ABSTRACT

In this paper, whether markets are integrated or segmented is endogenous and is determined by the interaction of demand parameters, tariffs, transportation costs, and arbitrage. Given certain restrictions, it is shown, in equilibrium, that policy makers choose tariffs to segment markets. The effects of trade liberalization (reducing all tariffs to zero) in an endogenous market structure framework are determined and compared to the existing literature. The results differ substantially highlighting the importance of explicitly modelling costly arbitrage in imperfectly competitive models.

JEL Classification: F12, F15

Keywords: Integrated Markets, Segmented Markets, Trade Liberalization

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1. Introduction

Since the early 1980's, the distinction between integrated markets, Markussen (1981), and segmented markets, Brandt (1981), has been fundamental to the understanding of trade and trade policy in the presence of imperfect competition. However, it is the contention of this paper that what is meant by integrated and segmented markets and the conditions under which one or the other may arise is problematic.

According to Helpman (1984), the international market for a commodity is integrated if firms face the world demand curve for the commodity and the commodity is sold for the same price in all countries, whereas the international market for a commodity is segmented if firms face distinct country-specific demand curves and make separate profit maximising decisions in each country. Under the segmented markets assumption there is no presumption that prices are the same in all countries so that arbitrage opportunities exist. These arbitrage opportunities must be ruled out if firms are to truly make separate profit maximising decisions in each country and this is usually achieved by assuming the presence of transport or other trade costs. The main contribution of this paper is to model this assumption explicitly and discover its implications.

Trade costs can make arbitrage unprofitable and play a crucial role in determining whether markets are integrated or segmented. If the equilibrium prices that result from firms making separate profit maximisation decisions in each market differ by less than trade costs, then these prices can be sustained as an equilibrium and markets are segmented. On the other hand, if these prices differ by more than trade costs, then arbitrage opportunities exist and these prices cannot be sustained as an equilibrium. In the latter case, markets are integrated (interdependent) and the price differential between markets is reduced until all arbitrage opportunities are exhausted. This occurs when the price differential between markets equals the trade costs. Whether markets are integrated or segmented is endogenous and depends on the interaction between firms' profit maximisation decisions, arbitrage, and trade costs.

Although this seems obvious, the literature has not fully appreciated the point and continues to assume one market structure or the other, European Commission (1988), Haaland and Wooten (1992), Markussen and Venables (1988), Smith and Venables (1988), Venables (1990a), Venables (1990b) expresses concern about assuming one market structure or the other and addresses the issue to some extent by modelling capacity decisions as decisions made in integrated or worldwide markets while modelling output or price decisions as decisions made in integrated or segmented markets. However, once again whether markets are integrated or segmented is assumed rather than modelled.

In this paper, whether markets are integrated or segmented is endogenous and determined by the interaction of firms' profit maximisation decisions, arbitrage, and trade costs. The model has two stages. In the first stage, policy makers in each of two countries, home and foreign, choose tariffs to maximise welfare. In the second stage, two Cournot competitors, one located in each country, choose sales in each market to maximise profits subject to an arbitrage constraint. The arbitrage constraint ensures that the price differential between the two markets must not exceed trade costs (the sum of transportation costs and import tariffs). When the arbitrage constraint binds, markets are integrated and firms' profit maximisation decisions in one market have implications for decisions in the other market; when it does not bind, markets are segmented and firms' make independent profit maximisation decisions in each market.

It is assumed that marginal costs are constant and equal in both countries and that per-unit transportation costs are identical in each country. In addition, demand is assumed to be linear in each country with demand being greater in the home country. This latter assumption makes the problem interesting as it introduces the possibility that the arbitrage constraint might bind.

Given these assumptions, it is found that the policy makers' choice of tariffs determines whether markets are integrated or segmented in the second stage of the game. Tariffs tend to increase trade costs by more than they increase prices, so higher tariffs relax the arbitrage constraint and lead to markets being segmented. Assuming that home demand is not much greater than foreign demand, it is shown that the iterated dominant

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1 This point is made by Venables (1990a) and Ben Zekiel and Helpman (1992).
2 Ben Zekiel and Helpman (1992) assume that international markets are segmented (arbitrage is ruled out by assumption) and find in a price setting model that equilibrium prices do not differ by more than transportation costs. Therefore, even if arbitrage was not ruled out by assumption, in equilibrium, there are no arbitrage profits. That is, in equilibrium, firms make independent profit maximisation decisions in each market. This does not imply this result as an indication that the markets are segmented. It is not clear that Zekiel and Helpman would argue, for whom the result they state on p49 that "The lowest level of price competition is being about price integration across markets despite the existence of an arbitrage equilibrium of separate markets,"
strategy equilibrium of the first stage tariff game involves each country choosing the usual optimal segmented markets tariffs. The choice of these tariffs does in fact lead to market segmentation. Therefore, in equilibrium, the policy makers choose to segment the two markets. This results contrasts with Horn and Shy (1996) where, in equilibrium, it is not policy makers, but firms that choose to segment their markets by bundling non-tradeable services with tradeable products. As in this paper, in Horn and Shy, market structure is determined endogenously by the interaction of firms' maximisation decisions and costly arbitrage; though, to the author, the use of transportation costs to limit arbitrage possibilities is a simpler and more transparent device than the bundling of non-tradeable services with tradeable products.

To dispel the idea that assuming a particular market structure, rather than having it being endogenously determined, is just a simplification with no significant implications, economic integration is analysed in the endogenous market structure framework of this paper and the results are compared with the existing literature. Economic integration is chosen because it is an area in which endogenous assumptions about market structure permeate the literature. Markets are either assumed to be segmented or integrated and economic integration takes the form of reductions in trade costs, Venables (1990a), or economic integration is modelled as a movement from a segmented markets equilibrium to an integrated markets equilibrium, European Commission (1990), Haaland and Wootten (1992), and Venables (1990a). In this paper, economic integration is modelled as a reduction of all import tariffs to zero. Market structure then endogenously responds to this reduction in trade costs. To avoid confusion between the terms economic integration and integrated market a reduction in all import tariffs will be referred to as trade liberalisation.

Assuming that home demand is not too much greater than foreign demand pre-liberalisation, the markets are segmented. Post-liberalisation, two cases are considered. The first is where zero tariffs lead in equilibrium to the markets being integrated and the second is where zero tariffs lead in equilibrium to the markets being segmented. In the first case, it is shown that the foreign country unambiguously gains from trade liberalisation. By assumption, the home market is larger than the foreign market and as a result the extra profit earned by the foreign firm in the home market dominates other welfare changes. On the other hand, the home-country loses from trade liberalisation when transportation costs are high, but gains when they are low. The loss in home firm profit earned in the large home market dominates other welfare effects unless transportation costs are low in which case the binding arbitrage constraint reduces price in the home market to such an extent that gains in consumer surplus dominate losses in profit and tariff revenue. These results contrast with those in Venables (1990a) where, in the presence of transportation costs, both countries unambiguously gain from trade liberalisation.

In the second case, where markets are segmented following integration, it is shown that the foreign country gains from trade liberalisation unless transportation costs are high and the difference in demand between home and foreign is small. With a small difference in demand and high transportation costs the decrease in foreign firm profit in the foreign market is greater than the increase in foreign firm profit in the home market (this profit gets eroded by the transportation costs). This net loss in profit more than offsets any gains in consumer surplus. The result that the foreign country can gain from trade liberalisation contrasts with the results of Venables (1990a), where, in the presence of high transportation costs, both countries unambiguously lose from trade liberalisation.

On the other hand, it is shown that the home country loses from trade liberalisation unless transportation costs are low and the difference in demand between home and foreign is small. With a small difference in demand and low transportation costs the decrease in home firm profit in the home market is smaller than the increase in home firm profit in the foreign market so that overall both home firm profit and consumer surplus increase. Once again, the result that the home country can lose from trade liberalisation contrasts with the results of Venables (1990a), where, in the presence of low transportation costs, both countries unambiguously gain from trade liberalisation.

The results of this paper differ from those in Venables (1990a) because, in the presence of trade costs and arbitrage, it is necessary to assume that demand in home and foreign differ in order to have an equilibrium in which markets are integrated. With symmetric demand as in Venables, segmented market equilibrium prices are identical and costly arbitrage is
not profitable,

2. The Model

There are two countries, home and foreign, in each country there is one firm producing a homogenous product. The output of the two firms is sold in both countries. The two firms are Cournot competitors and choose sales in each country (market) to maximize profit.

