begin{aligned}\Pi_a(r_1) &= \Pi_b(r_1) \\ &= \frac{(a-d)^2}{(4+7\tilde{e}+2\tilde{e}^2)^2} \times \\ &\quad \times \left(2(1+\tilde{e})^3 - 2\tilde{t}(1+\tilde{e})^2(2+\tilde{e}) + \tilde{t}^2(10+32\tilde{e}+35\tilde{e}^2+\frac{29}{2}\tilde{e}^3+2\tilde{e}^4)\right) - gk\end{aligned}$$

(iii) Under r_2, there are no shipments across countries, each multinational firm m, $m = m_1, m_2$, solving the same problem as in (ii) (i.e. FOCs given by (35) and (36)). Equilibrium sales in each country are $X^A = X^B = \frac{2(a-d)}{3+\tilde{e}}$, while $x_m^A = x_m^B = \frac{a-d}{3+\tilde{e}}$; prices are $p^A = p^B = \frac{a(1+\tilde{e})+2d}{3+\tilde{e}}$. The reduced-form profit function for each multinational firm is

$$\Pi_m(r_2) = \frac{(a-d)^2(2+\tilde{e})}{(3+\tilde{e})^2} - 2gk$$

Proof of Proposition 3 Proof of Proposition 3 (in addition to proof of the equilibria depicted in Figure 6 and that properties (1) and (2) hold) proceeds by numerical verification, in analogous fashion to that of Proposition 1 above. Given that there are only two merger stages, only merger surplus functions Ψ_I, Ψ_{II} and Ψ_{IV} as defined above need to be computed. Of note, while the reduced-form payoffs are a function of parameters $(a-d)$, gk, $\tilde{e}$ and $\tilde{t}$, the relative magnitude (and sign) of the merger surplus functions – on which the proofs rest – depend only on $\tilde{e}$ and $\tilde{t}$. (To see this, notice that fixed costs gk enter the payoffs additively and thus cancel out, while the square of the intercept term $(a-d)^2$ enters the payoffs – net of the fixed costs – multiplicatively.)

