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**Theoretical Models of Trade Blocs and
Integrated Markets**

by

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Declaration

This thesis is all my own work, except for Chapter 4 which is adapted from a joint paper with David R. Collie and Morten Hviid, published in the *Journal of Economic Integration*, Vol. 14 No. 4, December 1999. I confirm that this thesis has not been submitted for a degree at another university.

Summary

This thesis consists of four main chapters, together with a general introduction and conclusion. The thesis examines, both separately and together, the formation of trade blocs and global market integration. All the models use a partial equilibrium framework, with firms competing as Cournot oligopolists.

Chapter 2 presents two models of trade bloc formation under segmented markets. In the first model, with common constant marginal costs, global free trade is optimal for all countries when there are no more than four countries, but with five or more countries there is an incentive to form a trade bloc containing most countries, but excluding at least one. The second model introduces a cost function where a firm's marginal cost is lower when it is located in a larger trade bloc, with little effect on the results. Chapter 3 analyses the formation of trade blocs between countries with different market sizes under segmented markets. The formation of a two country customs union or free trade area will always raise the smaller country's welfare, while the larger country will usually lose from a free trade area, and sometimes from a customs union.

Chapter 4, which is joint work with David R. Collie and Morten Hviid, presents a model of strategic trade policy under integrated markets, under complete and incomplete information. In the former case, a low cost country will give an export subsidy which is fully countervailed by the high cost country's import tariff. In the simultaneous signalling game, each country's expected welfare is higher than under free trade. Chapter 5 considers models of trade bloc formation under integrated markets. With common constant costs, there is no incentive for blocs to form. When costs are decreasing in membership of a bloc, either global free trade is optimal or countries would prefer to belong to the smaller of two blocs.

Chapter 1.

Introduction

1.1 General introduction and motivation

This thesis contains four main chapters which examine, both separately and together, the formation of trade blocs and global market integration. As is argued in this introduction, these are two important issues facing the world trading system today, but despite their significance there are many important implications of both which are not well understood and are not considered by existing theoretical models. Throughout the thesis a partial equilibrium approach, in which firms compete as Cournot oligopolists, is taken, following much of the literature on strategic trade policy.

In recent years there has been much talk about both globalisation and regionalisation within the world trading system. The first of these terms encapsulates the idea that the world is in some way becoming smaller. In the context of trade, this is largely because improvements in transport and communications have reduced transactions costs and increased transparency where price differences exist between markets. Meanwhile the process of regionalisation suggests that neighbouring countries are becoming integrated at a faster rate than countries which are further apart. Both these factors are modelled in this thesis, the former by analysing trade policy under integrated markets and the latter by examining the causes and consequences of trade bloc formation. An additional factor which might arise from the process of regional integration is a fall in the costs facing firms within a trade bloc, which is included in some models in this thesis.

The recent rise in the importance of trade blocs, taken here to mean any form of trade agreement such as a customs union or free trade area which involves the abolition of tariffs between its members, is an issue which is currently of great concern to both trade theorists and policy makers. As of May 1998, almost 180 regional trade agreements had been reported to the World Trade Organisation (WTO), a third of them since 1990, and all WTO members except Japan, Hong Kong and Korea belonged to at least one.¹ The formation of the North American Free Trade Agreement (NAFTA) and successive expansions of the European Union (EU) and European Economic Area (EEA), in particular, have led to much debate about the advantages and disadvantages, to both member countries and the world as a whole, of such arrangements. A comprehensive overview of the debate is provided by Panagariya (1998). Among the major issues are the effects of the formation and expansion of trade blocs on members' and non-members' tariff rates and welfare, and the relationship between regional and multilateral free trade. This thesis does not address the latter set of issues, but contributes to the discussion on the former. This literature was largely inspired by Krugman's (1991) monopolistic competition model of symmetric customs unions, which suggested that global welfare would be minimised when the world was divided into three customs unions. However other papers (Bond and Syropoulos (1995, 1996), Sinclair and Vines (1994)) have shown that this result is not robust to changes in factors such as countries' endowments, the type of trade bloc and the nature of competition.