The cost of transporting one unit of output from one country to another is given by \( T \). In addition, the policy maker in each country levies per-unit tariffs on imports. These tariffs are \( t \) and \( t' \) for the home and foreign countries, respectively, and nonnegative. They are chosen by the policy maker to maximize welfare.

Given tariffs, transportation costs, and sales in each market, arbitrage ensures that the price in the two markets does not differ by more than the total costs (transportation costs plus tariffs). When firms make their profit maximizing sales decisions they take account of the constraint imposed by this arbitrage.

The game played between the policy makers and the firms has two stages. In the first stage, policy makers in each country choose tariffs to maximize welfare. The use of production and export subsidies is ruled out by assumption and justified on the grounds that this paper is concerned with the relationship between trade costs (including tariffs), arbitrage, and market structure. In the second stage, firms take these tariffs as given and maximize profit subject to the constraint imposed by arbitrage. As usual, the game is solved backwards to ensure optimal decision are made at each stage in the game.

3. Stage Two

Given tariffs, each firm chooses sales in each market to maximize profit subject to the constraint imposed by arbitrage. The equilibrium concept adopted is Cournot-Nash equilibrium. Home firm sales in the home and foreign markets are given by \( x \) and \( x' \), respectively, and foreign firm sales in the home and foreign markets are given by \( y \) and \( y' \), respectively. Demands in each country are assumed to be linear and given by

\[
\begin{align*}
    p &= a - b(x + y) \\
    p' &= a' - b(x' + y')
\end{align*}
\]

for the home and foreign countries, respectively, where \( p \) and \( p' \) are per-unit prices and \( a > a' \). This latter assumption makes the problem interesting because it introduces the possibility that the arbitrage condition might bind. Finally, it is assumed that both firms have the same constant marginal cost of production, \( c \).

The home firm's profit maximization problem is

\[
\max_{x, x'} \Pi_2 = (p - c) \cdot x + (p' - c \cdot T - t') \cdot x'
\]

subject to

\[
\begin{align*}
    p &\leq t + T \\
    p' &\leq t' + T \\
    x &\geq 0 \\
    x' &\geq 0
\end{align*}
\]

and

\[
\begin{align*}
    \Pi_2(x, x') &\geq 0
\end{align*}
\]

where (3.3) and (3.4) are constraints imposed by arbitrage and (3.5) and (3.6) are non-negativity constraints. The Kuhn-Tucker necessary conditions for a solution to this problem are also sufficient as the objective function in (3.2) is concave and constraints (3.3) to (3.6) are linear.

The foreign firm's problem is identical in structure and given by

\[
\max_{y, y'} \Pi_2' = (p' - c) \cdot y + (p - c \cdot T - t) \cdot y'
\]

subject to arbitrage and non-negativity constraints. As for the Home firm's problem, the Kuhn-Tucker necessary conditions for a solution to the foreign firm's problem are also sufficient as the objective function in (3.7) is concave and the constraints are linear.

The Kuhn-Tucker conditions for the home and foreign firms are solved simultaneously for equilibrium sales by each firm in each market. Depending on the parameters of the model, there are many solutions for the Cournot-Nash equilibrium sales. These solutions are associated with different combinations of constraints binding.

Case 1 - Segmented Markets

In this case, it is assumed that no constraints bind. The solution for sales are the usual segmented markets equilibrium sales and are given in an Appendix available from...
the author on request.\footnote{This Appendix note also be found in the working paper version of this paper, Wright (2000).} Substituting these sales into the constraints, with strict inequality, gives necessary and sufficient conditions on the parameters for this case to arise. These conditions are

\[ t' > a - a + 3T - 2t \tag{3.8} \]

\[ t' < a' - c - 2T - t_p' \tag{3.9} \]

and

\[ t < \frac{a - c}{2} - T < t_p' \tag{3.10} \]

Conditions (3.9) and (3.10) state that \( t' \) and \( t \) must be less than their prohibitive levels, \( t_p' \) and \( t_p \).\footnote{The monopoly price in the home market is \( p_m = \frac{a}{c} \). The tariff, \( t \), is prohibitive if \( p_m < c + T + t \), that is, the monopoly price in the home market is less than foreign production costs plus foreign trade costs.} This ensures that \( y > 0 \) and \( x > 0 \). Substituting equilibrium sales into the home and foreign inverse demand functions yields segmented markets equilibrium prices

\[ p_1 = \frac{a + 2c + T + t}{3}, \quad p_1' = \frac{a' + 2c + T + t'}{3}. \tag{3.11} \]

Condition (3.8) ensures that prices in the home and foreign markets differ by less than trade costs. Consider a tariff pair that satisfies (3.8) to (3.10). Any pair in the region associated with Case 1 in Diagram 1 will suffice. Now reduce \( t \), from (3.11) note that \( p_1 \) falls by \( \frac{a}{3} \), that is, the home price falls by a third of the home tariff fall. For big enough reductions in \( t \), constraint (3.3) will bind. Instead of reducing \( t \), reduce \( t' \). From (3.11) note that \( p_1' \) falls by \( \frac{a'}{3} \), that is, the foreign price falls by a third of the foreign tariff fall.

For big enough reductions in \( t' \), given \( t \), constraint (3.3) will bind. Condition (3.8) gives those tariff pairs which satisfy (3.3) with strict inequality.

**Case 3. Integrated Markets**

Here it is assumed that only constraint (3.3) binds, that is, prices in the two markets differ by exactly trade costs, \( p - p' = t + T \). Note that \( p > p' \) for positive \( t + T \). The solutions for sales, in each market, by each firm, are not unique since there are six unknowns (four sales variables and two Lagrange multipliers) and only five independent equations.

The multiplicity of Cournot-Nash equilibria causes a problem of equilibrium selection. However, in the Appendix, it is shown that although sales, in each market, by each firm

are not unique, aggregate sales in each market and aggregate production are unique. In addition, it is shown that foreign firm profit is the same in all equilibria, that is, foreign firm profit is independent of how foreign firm aggregate production is allocated between the two markets, as long as it is allocated so that equilibrium aggregate sales are obtained.

On the other hand, it is shown that home firm profit is greater in equilibria in which home sales in the home market are greater. The intuition is clear. Given equilibrium aggregate outputs and sales and so equilibrium prices in each market, if the foreign firm sells one more unit in the foreign market and one less unit in the home market it saves trade costs of \( t + T \), but loses revenue of \( p - p' = t + T \), that is, its profit is unchanged. However, if the home firm sells one more unit in the home market and one less unit in the foreign market it gains revenue \( p - p' = t + T \) and saves trade costs of \( T + t' \), that is, its profit increases by \( t + T + 2T \). Clearly, the equilibrium in which home firm sales in the home market are largest Pareto dominates all other equilibria. As a result, this is the equilibrium which will be used in the analysis that follows.\footnote{The equilibrium which the payoff difference is zero of Matsuyama and Sekhon (1988, Ch 1) and is identical to the equilibrium chosen by Ben Zvi and Hoffman (1992).} The sales associated with this equilibrium are given in the Appendix.

Substituting equilibrium sales into the constraints with strict inequality for all the constraints accept (3.3), gives necessary and sufficient conditions on the parameters for this case to arise. These conditions are

\[ t' \leq a - a + 3T - 2t \tag{3.12} \]

and

\[ t' < 2a - c + T + 2t, \tag{3.13} \]

Condition (3.12) is the complement of condition (3.8) for segmented markets. Since \( t' \geq 0 \) and \( t \geq 0 \), for condition (3.12) to be satisfied

\[ a - a + 3T \geq 0, \tag{3.14} \]

Unless explicitly stated, condition (3.14) is assumed to be satisfied in the remainder of this paper. Without it the integrated markets equilibrium can not arise. Condition (3.13) is derived from constraint (3.3) and is satisfied for any \( t \) and \( t' \) that satisfies (3.12) if
2a' \quad a + c + T > a \quad a' \quad 3T \text{ or } 3a' \quad 2a \quad c + 4T > 0, \text{ This latter condition is satisfied if } \frac{a' c}{2} + \frac{2T}{a'} > a \quad a' \quad 3T, \quad (3.15)

that is, if the prohibitive foreign tariff derived above is greater than the intercept term in condition (3.12). These conditions are satisfied by tariff pairs in the region associated with Case 2 in Diagram 1. Note that as drawn condition (3.15) is satisfied, Condition (3.15) is satisfied as long as is not too large relative to \( a' \), that is, as long as demand in the home country is not too much greater than demand in the foreign country.