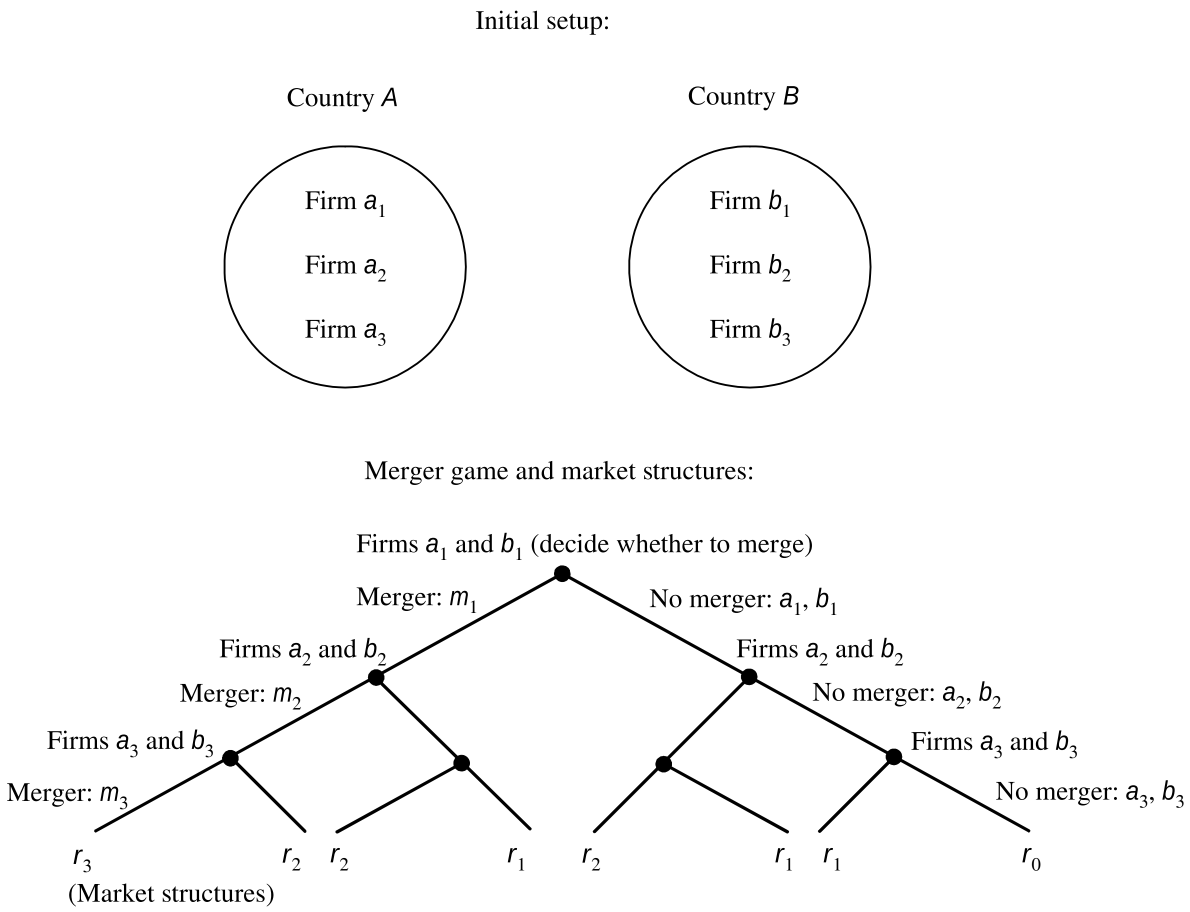


Figure 1: Sequential cross-border merger game with three merger stages. From each node of the merger game tree, left depicts 'merger', right depicts 'no merger'