¹ *Financial Times*, 18 May 1998.

All the models mentioned above assume symmetry between countries and blocs, which is an assumption that the models in this thesis move away from. Although the assumption of symmetry between blocs allows for many clear results to be obtained concerning the effects of changes in the size and number of blocs, the question of whether a symmetric bloc structure is a plausible equilibrium is not generally addressed. In addition, these models are likely to miss important effects arising from different bloc sizes, such as a possible increase in market power for a large bloc, relative to a smaller bloc, when setting its tariff rate. The assumption of symmetry between countries also limits the insights which can be gained from models of trade bloc formation. Although this assumption can simplify the analysis of bloc formation and leads to many clear and interesting results, some real life events, such as the formation of NAFTA, cannot be explained in such a context.

At first it was widely believed that the proliferation of regional trade agreements was related to fears about the future of multilateral trade reforms, as there were major doubts as to whether the Uruguay Round of GATT negotiations would be successfully completed. However, the trend towards regionalism does not appear to have subsided since the completion of the Round, suggesting that there are benefits to be achieved from trade bloc membership within a stable multilateral system.² Three of the chapters in this thesis develop models of trade bloc formation in which firms compete as Cournot oligopolists, following in the tradition of much of the literature on strategic trade policy (for example Brander and Spencer (1984, 1985); the literature

² Although the perceived benefits from membership of a trade bloc might be non-economic, this thesis concentrates on the possible economic benefits.

on strategic trade policy is surveyed extensively in Brander (1995)). Some previous papers (Sinclair and Vines (1994), Collie (1997)) analyse the behaviour of trade blocs under Cournot oligopoly, but assume a symmetric bloc structure. Yi (1996) removes this assumption and instead considers the optimal structure of trade blocs. The models in Chapters 2 and 5 follow his approach closely. While assuming that countries are symmetric, trade blocs of different sizes are allowed to form using an equilibrium concept based on Yi's 'unanimous regionalism.' Under this assumption, the existing members of a trade bloc must all agree before a new member can be admitted. Thus any trade bloc can prevent outsiders from joining. This seems more consistent with the observed behaviour of, for example, the EU and NAFTA than the alternative assumption of 'open regionalism', under which any country which desires entry to a trade bloc is free to join.

A novel feature added to the models in Chapters 2 and 5 is consideration of the case in which increasing membership of a trade bloc can lower the marginal cost of firms based in member countries. The assumption of common marginal costs is replaced by marginal costs decreasing in the size of the trade bloc in which the firm is based. Hence, when the world is divided into two asymmetric blocs, firms based in countries in the larger bloc have lower costs than firms located in the smaller bloc. There are a number of reasons why this might be true, including the harmonisation of standards and an increase in research joint ventures, but perhaps the most important cause, given the partial equilibrium nature of the model, is a likely fall in the cost of intermediate inputs arising from the abolition of tariffs on trade between partners.

The potential reduction in firms' costs due to trade bloc membership is an important effect which has generally been ignored in previous partial equilibrium models, although it has been recognised by policy makers. Many of the measures introduced under the EU's '1992' programme, in response to the Commission's report on *The Costs of Non-Europe* (Commission of the European Communities (1988)), were designed to both deepen regional integration and reduce the costs of firms located in member states. Among the costs identified by the report, customs procedures were estimated to cost around 8 billion ECU per year (1985 prices), with an effect equivalent to a tariff of 1.6% on intra-EU trade, while the cost of differing technical standards and regulations was estimated at 40 billion ECU per year. Hence there is a clear possibility that increased regional integration could have a significant effect in reducing costs faced by firms within Europe.