Substituting equilibrium sales into the home and foreign inverse demand functions yields the integrated markets equilibrium prices

\[ p_1 = \frac{a + a' + 4c + 5T + 4T + t'}{6}; \quad p_1' = \frac{a + a' + 4c + T + 2T + t'}{6}. \quad (3.16)\]

**Case 3 • Foreign Sales in the Home Market are Zero and Markets are Segmented**

Here it is assumed that foreign sales in the home market are zero, \( y_2 = 0 \), and no other constraints bind. The solutions for sales and prices in each market is given in the Appendix. As expected, the solution for \( x_2 \) is monopoly sales and the solutions for \( x_1 \) and \( y_1 \) are the usual segmented markets equilibrium sales, Substituting these solutions into the constraints, gives necessary and sufficient conditions on the parameters for this case to arise. These conditions are

\[ t \geq \frac{a c}{2} - \frac{2T}{a'} = t_p, \quad (3.17)\]

\[ t' \leq \frac{a' c}{2} - \frac{2T}{a'} = t'_p. \quad (3.18)\]

These conditions state that \( t \) must be greater than its prohibitive level and \( t' \) must be less than its prohibitive level. Conditions (3.17) and (3.18) are satisfied by tariff pairs in the region associated with Case 3 in Diagram 1.

**Case 4 • Home Sales in the Foreign Market are Zero and Markets are Segmented**

Here it is assumed that home sales in the foreign market are zero, \( x_1 = 0 \), and no other constraints bind. The solutions for sales in each market are given in the Appendix.

The necessary and sufficient conditions for this case to arise are

\[ t' \geq \frac{a' c}{2} - \frac{2T}{a'} = t'_{p}. \quad (3.19)\]

\[ t < \frac{a c}{2} = t_p, \quad (3.20)\]

\[ 4t > 2a \quad 3a' + c \quad 4T, \quad (3.21)\]

Condition (3.21) is derived from constraint (3.3) and is satisfied for all positive \( t \) if condition (3.15) is satisfied. Conditions (3.19), (3.20), and (3.21) are satisfied by tariff pairs in the region associated with Case 4 in Diagram 1.

**Case 5 • Monopoly in Both Markets and Markets are Segmented**

It is assumed that home sales in the foreign market are zero, \( x_2 = 0 \), foreign sales in the home market are zero, \( y_1 = 0 \), and no other constraints bind. The solution for equilibrium sales is given in the Appendix. The necessary and sufficient conditions for this case to arise are as expected

\[ t \geq \frac{a c}{2} + \frac{2T}{a'} = t_p; \quad t' \geq \frac{a' c}{2} + \frac{2T}{a'} = t'_{p}. \quad (3.22)\]

Tariffs must be set at the prohibitive rate or greater. Condition (3.22) is satisfied by tariff pairs in the region associated with Case 5 in Diagram 1.

Examination of Diagram 1 reveals that the mutually exclusive regions associated with the 5 cases above cover the entire non-negative tariff space. Therefore, no other cases are possible. In particular, constraint (3.4) never binds. This is proved in the Appendix.

**4. Stage 1**

In this stage, policy makers choose tariffs to maximise welfare. Tariffs are chosen simultaneously and the equilibrium concept adopted is Nash equilibrium. Welfare in each country is the sum of consumer surpluses, tariff revenue, and firm profit, for the home policy maker, it is given by

\[ W = \frac{1}{2}(a x + y)^2 + t y + (a x + y) c x + (a' x') c x' + (a c) x'. \quad (4.1)\]

where the first term is consumer surplus, the second term is tariff revenue, the third term is home firm profit earned in the home market, and the fourth term is home firm profit earned in the foreign market. Welfare in the foreign country is given by a similar expression.

When choosing tariffs, the policy makers take into account that different choices result in different equilibria. For example, if the chosen tariffs fall into the region given by Case
1 in Diagram 1, then a segmented markets equilibrium results; on the other hand, if the
corrected tariffs fall into the region given by Case 2, then an integrated markets equilibrium
results. To solve for the Nash equilibrium tariffs the best response function of the home
policy maker is first derived. It turns out, given certain restrictions on parameter in the
model, that the home policy maker has a dominant strategy. That is, regardless of the
tariff chosen by the foreign policy maker, the home policy maker’s best response is always
the same tariff. Given the home policy maker a dominates strategy, the foreign policy
maker knows the tariff that will be chosen by the home policy maker and chooses a best
response to this tariff. These tariffs form a Nash equilibrium.

4.1. Home Policy Maker’s Problem

Given the foreign tariff, the home policy maker’s problem is to choose the home tariff to maximize home welfare.

**Proposition 1:** Given restrictions (3.14) and (3.15), the home policy maker has a
dominant strategy which is to set \( t^* = \frac{1}{\beta - 1} = t_s \) regardless of the tariff chosen by
the foreign policy maker. This tariff is in fact the usual optimal segmented markets
equilibrium tariff.

**Proof:** See the Appendix

The intuition for this result follows from the rent extraction and profit shifting effects of
a tariff. [Brander and Spencer (1984) and Helpman and Krugman (1989)]. Consider a tariff
pair on the boundary between Case 1 and Case 2. At this point, welfare under segmented
or integrated markets is identical. Given the \( t^* \) associated with this point, consider the
effects of changing \( t \).

An increase in \( t \) of \( \Delta t \) increases \( p_s \) by \( \frac{\Delta t}{1-\beta} \) from (3.11). Nothing is changed in the foreign
market because the increase in \( t \) causes the markets to be segmented, but consumer surplus falls in the home market. However, as the optimal segmented markets home tariff is greater than any home tariff on the boundary between Cases 1 and 2, \( \Delta t > \frac{\Delta t}{1-\beta} \), the profit shifting and rent extraction effects of the tariff offset the loss in consumer surplus and home
welfare increases. Profit is shifted from the foreign firm to the home firm in the home
market because the tariff credibly commits the home firm to greater output in equilibrium.

Rent is extracted from the foreign firm because the home price rises by less than the tariff,
Given \( t^* \), welfare is greater at \( t_s \) than on the boundary between Cases 1 and 2.

From (3.16), a decrease in \( t \) of \( \Delta t \) decreases \( p_s \) by \( \frac{\Delta t}{1-\beta} \) and increases \( p_f \) by \( \frac{\Delta t}{1-\beta} \). The
difference in price has fallen by \( \Delta t \) and so constraint (3.3) continues to bind and the markets
are integrated. The fall in the home tariff results in less rent extraction and profit shifting
in the home market though consumer surplus increases. In fact, the increase in consumer
surplus is greater than the loss in rent and profit because with integrated markets price
changes by twice as much as with segmented markets when the home tariff changes. Unlike
segmented markets, where the change in the home tariff had no effect on the foreign market,
with integrated markets a decrease in \( t \) causes the foreign price to increase, home sales in
the foreign market decrease by \( \frac{\Delta t}{1-\beta} \) whereas foreign sales in the foreign market increase by
\( \frac{\Delta t}{1-\beta} \). This tends to decrease home firm profits earned in the foreign market and it is this
additional loss in profit in the foreign market that leads the home government to choose \( t_s \)
as a dominant strategy.

Where home demand is large relative to foreign demand (a large relative to \( a^* \)), a large
home tariff is needed to segment the markets. This tariff can be higher than the optimal
segmented markets equilibrium tariff so that it is possible that the home policy maker would
prefer to have the markets integrated, with the optimal integrated markets equilibrium
tariff, than segmented without the optimal segmented markets equilibrium tariff.

In deriving Proposition 1, the integrated markets equilibrium in which home firm sales
in the home market are largest was chosen. Rather than weaken the proposition, this
choice strengthens it as it provides the greatest incentive to the home policy maker to not
segment markets. This follows because home welfare in an integrated markets equilibrium
is increasing in home firm sales in the home market, as shown in the Appendix.

4.2. The Foreign Policy Maker’s Problem and Equilibrium

Given the home policy maker’s tariff, the foreign policy maker chooses \( t^* \) to maximize
foreign welfare. It was shown in Proposition 1 that the home policy maker has a dominant
strategy to choose \( t_s \). The foreign policy maker knows the home policy maker has a
dominant strategy, therefore the foreign policy maker chooses the \( t^* \) which is a best
response to \( t_s \). Given \( t_s \), an examination of Diagram 1 reveals that only Cases 1 and 4 are
possible, So if \( I^* = \frac{-a^* - c + \sqrt{(a^* + c)^2 - 4ac}}{2a} < I^* \), then \( I^* \) is the best response and \( I^* \) is the best response otherwise. These results are summarised in the following proposition.