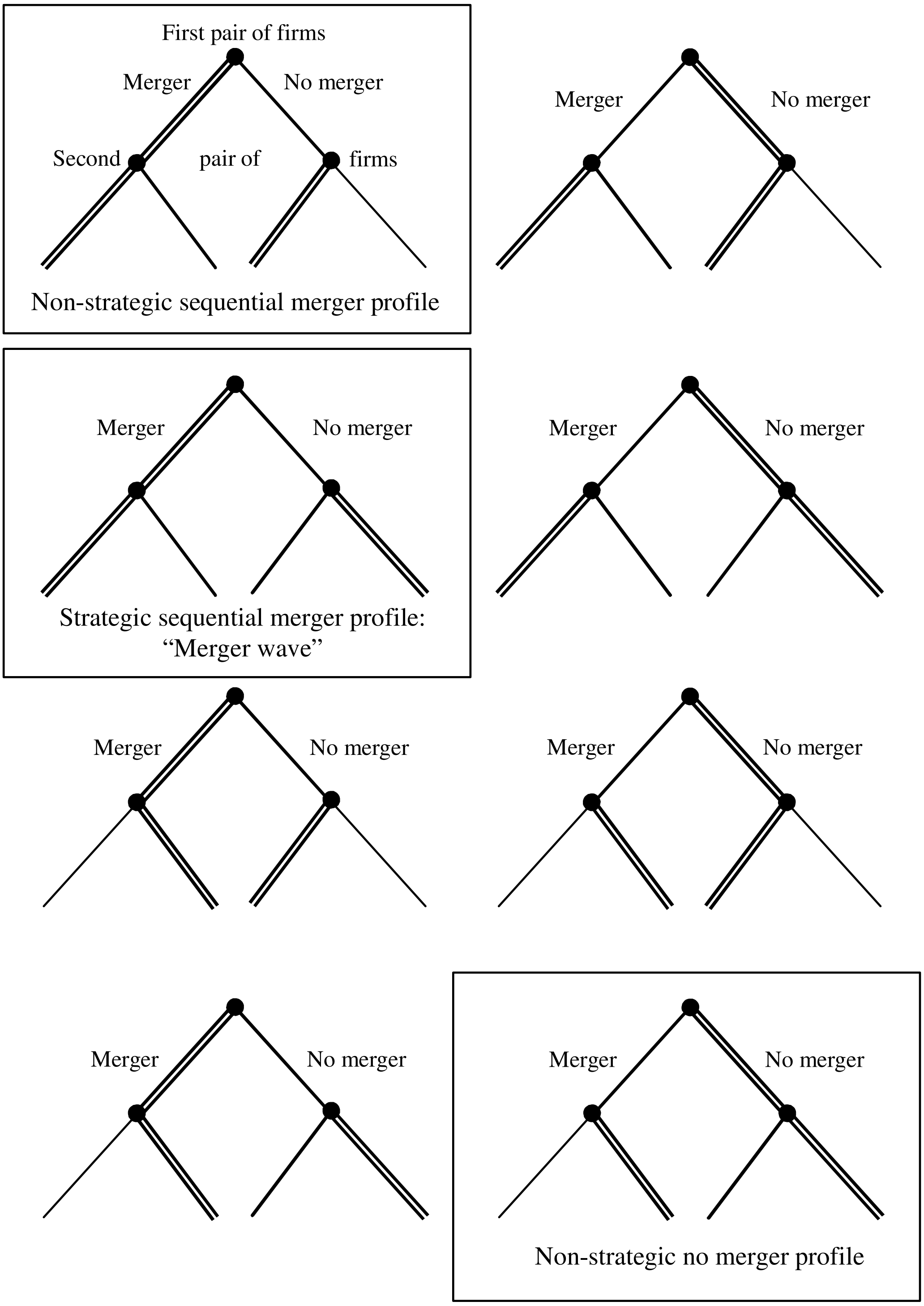


Figure 2: The “all-or-none” merger result, yielding bounds for the case where there are two merger stages. From each node, left depicts ‘merger’ and right depicts ‘no merger’. Only the highlighted strategy profiles can be supported as SPNE when the oligopoly model satisfies conditions (1) and (2).