While the two models presented in Chapters 2 and 5 assume, as in the previous literature dealing with trade blocs under imperfect competition, that countries are symmetric, there may be important effects arising from asymmetries between countries which cannot be accounted for by such models. Whereas a model with symmetric countries could provide an insight into the economic motivation behind certain trade blocs, such as the early European Economic Community or MERCOSUR, where countries are in many ways similar, other trade blocs clearly cannot be characterised as symmetric. For instance, NAFTA consists of three members (the United States, Canada and Mexico) which have vast differences in income and levels of development, while the eagerness of many Eastern European states to join the EU cannot be explained by a symmetric model. Hence Chapter 3

presents a framework for the analysis of the formation of trade blocs between asymmetric countries, where the asymmetry is characterised by differences in a demand parameter. This allows for an explanation of why a small country might wish to join a large partner in a free trade agreement or customs union, while also suggesting a reason for the existence of side agreements which accompany many such trade agreements, typically featuring concessions made by small countries to their larger partners on non-trade issues.

The trend towards regionalism is one factor which could be associated with a move towards integrated markets. When Smith and Venables (1988) estimated the potential gains to European countries from the 1992 programme, one of the factors they considered was the possibility of a move from segmented to integrated markets. Taken together with the cost reducing effect of deeper integration, they showed that significant welfare gains were possible. With Cournot competition and no entry, a move to integrated markets raised the estimated welfare gain (as a percentage of EU consumption) from the 1992 measures from 0.63% to 2.61%.³

Although the evidence that markets are becoming more integrated is somewhat limited, a recent report by the European Commission (DG15 (1996)) finds some evidence of price convergence between countries, which is taken to be evidence of increasing integration. The greatest convergence has tended to occur in highly traded sectors, especially those where competition from outside the EU is significant,

³ Other scenarios considered by Smith and Venables (1988) assumed free entry and Bertrand competition. The equivalent figures for welfare gains, without and with a move to integrated markets, with free entry are 0.98% and 6.15%. With Bertrand competition, the change from segmented to integrated markets has no welfare effect.

suggesting that market integration is a global phenomenon rather than simply a regional one resulting from EU policy initiatives. The study also finds that price convergence is greater in markets characterised by homogeneous products.

While regionalism and market integration are clearly linked to some extent, at the same time there are good reasons to believe that global markets are becoming more integrated independently of any regional effects. In recent decades there have been rapid improvements in transport and communications, meaning that transactions costs on trade have fallen while there is a greater awareness of differences in product availability and prices between markets. These factors suggest that the importance of geographical distance between markets is declining. In addition, the continuing development of Internet commerce means that many products are available to consumers around the world from a single source. Hence the assumption, common to most of the literature on strategic trade policy, that markets are nationally segmented is gradually becoming less tenable. In fact, many firms now regard the global economy as their market place, and such a situation calls for the analysis of trade policy in a single integrated world market rather than in segmented markets. The analysis of strategic trade policy under integrated markets is not widely understood with only a few papers (Markusen and Venables (1988), Venables (1994), Fisher and Wilson (1995), Collie (1998)) dealing with this case. Although the assumption of segmented markets, taken together with constant marginal costs, greatly simplifies the analysis of trade policy by allowing any country's market to be analysed independently of all other markets, this strategic independence between markets is increasingly unappealing given the current economic environment and the often

commented on trend towards globalisation. Although the alternative assumption of integrated markets, implying perfect arbitrage between countries, is also very strong, it is important to understand the similarities and differences between the two assumptions in the presence of increasing global economic integration.

Integrated markets imply certain restrictions on the types of trade policy which can be used by governments. In general, subsidies used on their own are inconsistent with integrated markets as they allow profitable arbitrage opportunities, while import tariffs artificially segment markets. Hence the models in Chapters 4 and 5 use a trade policy instrument which combines an import tariff (subsidy) with an equal export subsidy (tax). There are three main reasons for using this trade policy instrument. Firstly, the use of an equal import tariff allows export subsidies to be used under integrated markets as they ensure there is no opportunity for arbitrageurs to make a profit by repeatedly exporting a good, collecting the export subsidy and then re-importing the good. Secondly, this trade policy instrument ensures that markets remain integrated rather than being artificially segmented, as would be the case if an import tariff was used alone. Thirdly, the trade policy instrument greatly simplifies the analysis of trade policy under integrated markets as it implies a single arbitrage condition which holds with equality, rather than the two inequalities which would be implied by the use of conventional trade policy.