**Proposition 2:** Given restriction (3.15), the unique Nash equilibrium to the policy makers' tariff game is \( (I^*, I^*) \) if \( I^* \leq I^* \) and \( (I^*, I^*) \) if \( I^* > I^* \). That is, it is optimal for the policy makers to segment home and foreign markets.

The intuition is clear and simply follows from \( I^* \) being a dominant strategy for the home policy maker. This proposition provides a nice contrast with the results of Horn and Shy (1996). Rather than policy makers choosing to segment markets through tariffs, Horn and Shy found that firms choose to segment markets by bundling nontraded services with tradable products. In both cases, markets are segmented by making arbitrage costly.

To the author's knowledge, the idea that policy makers might optimally choose tariffs to segment markets is new to the literature and highlights the importance of endogenising market structure, for if a market structure is assumed exogenously, then propositions like Proposition 2 are ruled out by assumption.

The result that policy makers choose to segment home and foreign markets was derived by applying a price arbitrage condition to a Cournot model in which firms are quantity competitors. If instead of choosing output, firms chose price, and a differentiated products Bertrand model was used, nothing substantive would change. This is because the qualitative effects of a tariff in a Cournot model and a Bertrand model are identical; in either case, the effects of a home tariff are to increase the price of the products sold by the home and foreign firms in the home market and to increase the sales of the home firm in the home market, while reducing the sales of the foreign firm in the home market [Helpman and Krugman (1989, Chapter 6)]. With tariffs having similar effects in both models a detailed analysis of a Bertrand model should result in a Proposition very much like Proposition 2.

To further emphasise the importance of endogenising market structure, the effects of trade liberalisation (economic integration) are examined in the endogenous market structure framework of this paper and compared to previous results in the literature.

5. Trade Liberalisation (Economic Integration)

Economic integration is chosen as a vehicle of comparison between models in which market structure is exogenously given or endogenously determined because it is an area in which exogenous assumptions about market structure permeate the literature. Markets are either assumed to be segmented or integrated and economic integration takes the form of reductions in trade costs, Venables (1990a), or economic integration is modelled as a movement from a segmented markets equilibrium to an integrated markets equilibrium, European Commission (1990), Hall and Woodon (1992), and Venables (1990a). In this paper, economic integration is modelled as trade liberalisation where all tariffs between home and foreign are set to zero.

5.1. Pre- liberalisation

Given restriction (3.15), it was demonstrated above that the equilibrium of the tariff game resulted in the home and foreign markets being segmented. It is now further assumed that

\[ a^* < 4T > 0 \]  

so that \( I^* < I^* \) and the equilibrium tariffs are the usual segmented markets equilibrium tariffs. The benchmark pre-liberalisation equilibrium is one in which both home and foreign firms have positive sales in both the home and foreign markets. Substituting \( I^* \), \( I^* \), and \( I^* \) into the expressions for home and foreign segmented markets equilibrium welfare yields pre-liberalisation welfare, denoted by \( \hat{W}_h \) and \( \hat{W}_f \) for the home and foreign countries, respectively, where the hat denotes a pre-liberalisation value. Pre-liberalisation equilibrium prices are denoted by \( \hat{p}_h \) and \( \hat{p}_f \). Expressions for pre-liberalisation welfare and price can be found in the Appendix.

5.2. Post-liberalisation - Integrated Markets (\( a^* \), \( T > 0 \))

Initially (3.14) is assumed so that post-liberalisation the home and foreign markets are integrated. Therefore, markets are segmented pre-liberalisation and integrated post-liberalisation. This provides some justification for the approach adopted by the European Commission (1988), Venables (1990a), and Hall and Woodon (1992), where economic integration (trade liberalisation) is modelled as a movement from segmented markets to integrated markets, however, the justification only applies if (3.14) is satisfied. In addition,
their approach differs from that of this paper in two ways. First, tariffs in the segmented markets equilibrium are arbitrary in their work whereas they are optimal in this paper and secondly, whether markets are segmented or integrated is exogenous in their work, but endogenous in this paper.

Substituting \( l = 0 \) and \( l^* = 0 \) into the expressions for home and foreign integrated markets equilibrium welfare yields post-liberalisation integrated markets equilibrium welfare denoted by \( W_h \) and \( W_* \) for the home and foreign countries, respectively, where the bar denotes a post-liberalisation value, post-liberalisation integrated markets equilibrium prices are denoted by \( p_h \) and \( p_* \). Expression for post-liberalisation integrated markets equilibrium welfare and prices can be found in the Appendix.

In the Appendix it is shown that trade liberalisation unambiguously reduces price in the home market, that is, \( p_h > p_* \). This is as expected as the removal of the home tariff tends to reduce home price as does the fact that the price differential between the two markets must be reduced. As shown in the Appendix, the effect of trade liberalisation on price in the foreign market is ambiguous. Once again, this is as expected as the removal of the foreign tariff tends to reduce the foreign price while the fact that markets become integrated tends to increase the price in foreign market (prices rise in the low price market).

These results contrast with those of Hallland and Wooton (1992) who found that it was possible for prices in both markets to rise in the move from segmented to integrated markets if trade costs are large. Although Hallland and Wooton used a symmetric differentiated products model, the differing results follow because whether markets are integrated or segmented is endogenous in this paper, but not in theirs. This endogeneity means that if transportation costs are large, then (3.14) is not satisfied and markets are segmented following liberalisation. The condition under which prices rise in both markets in Hallland and Wooton is precisely the condition in this paper that rules out markets being integrated following trade liberalisation.

A comparison of \( W_h \) and \( W_* \) and \( W^*_h \) and \( W^*_* \) gives the effects of trade liberalisation on home and foreign welfare respectively. In the Appendix, it is shown that foreign welfare unambiguously increases following trade liberalisation. The extra profit earned by the foreign firm in the larger home market is greater than the loss of profit and tariff revenue earned in the smaller foreign market and more than offsets any loss in consumer surplus that may arise.

The model is simulated in the Appendix and it is found that the effect of trade liberalisation on home welfare is ambiguous. The reduction in the home tariff reduces home firm profit in the home market and stops rent extraction from the foreign firm through eliminating tariff revenue. This loss is offset to some extent by the unambiguous increase in home consumer surplus and the increase in profit earned by the home firm in the foreign market. For small transportation costs, home welfare increases following trade liberalisation as the increase in consumer surplus more than offsets the loss in tariff revenue and the loss in profit. On the other hand, for large transportation costs, home welfare decreases following trade liberalisation. Home price does not fall as much following liberalization because trade costs are greater in this case. This allows a larger price differential between the two markets. As a result, the increase in consumer surplus is smaller and does not offset the loss in tariff revenue and profit. Essentially, higher are transportation costs the less competitive are the markets following trade liberalisation.

It should be noted that, regardless of transportation costs, the sum of home and foreign welfare increases following trade liberalisation. Therefore, the aggregate gains from liberalisation can be redistributed between home and foreign so that neither country is worse off following trade liberalisation. However, in the absence of a redistribution mechanism, it is possible for the large country (the one with greater demand) to lose from trade liberalisation. The above results are summarised in the following proposition.

**Proposition 3:** Given restrictions (3.15) and (5.1), so that the benchmark pre-liberalisation equilibrium is a segmented markets equilibrium in which both firms sell in both markets, trade liberalisation unambiguously increases foreign welfare, but has an ambiguous effect on home welfare.

These results contrast with Venables (1990a), who found in the presence of transportation costs that the move from segmented to integrated markets always increased welfare. Although Venables derived these results in a symmetric differentiated products model.
model the difference between his result and those in this paper arise because whether markets are integrated or segmented is endogenous in this paper, but exogenous in his. In Venables (1999a), the exogenous move from segmented to integrated markets yields the benefits of extra competition without increasing trade volumes. In fact, trade volumes fall and so transportation costs fall. It is this fall in transportation costs which yield his unambiguous welfare increases. In this paper, the move from segmented to integrated markets is endogenous and results from the removal of tariffs. Trade volumes increase, but if transportation costs are high, then the benefits of extra competition in the home market are less (price in the home market falls by less) and so home can be worse off following trade liberalisation. Explicit recognition that whether markets are integrated or segmented is endogenous and explicit recognition that economic integration is a reduction in trade costs leads to the differing results.