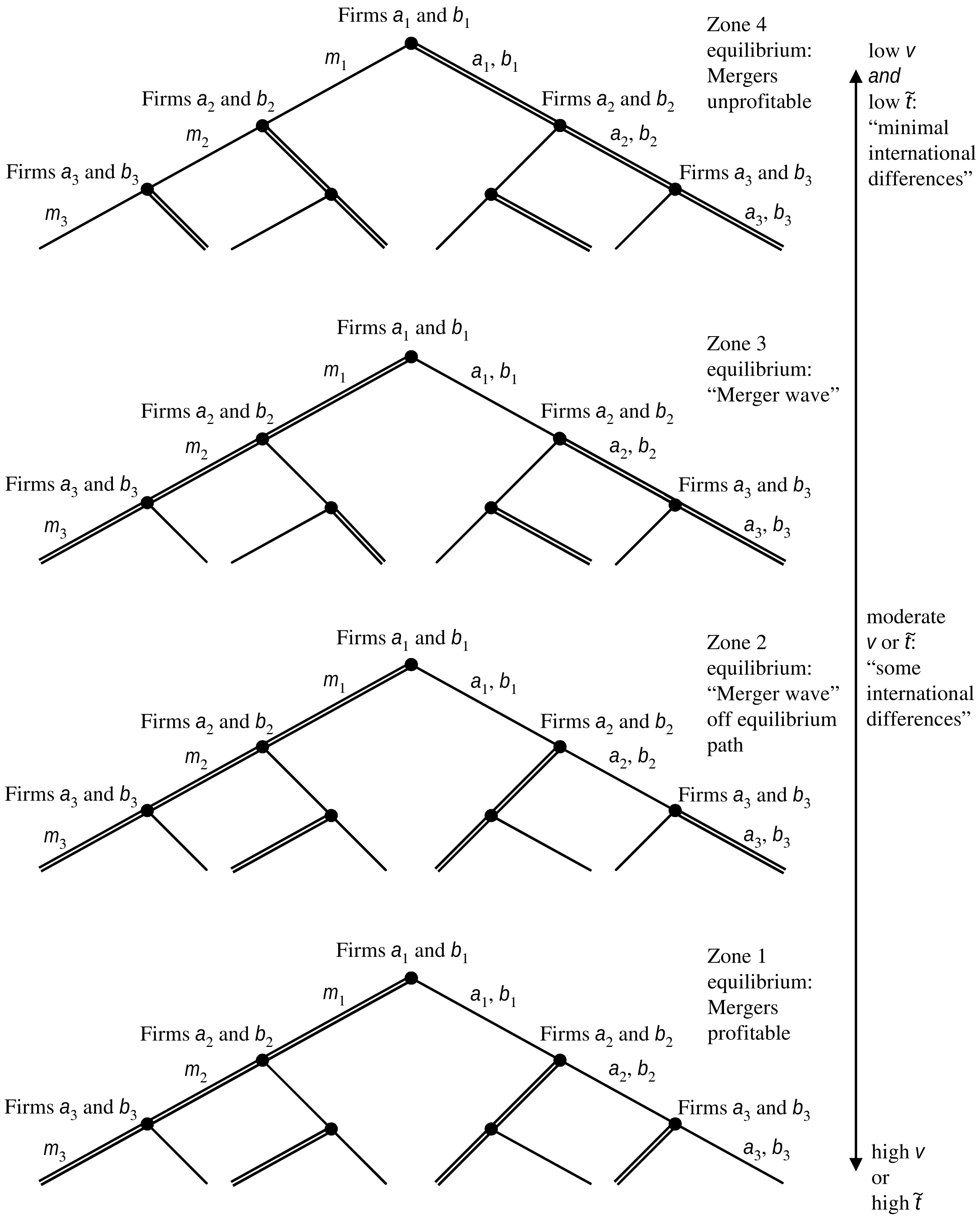


Figure 3: Equilibrium of the sequential cross-border merger game in each zone in the vertically-differentiated oligopoly (in the absence of fixed costs of merger); v quality gap, $\tilde{t}$ (normalised) trade cost

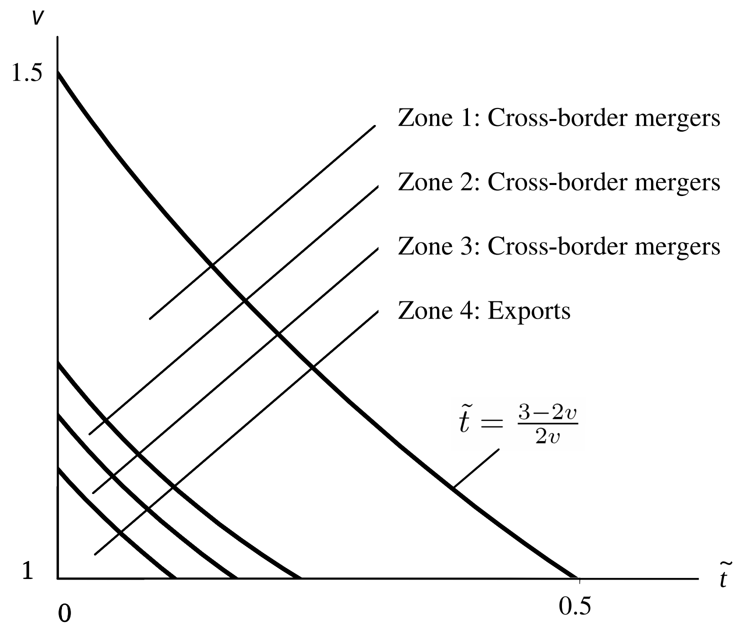


Figure 4: Zones in the space of parameters in the vertically-differentiated oligopoly