The trade policy instrument described above is introduced in Chapter 4, where it is used in a two-country strategic trade policy model under both complete and incomplete information. In Chapter 5 the complete information model is extended to a

multi-country model, and the formation of trade blocs under integrated markets is analysed.

This introductory chapter continues by considering alternative approaches to modelling the formation of trade blocs and explaining the approach taken in later chapters. The last section of this chapter contains an outline of the remainder of the thesis.

1.2. Modelling trade bloc formation

Given that one of the main aims of this thesis is to analyse the optimal size of trade blocs under various assumptions, it is important to consider how the formation of a trade bloc should be modelled. Chapters 2 and 5 look explicitly at models of bloc formation, while the model of trade blocs between asymmetric countries in Chapter 3 also involves certain underlying assumptions about the behaviour of both members and non-members, even though there is no consideration of equilibrium trade bloc structures. The game theoretic literature on coalition formation is extensive, with many recent contributions both at a purely theoretical level and with particular applications in areas such as industrial organisation, public economics and international trade. The aim of this section is to identify certain key differences between approaches and consider how best to model trade bloc formation. The following issues need to be considered, and are discussed below. Should bloc formation be modelled as a cooperative or a non-cooperative game? What is the

process by which coalitions are formed? When is a coalition stable? After a coalition is formed, what happens to those who are excluded? And what assumptions are made about the behaviour of these outsiders?

Perhaps the most fundamental distinction between models of coalition formation is that between cooperative and non-cooperative approaches. Cooperative approaches are generally based on core theory, an example being Hart and Kurz's (1983) paper, which models endogenous coalition formation as a cooperative game, using a coalition structure value developed by Owen (1977). It is assumed that players form coalitions to bargain over a fixed total pay-off, with only efficient outcomes considered. However, this does not seem to be a realistic approach to modelling trade blocs. In the global economy, countries and firms which belong to the same trade bloc still behave non-cooperatively in the markets where they compete and the assumption of efficient outcomes does not seem reasonable. While there are some mechanisms in place in the EU for redistributing income between countries, these are not really linked to the distribution of gains from trade. Rather than thinking of some total payoff to all members resulting from the formation of a trade bloc and explaining how it is divided between countries, it seems more realistic to consider the payoff to each country acting individually without the possibility of transfers between countries. An additional drawback of cooperative equilibrium concepts such as the core or the bargaining set is that they concentrate on the allocation of fixed payoffs. As Ray and Vohra (1997) note, this is only appropriate when the actions of players outside the coalition do not affect the payoffs of coalition members. This is not generally the case when looking at models of international trade. Hence a non-cooperative approach to

trade bloc formation is preferred, where firms and countries compete to maximise their own payoffs.

When considering the process of coalition formation, some assumption needs to be made about the form which negotiations take. It is assumed in Chapters 2 and 5, following Bloch (1995, 1996) and Yi (1996) that the process involves one player proposing a coalition consisting of a subset of the players, after which each potential member of the coalition can accept or reject the coalition. The coalition forms if and only if all potential members agree to it. This comes closer to matching the process by which trade blocs are actually formed than an alternative assumption of matching proposals (as in Hart and Kurz (1983)), under which every player proposes the coalition which it wishes to belong to and the coalition is formed if and only if all members make the same proposal. Another possible assumption would be that made by Bernheim et al. (1987) and Ray and Vohra (1997), that the negotiating process begins with the grand coalition, from which groups of players can leave to form separate coalitions. However, in a trade model, this is equivalent to assuming that the starting point for negotiations is global free trade, which does not seem to be a reasonable assumption when observing the real world.

Another issue surrounding the formation of coalitions is whether or not any agreement is binding. Bernheim et al. (1987) introduced the concept of a coalition-proof Nash equilibrium (CPNE). A CPNE must be self-enforcing, meaning that each player's action must be a best response to other players' actions, and no coalition of players can profitably deviate. An alternative assumption is made by Ray and Vohra

(1997) in their model of equilibrium binding agreements. They assume that players joining a coalition sign a binding agreement, so the coalition does not need to be self-enforcing. Although it is arguable which of these two cases is more appropriate to the issue of trade bloc formation, the former is used and it is assumed that agreements must be self-enforcing.