5.3. Post-liberalisation - Segmented Markets \((a - a^* - 3T) \leq 0\)

Condition (3.14) is no longer assumed so that post liberalisation the home and foreign markets remain segmented. Substituting \(t = 0\) and \(T = 0\) into the expressions for home and foreign segmented markets equilibrium welfare yields post liberalisation segmented markets equilibrium welfare denoted by \(W_a^*\) and \(W_a^*\) for the home and foreign countries, respectively; where the bar signifies a post liberalisation value. Expressions for post liberalisation segmented markets equilibrium welfare and prices are given in the Appendix. It is found that trade liberalisation unambiguously reduces price in the home and foreign markets by \(\frac{4T}{T^*}\) and \(\frac{4T}{T^*}\), respectively.

**Proposition 4:** Given restrictions (3.15) and (5.1), the effects of trade liberalisation on the home and foreign country welfare depend on the size of transportation costs, \(T\), and differences in demand, \(a\), compared to \(a^*\). For small \(T\), the foreign country is unambiguously better off while the home country may be worse off if the difference between \(a\) and \(a^*\) is large. For large \(T\), the home country is unambiguously worse off while the foreign country may be better off if the difference between \(a\) and \(a^*\) is large.

**Proof:** See the Appendix.

There are two forces in operation. As the difference between \(a\) and \(a^*\) increases; the profit that is shifted to the foreign firm and away from the home firm in the larger home market, following liberalisation, becomes greater than the profit that is shifted to the home firm and away from the foreign firm in the smaller foreign market. This tends to decrease welfare in the home country and increase welfare in the foreign country following liberalisation. The larger is \(T\), the smaller are the gains from trade liberalisation because increases in profit earned abroad are eroded by the high transportation costs.

For small \(T\) (large \(T\)) and a small difference between \(a\) and \(a^*\), the simulation in the Appendix demonstrates that both countries gain (lose) from trade liberalisation. This result is identical to that obtained in Venables (1999a) for symmetric countries. Trade liberalisation increases the volume of trade which tends to increase welfare. However, this increase in welfare is completely eroded if transportation costs are high.

6. Conclusion

This paper has taken seriously the idea that market segmentation, which leads to different prices in different markets, can only be sustained as an equilibrium if arbitrage is not profitable. Taking this idea seriously means that it can not be assumed that arbitrage is unprofitable, rather the reason for the unprofitable arbitrage must be modelled. This paper makes arbitrage costly via the mechanism of transportation costs and tariffs and complements the work of Horn and Shy (1996), where costly arbitrage was introduced via the bundling of non-tradable services with tradable commodities.

In this paper, in the presence of costly arbitrage, the interaction of transportation costs, tariffs, and demand parameters, was found to determine whether markets are integrated or segmented. Given that home and foreign demand are different, but not too different, it was also found that policy makers choose to segment markets through their choice of tariffs. This highlights the importance of modelling costly arbitrage explicitly for in its absence no such result is possible.

Whether markets are integrated or segmented is endogenous and it is crucial to model it as such. This is further highlighted by considering the effects of trade liberalisation in the framework of this paper. It can not be assumed that markets are segmented or

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9. Venables (1999a), Proposition 2 (I) (Proposition 2 (I))
integrated nor that trade liberalisation changes the equilibrium from a segmented markets to an integrated markets equilibrium. This depends on the parameters of the model. In contrast to the existing literature, it was found that when two countries undertake trade liberalisation, either country can be worse off or better off as a result of this liberalisation.

In deriving the results in this paper, it was assumed that demand in home and foreign are different, but not too different. If demand is much greater in home than foreign, then condition (3.15) is not satisfied, and the results of this paper may no longer be valid. In particular, the equilibrium of the tariff game may not involve tariffs which segment the two markets. The difficulty introduced when condition (3.15) is not satisfied is the manifestation of another region in Diagram 1. In this region, markets are integrated, but foreign sales in the home market are zero. In this case, there are multiple equilibria for sales in each market, aggregate sales, and aggregate output. As a result, there is no obvious focal point and a serious problem of equilibrium selection arises. Although this case is possible, it is not central to the argument of this paper, namely that whether markets are integrated or segmented is endogenous and should be modelled that way.

REFERENCES
STAGE TWO

Case 1 - Segmented Markets

The solutions for sales are
\[ x_1 = \frac{a - c + T + t}{36}; \quad x_1^* = \frac{a' - c + 2T + 2t}{36}; \]
\[ y_1 = \frac{a - c + 2T + 2t}{36}; \quad y_1^* = \frac{a' - c + T + t}{36}. \]

Case 2 - Integrated Markets

The solutions for sales are
\[ x_2 = \frac{a - a' - 2T - 2t'}{66}; \quad x_2^* = \frac{5a' = a - 4c + T + 2t - T'}{66}; \quad y_2' = \frac{a + a' - 2c - T - 2t'}{36} \]
\[ y_2 = \frac{a + a' - 2c - T - 2t'}{66}; \quad y_2^* = \frac{5a' = a - 4c + T + 2t - T'}{66}. \]

These are not unique, however, aggregate sales and production are since
\[ x_2 + y_2 = \frac{5a = a' = 4c = 5T = 4t = 2t'}{66}; \quad x_2^* + y_2^* = \frac{5a' = a = 4c + T + 2t - T'}{66}; \]
\[ y_2 + y_2' = \frac{a + a' = 2c - T - 2t'}{36}; \quad y_2 + y_2' = \frac{a + a' = 2c - T - 2t'}{36}. \]

Substituting (A.1) into home and foreign firm profit respectively yields
\[ \Pi_1 = \left( \frac{4c^2 - 2t^2 - 11T^2 - 87t' + t^2 + 10T'a + 2T'a + a^2}{186} \right) + 2c(T + 8T' + 7t - 2a - 2a') - 26(Ta^2 = 16T'a^2 + 20a'a + a^2) + 36T + 18t + 18t' + 2(7T + 5T' - 4a + 5a' - 96y'). \]
\[ \Pi_2 = \left( \frac{a + a' = 2c - T - 2t'}{186} \right)^2 \]

Note that foreign firm profit is independent of \( y' \), whereas home firm profit is not.

Differentiating (A.2) with respect to \( y' \) yields
\[ \frac{d\Pi_1}{dy'} = T + 2T' + t' > 0, \]
so that home firm profit is increasing in \( y' \), that is, equilibria in which \( y' \) is greater have higher home firm profit. Since aggregate sales and production are the same in all equilibria, the equilibrium in which \( y' \) is greatest is also the equilibrium in which \( x \) is the greatest.

The Kuhn-Tucker conditions require the Lagrange multiplier on the foreign equivalent of constraint (3,3) to be greater than or equal to zero so that, \( \lambda^*_f \geq 0 \), Calculation reveals that

\[
\lambda^*_f = \frac{a + a^* - 2c + 2 + T'}{66} y'
\]

which is \( \geq 0 \) if

\[
y' \leq \frac{a + a^* - 2c + 2 + T'}{66}.
\]

(A,5)

Therefore the maximum value \( y^* \) can take is given by the right hand side of (A,3).

Choosing the equilibrium in which home firm sales are largest yields the following equilibrium sales

\[
y_2 - y^*_2 = \frac{a + a^* - 2c + 2 + T'}{66} x^*_2 = \frac{2a^* - a + c + T + 2 + T'}{36}.
\]

Case 3 • Foreign Sales in the Home Market are Zero and Markets are Segmented

The solutions for sales are

\[
x_3 = \frac{a + c}{26}; \quad x^*_3 = \frac{a^* + 2T + 2T'}{36}; \quad y_3 = 0; \quad y^*_3 = \frac{a^* + c + T + T'}{36}.
\]

Equilibrium prices are given by

\[
p_3 = \frac{a + c}{2}; \quad p^*_3 = \frac{a^* + 2c + T + T'}{3}.
\]

where \( p_3 \) is the monopoly price and \( p^*_3 \) is the segmented markets equilibrium price in the foreign market.