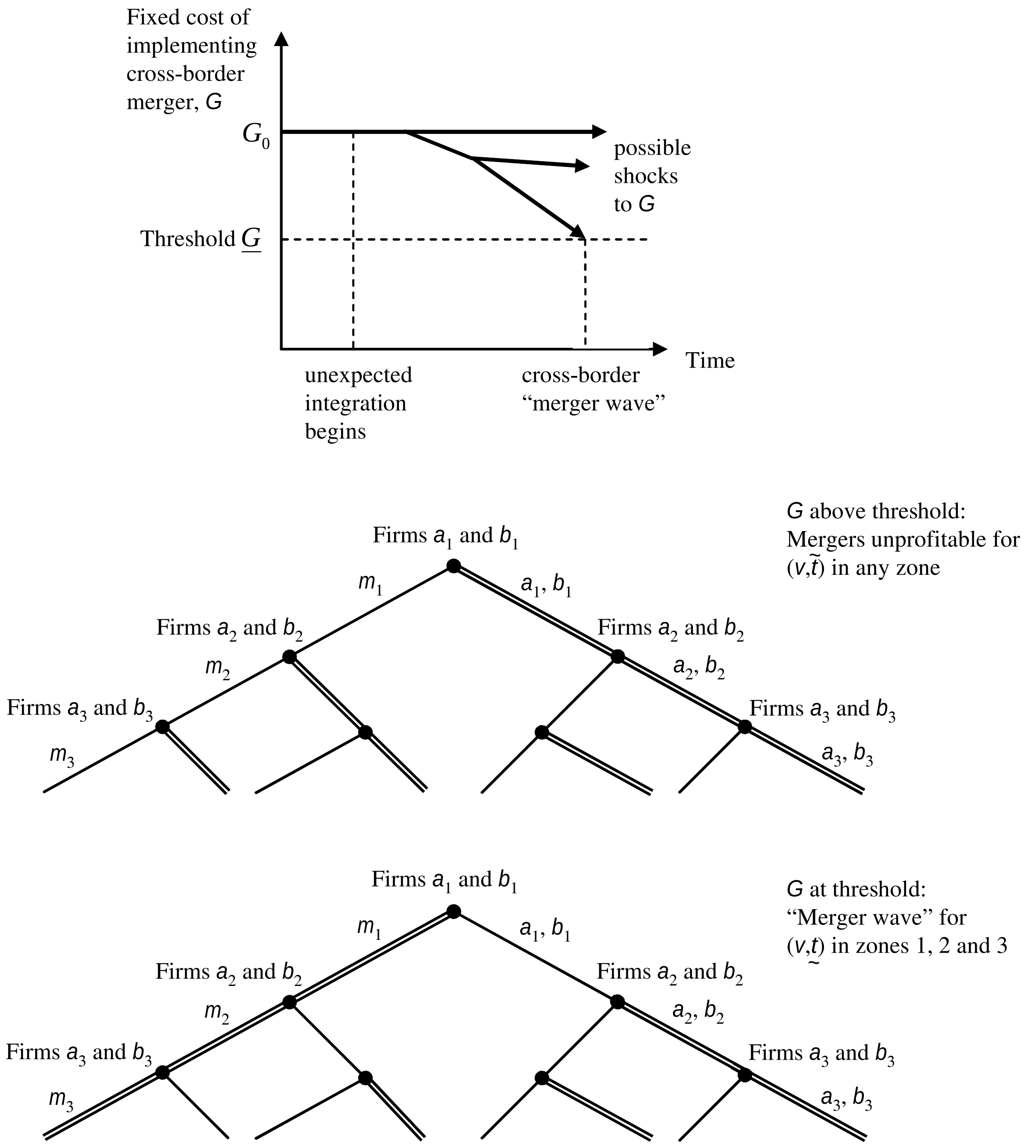
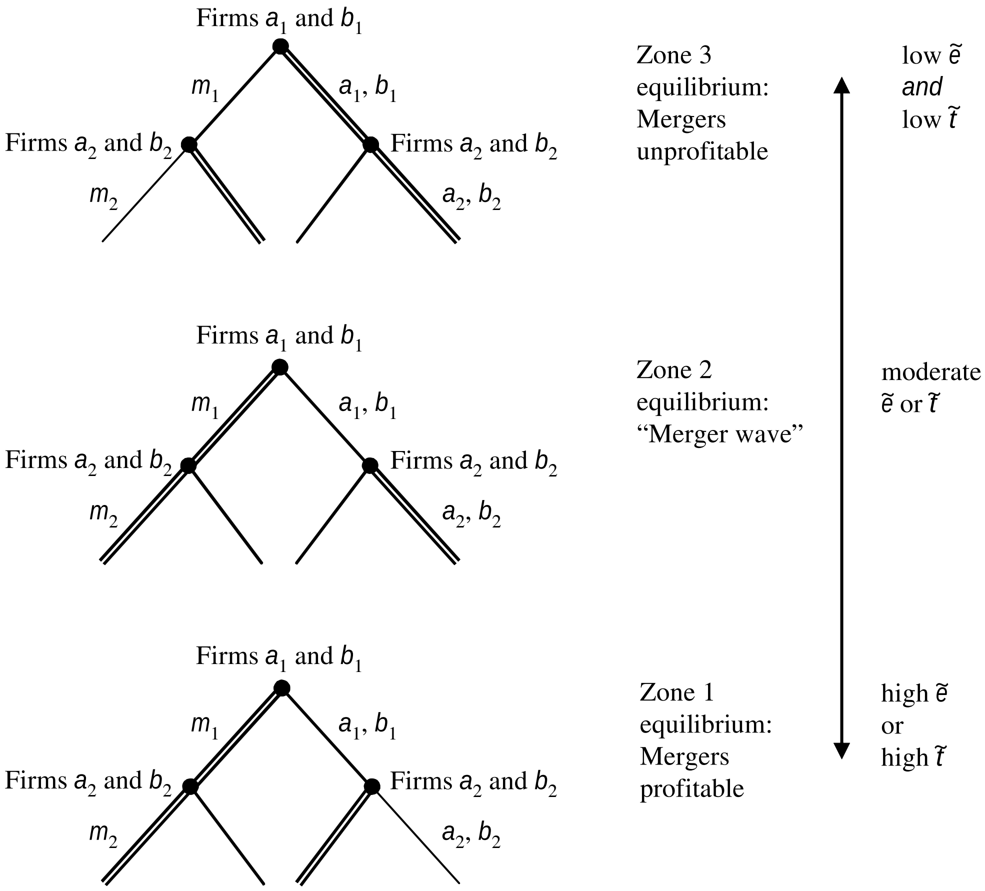