A related issue is that of stability of a coalition. Under the solution concepts considered by d'Aspremont et al. (1983) and Hart and Kurz (1983), a coalition structure is only stable if there is no incentive for any player or group of players to leave their coalition or join another. The 'internal stability' concept, that a coalition is not stable if one or more of the members do not want to belong to it, is essential for any model of trade bloc formation. Countries are not forced to join preferential trade agreements, but do so only if they perceive it to be in their interests. However, the 'external stability' concept, that no player outside a coalition should wish to become a member, does not seem appropriate when considering trade blocs. Many countries in Central and Eastern Europe wish to join the EU, and similarly many countries in Central and South America wish to join NAFTA, but the existing members of these organisations are free to block entry. Hence the ability to block entry should be a feature of how trade bloc formation is modelled. This is a feature of a number of models of coalition formation, including Bernheim et al. (1987), Ray and Vohra (1997) and Bloch (1995).

When considering the formation of a coalition, the assumption made about what happens to non-members is crucial. Two possible extreme assumptions were

introduced by Hart and Kurz (1983). Under their concept of δ -stability, all outsiders form a single coalition, whereas with γ -stability all outsiders remain as singletons. In the model of Bernheim et al. (1987), in which a new coalition can only be formed by a player or group of players leaving an existing coalition, it is assumed that other members of the coalition which breaks down can form any coalitions among themselves but all players outside that coalition remain in their original coalitions. Finally, Ray and Vohra (1997) assume that any (optimal) coalition structure is possible. The last of these four possible assumptions would seem to be the best, as it incorporates the others as special cases, and where possible it is used in Chapters 2 and 5. However, given the difficulty of solving some of the models in this thesis, even when only allowing for two blocs, it is not always possible to use the most general assumption. For the case considered in Chapter 2 with segmented markets, Yi (1996), using a similar but more general model of trade bloc formation, has shown that with a reasonable assumption about the number of countries in the world there will never be more than two blocs in equilibrium.⁴ Hence assuming a maximum of two blocs in the world, as is done for some results in Chapter 2, is not unduly restrictive. Under integrated markets, as considered in Chapter 5, the model with constant costs can be solved more generally but the model with costs dependent on the size of the trade bloc is only solved for two blocs. The focus of Chapter 3 is somewhat different, looking at the effects of asymmetric countries forming or expanding trade blocs without trying to find an equilibrium structure. In that chapter it is generally assumed for simplicity that outsiders are all singletons; however, given the assumptions of the

⁴ The relationship between Yi's model and the model presented in Chapter 2 is discussed in more detail in that chapter.

model, a sufficient assumption is that the structure of any trade blocs other than that being considered does not change.

The final issue regarding the modelling of coalition formation mentioned above is that of the assumption made concerning the actions of outsiders. The two obvious assumptions which could be made about their response to a trade bloc being formed are firstly that their actions are unchanged (Bernheim et al. (1987)) and secondly that they play best responses (Ray and Vohra (1997), Bloch (1995)). Throughout this thesis, the second of these assumptions is used.

Taking into account the discussion above, the formation of trade blocs is modelled as a noncooperative sequential game, based on Bloch's (1995) model of endogenous formation of associations in oligopolies and Yi's (1996) model of endogenous trade bloc formation with unanimous regionalism. Bloch (1995) considers a Cournot oligopoly with homogeneous products, with associations formed to reduce costs but not to collude on the market. The unique equilibrium association structure consists of two asymmetric coalitions, the larger of which contains roughly three quarters of the firms in the industry.