Case 4 • Home Sales in the Foreign Market are Zero and Markets are Segmented

The solutions for sales are

\[
x_4 = \frac{a + c + T + T'}{36}; \quad x^*_4 = 0 \quad y_4 = \frac{a + c}{26}; \quad y^*_4 = \frac{a^* - c}{26}.
\]

Case 5 • Monopoly in Both Markets and Markets are Segmented

The solutions for sales are

\[
x_5 = \frac{a + c}{26}; \quad x^*_5 = 0 \quad y_5 = 0; \quad y^*_5 = \frac{a^* - c}{26}.
\]

Proof that constraint (3,4) does not bind

Consider a tariff pair on the boundary between Cases 1 and 2. Given this pair, \( p = p^* + T + T' \) by constraint (3,3) so that \( p \geq p^* \). Clearly constraint (3,4) does not bind at this pair. For constraint (3,4) to bind \( p^* \geq p \). If \( T' \) is increased, then from (3,11) \( p^* \) increases by \( \frac{c}{26} \). If \( T' \) is increased enough, then it is possible for \( p^* \geq p \). However, constraint (3,4) will never bind as the right hand side of (3,4) increases more than the left hand side of (3,4) when \( T' \) is increased. Therefore, constraint (3,4) never binds and can be ignored in the analysis.

STAGE 1

Proof of Proposition 1:

First it is shown that restrictions (3,14) and (3,15) ensure that

\[
a \quad \frac{a^*}{2} \quad \frac{3T'}{2} < T_s < \frac{a + c}{2} \quad \frac{T'}{2}.
\]

By restriction (3,15), \( 3a^* + a + 4T' > 0 \). Now \( c + T' > a + 4T' \) since \( a > c \), therefore, \( 3a^* + (a + c) \quad c + T' > 0 \). That is,

\[
a \quad \frac{a^*}{2} \quad \frac{3T'}{2} < \frac{a + c}{3} \quad \frac{T'}{3} = T_s.
\]

By restriction (3,14), \( a \quad \frac{a^*}{3} \quad \frac{3T'}{3} > 0 \). By restriction (3,14) and (3,15) \( a^* \quad c \quad 2T' > 0 \) and so \( a^* > c + 2T' \). Substituting this latter inequality into restriction (3,14) gives \( a \quad (c + 2T') \quad 3T' > 0 \). If \( a \quad c \quad 3T' > 0 \), Therefore, \( a \quad c \quad 4T' > 0 \) and so

\[
T_s = \frac{a + c}{2} \quad \frac{3T'}{3} < \frac{a + c}{2} \quad \frac{2T'}{2}.
\]

(A,5) and (A,6) together yield the inequality in (A,4). This result is used in Diagrams 1 and 2 to position the optimal segmented markets equilibrium tariff for home.

Next, three intervals for \( T' \) are considered,
(i) \( \frac{1}{10} \leq t^* \leq 1 \). Given \( t^* \), any \( t \) results in the markets being segmented. Cases 4 and 5 in Diagram 1. Since \( t_s \) is the optimal segmented markets equilibrium tariff in the home market, the home policy maker chooses \( t_s \) in response to any \( t^* \) in the region specified.

(ii) \( a^* \), \( 3T \leq t^* < \frac{e^{3T}}{2} \). As in (i), given \( t^* \), any \( t \) results in the markets being segmented. Cases 1 and 3 in Diagram 1; therefore, the home policy maker chooses \( t_s \) in response to any \( t^* \) in the region specified.

(iii) \( t^* < a^* \), \( 3T \). Given \( t^* \), the markets are integrated if \( t \) is chosen in the region associated with Case 2, but segmented for any other \( t \). In the segmented markets region, the best response is for the home policy maker to choose \( t_s \) as in (i) and (ii). Substituting the segmented markets equilibrium sales into home welfare yields equilibrium home welfare as a function of \( t \) and \( t^* \). This expression is given by

\[
W_s(t, t^*) = \frac{1}{180} (6a^2 + 2a^* + 8c^2 - 6d^4 + 9d^2 + 6a(t^2 - 2c) + 8cT + 6dT + 11T^2 + 8d^* + 16dT^* + 8T^2 + 4a^*(c + 2T + 2t^*)),
\]

(A7)

where the subscript denotes segmented markets. Substituting \( t_s \) into this expression gives segmented markets equilibrium home welfare as a function of \( t^* \). This expression is given by

\[
W_s(t^*) = \frac{1}{180} (7a^2 + 2a^* + 9c^2 + 10cT + 12T^2 - 2a(7c + T) + 8d^* + 16dT^* + 8T^2 + 4a^*(c + 2T + 2t^*)).
\]

For tariffs in the integrated markets region, Case 1, substituting the integrated markets equilibrium sales into the definition of home welfare yields equilibrium home welfare as a function of \( t \) and \( t^* \). This expression is given by

\[
W_i(t, t^*) = \frac{1}{10} \left( \frac{9e^{3T}}{26} \right) \left( \frac{18c^2 + 213T^2 + 433^2}{306} \right) \left( \frac{18T^*}{a^*} \right) = 13a^* + 74T^*a^* + 18a^* + 13a^* + 4c(31T^* + 14T^* + 2a + 11a^*) + T^*(194T^* + 22a + 146a^*)
\]

(A8)

Differentiating with respect to \( t^* \) yields

\[
\frac{28c + 9dT + 43T^* + 9a + 37a^*}{1800}.
\]

(A9)

Multiplying restriction (3,15) by 4.5 yields \( \frac{1}{4.5} (15,3a^* + 9a + 4.5c + 18T^*) > 0 \), Now, 23.5a^* + 22.5c + 79T^* + 43^* > 0 because \( a^* > c \). Stacking the two inequalities yields (A10) above.

Therefore, (A10) is \( > 0 \). Therefore, \( W_i(t^*) \) is increasing in \( t^* \). In (a) below it is shown that \( W_i(t^*) \) \( \neq 0 \) \( \forall t^* \) because \( W_s(0) = 0 \). Since \( W_i(t^*) \) \( \neq 0 \) \( \forall t^* \) the home policy maker chooses \( t_s \) in response to any \( t^* \) in the region specified. (a) At \( t^* = 0 \),

\[
W_i(0) = \frac{1}{180} \left( \frac{18c^2 + 213T^2}{306} \right) 22T^* 13a^* + 146T^*a^* + 18a^* + 13a^* + 4c(31T^* + 2a + 11a^*)
\]

(A11)
Differentiating (A.11) with respect to \( c \) yields \( 36c + 8a \ 124T \ 44a^2 \). At \( c = 0 \), this derivative is negative by restriction (3,15). In addition, (A.11) is a convex function of \( c \) which has a maximum at \( c = \frac{2a + 4T}{36} \). Now, by restriction (3,15), the maximum value \( c \) can take is \( 3a^* \ 2a + 4T \). By restriction (3,14), \( 3a^* \ 2a + 4T < 4a^* \frac{2a + 4T}{36} \). Therefore, over the relevant range, (A.11) is a decreasing function of \( c \). As a result, (A.11) is smallest where \( c \) is greatest, that is, at \( c = 3a^* \ 2a + 4T \). Substituting this value of \( c \) into (A.11) gives

\[
X = \frac{5T^2}{30T(a \ a^*)} + 43(a \ a^*)^2 \frac{360}{360},
\]

(A.12),

Since \( a \ a^* \ 3T > 0 \), simple rearrangement yields \( 10(a \ a^*) > 30T \). Substituting this inequality into (A.12) gives

\[
X > \frac{5T^2}{300} + 10(a \ a^*)^2 + 43(a \ a^*)^2 > 0,
\]

Therefore, the minimum value (A.11) can take is greater than zero and \( W_c(T^*) = W_c(T^*) > 0 \ V T^* \) since this difference is increasing in \( T^* \).