Figure 5: Investment integration and cross-border mergers in the vertically-differentiated oligopoly; G fixed cost of implementing cross-border merger



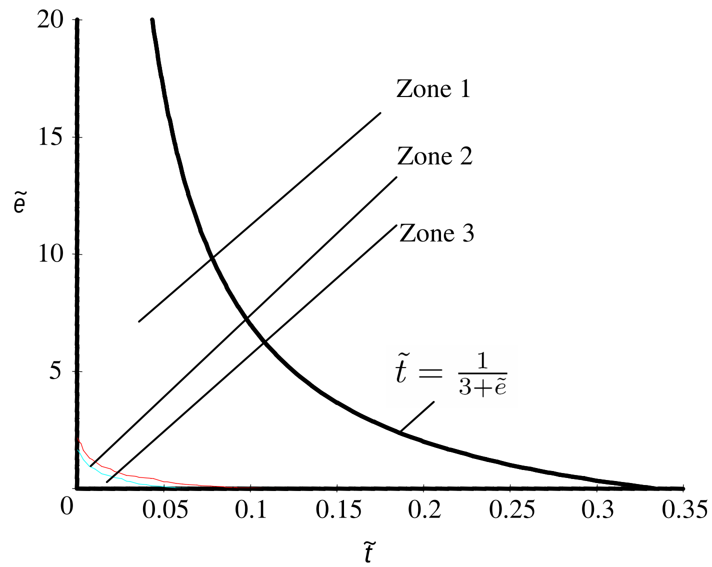


Figure 6: Equilibrium of the sequential cross-border merger game (with two merger stages) in each zone of the space of parameters in the fixed-stock-of-capital oligopoly (in the absence of fixed costs of merger); $\tilde{e}$ rate of change of marginal cost, $\tilde{t}$ (normalised) trade cost