**Proof that Home Welfare in an Integrated Markets Equilibrium is Increasing in Home Firm sales in the Home Market**

It was shown above that, in an integrated markets equilibrium, aggregate sales and production are unique. As a result, home and foreign price is also unique, Differentiating (A.1) of the text with respect to \( x \) and applying constraint (3,3) with equality yields

\[
\frac{\partial W}{\partial x} = 2T + T^* > 0,
\]

**Foreign Welfare as a Function of Tariffs**

Foreign welfare in a segmented markets equilibrium is

\[
W^*_f(T,T^*) = \frac{1}{186} \left( 2a^2 + 6a^2 + 6c^2 + 8c^2 + 8cT + 16cT + 11T^2 \right) 4a(c + 2T + 2T^*),
\]

(A.13)

\[
\partial W^*_f(T,T^*) = \frac{1}{186} \left( 2a^2 + 6a^2 + 6c^2 + 8c^2 + 8cT + 16cT + 11T^2 \right) 4a(c + 2T + 2T^*),
\]

Foreign welfare in an integrated markets equilibrium is

\[
W^*_f(T,T^*) = \frac{1}{126} \left( 5a^2 + 29a^2 + 32c^2 + 16cd + 20dT + 20dT^* + 5T^2 \right) 2a^*(a^* + 4c + 5T)
\]

(A.14)

\[
32a^* + 28dT + 14T - 19T^2 = 0 (a^* + 4c + 10T + 5T + 7T^* + a^* \left( 56c + 4t + 2T + 46t^* \right))
\]

**Pro-Liberalisation**

Substituting \( t = 0 \) and \( T^* = 0 \) into the expressions for home and foreign segmented markets equilibrium welfare, (A.7) and (A.13) yields

\[
\hat{W}_c = \frac{1}{1026} \left( 63a^2 + 2a^2 + 65c^2 + 34dT + 68T^2 \right) 18c(7c + T) 4a^*(a + 4T)
\]

and

\[
\hat{W}^*_c = \frac{1}{1026} \left( 2a^2 + 63a^2 + 65c + 34dT + 68T^2 \right) 18a^*(7c + T) 4a^*(a + 4T)
\]

with equilibrium prices given by

\[
\hat{p}_c = \frac{1}{9} (4a^* + 5c + 2T); \ \text{and} \ \hat{p}^*_c = \frac{1}{9} (4a^* + 5c + 2T),
\]

where the hat denotes a pro-liberalisation value,

**Post-Liberalisation - Integrated Markets \( a \ a^* \ 3T > 0 \)**

Substituting \( t = 0 \) and \( T^* = 0 \) into the expressions for home and foreign integrated markets, equilibrium welfare, (A.8) and (A.14) of the Appendix) yields

\[
W_c = \frac{1}{126} \left( 20a^2 + 5a^2 + 32c^2 \ 2a(a^* + 28c + 7T) + 56dT + 43T^2 \right) 2a^*(4c + 35T)
\]

and

\[
W^*_c = \frac{1}{126} \left( 5a^2 + 29a^2 + 56a^*c + 32c^2 + 2a^*T + 8dT + 5T^2 \right) 2a(a^* + 4c + 5T)
\]

with equilibrium prices given by

\[
\hat{p}_c = \frac{1}{9} (a + a^* + 4c + 5T); \ \text{and} \ \hat{p}^*_c = \frac{1}{9} (a + a^* + 4c + T),
\]

where the bar denotes a post-liberalisation value.

Trade liberalisation unambiguously reduces price in the home market since

\[
p_c \ \hat{p}_c = \left( 3(a \ a^*) \ 9T \right) 2(a \ c \ t) < 0
\]

by restriction (3,14). The effect of liberalisation on price in the foreign markets is ambiguous since

\[
p^*_c \ \hat{p}^*_c = \left( 3(a \ a^*) \ 9T \right) 2(a^* \ c \ T)
\]
can be positive or negative,

**Proof that Foreign Welfare Unambiguously Increases Following Liberalisation**

Calculation reveals that

\[
W_i^* \quad \tilde{W}_i^* = \frac{1}{648e} \left(37a^2 + 9a^2 \right) \left(18a^2 + 28c^2 + 90aT \right) \left(227T^2 \right) \left(64cT \right) 56ac \left(36T^2 \right),
\]

Condition (3.14) is \( a - a^* > 3T \), squaring both sides and multiplying by 9 gives

\[
9a^2 + 9a^2 \quad 18a^2 > 81T^2,
\]

Adding \( 28(a^2 + c^2) \) to both sides yields

\[
37a^2 + 9a^2 \quad 18a^2 + 28c^2 > 81T^2 + 28(a^2 + c^2), \quad (A.15)
\]

From (3.15) and (3.14), \( a^* > c + 2T \), multiplying both sides by \( 90T \) gives

\[
90aT > 90a^* + 180T^2. \quad (A.16)
\]

Summing (A.15) and (A.16) yields

\[
37a^2 + 9a^2 \quad 18a^2 + 28c^2 + 90aT \quad 227T^2 + 90cT + 28(a^2 + c^2). \quad (A.17)
\]

The RHS of (A.17) is

\[
261T^2 + 90a^* + 28(a^2 + c^2) - 261T^2 + 90cT + 28(a - c)^2 + 56ac
\]

and

\[
261T^2 + 90cT + 28(a - c)^2 + 56ac > 227T^2 + 64cT + 56ac \quad (A.18)
\]

because \( (a - c)^2 > 0 \). Rearranging (A.18) gives

\[
\left(347T^2 + 26cT + 28(a - c)^2\right) + 227T^2 + 64cT + 56ac > 227T^2 + 64cT + 56ac,
\]

Now \( 347T^2 + 26cT + 28(a - c)(a - c) > 0 \) because \( a - c > 0 \) so

\[
347T^2 + 26cT + 28(a - c)^2 > 26cT, \quad (A.19)
\]

Combining (A.17), (A.18), and (A.19) and rearranging yields

\[
37a^2 + 9a^2 \quad 18a^2 + 28c^2 + 99a^*T \quad 227T^2 \quad 64cT \quad 56ac \quad 26aT > 0,
\]

which is the condition for foreign welfare to increase following trade liberalisation.

**Simulation • Post-Liberalisation • Integrated Markets**

\[
a = 100, \quad a^* = 70, \quad b = 1, \quad c = 5, \quad T = 5, \quad 8
\]

| Table 1 |
|------------------|---|---|---|---|---|---|---|---|---|
|                | Home | CS | TR | H | TR_H | TR_HH | p | t | x |
| **Seg T = 5**   | 3488 | 1335 | 250 | 1903 | 1878 | 25 | 18.4 | 30 | 43.3 | 5 |
| **Lib T = 5**   | 3118 | 2050 | 0 | 1460 | 1182 | 278 | 35.8 | 0 | 36.3 | 13.3 |
| **Seg T = 8**   | 3453 | 1301 | 203 | 1949 | 1906 | 13 | 49 | 29 | 44 | 3.6 |
| **Lib T = 8**   | 3363 | 1901 | 0 | 1457 | 1211 | 248 | 38.8 | 0 | 36.3 | 14.3 |

Variables with an asterisk are foreign variables, \( W \) is welfare, \( CS \) is consumer surplus, \( TR \) is tariff revenue, \( H \) is profit, \( H_{TR} \) is profit earned in market \( j \) by the firm located in country \( i \), and \( T, p, t, x, x^* \) are as defined in the text. \( Seg \) denotes the pre-liberalisation state, where markets are segmented and \( Lib \) denotes the post-liberalisation state, where markets are integrated.

**Foreign Welfare**: From Table 1 it is seen, regardless of transportation costs, that foreign welfare increases as a result of trade liberalisation. Profit increases because of the large increase in profit earned by the foreign firm in the home market, Consumer surplus increases because price in the foreign market falls and welfare increases because the increase in profit and consumer surplus more than offsets the loss in tariff revenue.

**Home Welfare**: From Table 1 it is seen that home welfare increases following trade liberalisation when transportation costs are 5. This increase in welfare is small and arises because the increase in consumer surplus more than offsets the loss in tariff revenue and the loss in profit. However, when transportation costs are 8, home welfare falls following trade
liberalisation, Home price does not fall as much following liberalisation because trade costs are greater in this case. This allows a larger price differential between the two markets. As a result, the increase in consumer surplus is smaller and does not offset the loss in tariff revenue and profit. Essentially, the higher the transportation costs the less competitive are the markets following trade liberalisation.

Post-Liberalisation - Segmented Markets (a + a' = 3T ≤ 0)

Substituting t = 0 and t' = 0 into the expressions for Home and foreign segmented markets equilibrium welfare, \((\lambda, \gamma)\) and \((\lambda', \gamma')\) of the Appendix§ yields

\[
W_a = \frac{1}{18\lambda} (6a^2 + 2a^2 - 12ae + 8c^2 + 8cT + 11T^2 - 4a'(c + T))
\]

and

\[
W_a' = \frac{1}{18\lambda'} (2a^2 + 6a^2 - 12a'c + 8c^2 + 11T^2 - 4a'(c + 2T))
\]

with equilibrium prices given by

\[
p_a = \frac{1}{3}(a + 2c + T); \quad \text{and} \quad p_a' = \frac{1}{3}(a' + 2c + T),
\]

Trade liberalisation unambiguously reduces price in the home and foreign markets by \(\frac{4a}{3}\) and \(\frac{4a'}{3}\), respectively.

Proof of Proposition 4

Calculation reveals that

\[
W_a - W_a' = \frac{1}{18\lambda} (9a^2 + 16a^2 + 7c^2 + 38cT + 31T^2 + 18a(c + T) - 8a'(4c + 7T)) \quad (A.20)
\]

and

\[
W_a - W_a' = \frac{1}{18\lambda'} (9a^2 + 16a^2 + 7c^2 + 38cT + 31T^2 + 18a'(c + T) - 8a(4c + 7T)) \quad (A.21)
\]

To establish the sign of \((A.20)\) and \((A.21)\) it is initially assumed that \(a = a'\). In this case, home and foreign welfare are equal. Making this substitution and rearranging yields

\[
W_a - W_a' = \frac{1}{18\lambda} (7(a - c)^2 + 38(a - c)(c + T) + 31T^2) \quad (A.22)
\]

At \(T = 0\), \((A.22)\) is unambiguously greater than zero since \(a - c > 0\). Therefore, where \(T = 0\), trade liberalisation unambiguously increases home and foreign welfare.

Differentiating \((A.22)\) with respect to \(T\) yields

\[
\frac{d(W_a - W_a')}{dT} = 38(a - c) + 62T < 0,
\]

where the sign follows from the condition \(a - c > 4T > 0\)\(^\text{10}\). Therefore, for large \(T\) it is possible that trade liberalisation unambiguously decreases home and foreign welfare, This is

\(^{10}\) At this point in the text, the condition \(a - c > 4T > 0\) applies to the new tariff, not the prohibitive tariffs.
verified by calculating $\Lambda(22)$ at the maximum $T = \frac{1}{a-c}$. This yields $\frac{d}{d\alpha} (\alpha - c)^2 < 0$. These results have been derived assuming symmetric demand, but this paper is really concerned with the case where $\alpha > \alpha^*$.

Differentiating $\Lambda(20)$ with respect to $\alpha$ yields

$$\frac{dW_x}{d\alpha} = - \frac{18}{1626}(\alpha - c) < 0$$

and differentiating $\Lambda(21)$ with respect to $\alpha$ yields

$$\frac{dW_y}{d\alpha} = - \frac{32}{1626}(\alpha - c) > 0,$$

So as the difference between $\alpha$ and $\alpha^*$ increases there is a tendency for trade liberalisation to decrease home welfare and increase foreign welfare.

Therefore, for small $T$, the foreign country is unambiguously better off following trade liberalisation while the home country may be worse off following trade liberalisation if the difference between $\alpha$ and $\alpha^*$ is large. On the other hand, for large $T$, the home country is unambiguously worse off following trade liberalisation while the foreign country may be better off following trade liberalisation if the difference between $\alpha$ and $\alpha^*$ is large.

### Simulation - Post Liberalisation - Segmented Markets

Large $T$: $a^* = 70, b = 1, c = 5, T = 16$

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Welfare Effects of Trade Liberalisation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$H_{one}$</td>
</tr>
<tr>
<td>Seg $a = 71$</td>
<td>1637</td>
</tr>
<tr>
<td>Lib $a = 71$</td>
<td>1616</td>
</tr>
<tr>
<td>Seg $a = 100$</td>
<td>3398</td>
</tr>
<tr>
<td>Lib $a = 100$</td>
<td>3172</td>
</tr>
</tbody>
</table>

Examination of Table 2, where transportation costs are large, reveals that both countries are worse off following trade liberalisation when the difference between $\alpha = 71$ and $\alpha^* = 70$ is small. Consumer surplus increases in both countries following liberalisation. However, the increase in home (foreign) firm profit in the foreign (home) market is not sufficient to offset the decrease in home (foreign) firm profit in the home (foreign) market because of the high transportation costs eroding this profit. In fact, the loss in profit more than offsets the gain in consumer surplus in both countries. Trade liberalisation increases the volume of trade, but this is costly because of high transportation costs.

On the other hand, when the difference between $\alpha = 100$ and $\alpha^* = 70$ is large, the foreign country gains from trade liberalisation while the home country continues to lose. The increase in foreign firm profit earned in the larger home market more than offsets any loss of foreign firm profit earned in the foreign market so that both consumer surplus and foreign profit increase.
\textbf{Small} \( T: \ a^* = 70, b = 1, c = 5, T = 1 \)

\textbf{Table 3}

\textbf{Welfare Effects of Trade Liberalization}

<table>
<thead>
<tr>
<th>Home</th>
<th>W</th>
<th>CS</th>
<th>TR</th>
<th>H</th>
<th>H_{HH}</th>
<th>H_{FF}</th>
<th>p</th>
<th>( x )</th>
<th>( x^* )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seg a = 71</td>
<td>1733</td>
<td>664</td>
<td>149</td>
<td>919</td>
<td>874</td>
<td>46</td>
<td>34.6</td>
<td>21.6</td>
<td>29.6</td>
</tr>
<tr>
<td>Lib a = 71</td>
<td>1893</td>
<td>953</td>
<td>0</td>
<td>940</td>
<td>499</td>
<td>441</td>
<td>27.3</td>
<td>0</td>
<td>22.3</td>
</tr>
<tr>
<td>Seg a = 100</td>
<td>35.45</td>
<td>1381</td>
<td>317</td>
<td>1848</td>
<td>1802</td>
<td>46</td>
<td>47.4</td>
<td>31.3</td>
<td>42.4</td>
</tr>
<tr>
<td>Lib a = 100</td>
<td>3450</td>
<td>1985</td>
<td>0</td>
<td>1465</td>
<td>1824</td>
<td>441</td>
<td>37</td>
<td>0</td>
<td>32</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Foreign</th>
<th>W^*</th>
<th>CS^*</th>
<th>TR^*</th>
<th>H^*</th>
<th>H_{FF}^*</th>
<th>H_{HH}^*</th>
<th>p^*</th>
<th>( t^* )</th>
<th>( y )</th>
<th>( y^* )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seg a = 71</td>
<td>1864</td>
<td>644</td>
<td>145</td>
<td>895</td>
<td>847</td>
<td>47</td>
<td>34.1</td>
<td>21.3</td>
<td>6.9</td>
<td>29.1</td>
</tr>
<tr>
<td>Lib a = 71</td>
<td>1864</td>
<td>925</td>
<td>0</td>
<td>930</td>
<td>484</td>
<td>455</td>
<td>27</td>
<td>0</td>
<td>21.3</td>
<td>22</td>
</tr>
<tr>
<td>Seg a = 100</td>
<td>1738</td>
<td>644</td>
<td>145</td>
<td>950</td>
<td>847</td>
<td>402</td>
<td>34.1</td>
<td>21.3</td>
<td>10.1</td>
<td>29.1</td>
</tr>
<tr>
<td>Lib a = 100</td>
<td>2370</td>
<td>925</td>
<td>0</td>
<td>1445</td>
<td>484</td>
<td>961</td>
<td>27</td>
<td>0</td>
<td>31</td>
<td>22</td>
</tr>
</tbody>
</table>

Examination of Table 3, where transportation costs are small, reveals that both countries are better off following trade liberalization when the difference between \( a = 71 \) and \( a^* = 70 \) is small. Although in both countries tariff revenue decreases to zero as a result of trade liberalization, both consumer surplus and profit increases. With small transportation costs, the increase in home (foreign) firm profit earned in the foreign (home) market more than offsets the decrease in home (foreign) firm profit earned in the home (foreign) market. Trade liberalization increases the volume of trade and increases welfare in both countries since transportation costs are low.

On the other hand, when the difference between \( a = 100 \) and \( a^* = 70 \) is large, the home country loses from trade liberalization while the foreign country continues to gain. The increase in home firm profit earned in the smaller foreign market is not sufficient to offset the loss in home firm profit earned in the larger home market. In fact, the loss in home firm profit and tariff revenue is such that home welfare decreases.
Diagram 1

Case 1
Segmented Markets

Case 2
Integrated Markets

Case 4
Monopoly - Foreign market

Case 5
Monopoly - Both Markets

Monopoly - Both Markets

x^* = 0

y = 0

Monopoly - Home Market

y = 0

(0, 0)

Diagram boundaries:

- t*
- (a^*-c-2T)/2
- (a^*-3T)
- a-a^*-3T
- 0
- (a-a^*-3T)/2
- (a-c-T)/3
- (a-c-2T)/2
- t
Diagram 2

\[ t^* = \frac{(a-c-T)}{3} \]

\[ (a-a^-3T)/2 \]

\[ t_i \]

\[ W_{s1} \]

\[ W_{s2} \]

\[ (a-a^-3T)/2 \quad t_i = (a-c-T)/3 \]

\[ t \]