Firms are indexed $i = 1, 2, \dots, n$. One firm i is selected as the initiator and proposes an association, $A(i)$, consisting of a subset of the firms in the industry. All prospective members of association $A(i)$ respond in turn, and the association is only formed if all these firms agree. In this case the remaining firm with the lowest index number is chosen as the new initiator. If a prospective member of $A(i)$ rejects the

offer, it becomes the initiator in the new round. The game has an infinite horizon and firms do not discount payoffs. In the case of an infinite play of the game, all firms receive a payoff of zero. The process continues until an association structure emerges, which is a partition of all the firms in the industry into disjoint associations.⁵

The structure of Bloch's (1995) game, used by Yi (1996) when considering 'unanimous regionalism', allows existing members of an association to block entry by new members, so a structure is stable so long as no firm wishes to leave its association given that other associations can prevent it from entering. This approach seems suitable for the analysis of customs unions, as existing members can clearly prevent new members from entering.

This game allows for the formation of asymmetric associations, and it is possible that in equilibrium countries in one trade bloc would rather become members of a different bloc.⁶ This situation arises because of the ability of any member of a trade bloc to prevent the admission to the bloc of a country which it does not want to join.

⁵ Bloch (1995) shows that with symmetric firms the equilibria in the game of association formation in an oligopolistic industry are the same as those in a game in which firms sequentially announce choices of association sizes.

⁶ In Bloch's (1995) model, the firms in the larger association earn higher profits, so all firms would prefer to belong to this association. This presents the obvious problem of how membership of different associations is determined. In the industrial organisation setting of Bloch's paper, with firms identical *ex ante*, there is no clear way of determining which firms should belong to which association. In the case of trade blocs, geographical and political considerations will in reality play a major role in determining who belongs to which bloc. Hence the question of which countries belong to the preferred bloc, while theoretically undetermined, need not be a problem when applied to the real world.

1.3. Outline of the thesis

There are four main chapters in this thesis, together with this introduction and a general conclusion. Chapter 2 presents two models of trade bloc formation under segmented markets, first where firms have common constant marginal costs and then with costs decreasing in the number of countries belonging to a bloc. The first model is similar to Yi's (1996) model of customs union formation with unanimous regionalism, except that products are assumed to be homogeneous. Unlike in Yi's paper, explicit solutions are found for the optimal number of countries in the customs unions formed in equilibrium, given the number of countries in the world. As in Yi's paper, it is found that a majority of countries join the first bloc to form; in fact, very few are excluded. An important addition to the results found by Yi concerns the stability of free trade when the world consists of small numbers of countries. When there are no more than four countries, global free trade is shown to always be preferred by all countries, whereas when there are five or more countries in the world there is always an incentive for a trade bloc which excludes at least one country to be established.

The second model in Chapter 2 replaces the assumption of common marginal costs with marginal costs decreasing in the size of the trade bloc in which the firm is based. Hence, when the world is divided into two blocs, firms based in countries in the larger bloc have lower costs than firms located in the smaller bloc. While the cost reduction increases the welfare gains from trade bloc membership, it has little effect

on the results of the model. Tariff rates for a given size of bloc are similar to those when there is no cost reduction, and the size of the first bloc to form is unaffected.

Chapter 3 considers the formation of free trade areas and customs unions under segmented markets, in a world where countries differ in market size, as measured by a demand parameter. In all other ways, countries are identical to each other. It is shown that the formation or expansion of a free trade area will always lead to a reduction in members' tariffs and a rise in the joint welfare of both members and non-members. The smaller partner always gains, but usually the larger partner's welfare will decline. The effect of the formation of a two-country customs union on each country's tariff is generally ambiguous. A country's tariff is more likely to rise when (a) there are more countries to raise tariffs from; (b) the country is small; and (c) the country's partner is large. The welfare of the smaller country will always rise, while the effect on the larger country is ambiguous. Joint welfare of the member countries rises, but non-members' welfare falls. If customs union members form a single market, the optimal common external tariff and joint welfare will be the same as when markets remain segmented, but the large country is likely to be better off with the single market.

The results in Chapter 3 suggest there is unlikely to be any incentive for forming a free trade area unless transfers between partners are possible, while the result for customs unions is less clear. When a three-country model is considered, it is shown that while the formation of a two-country free trade area or customs union will raise the joint welfare of its members, in each case the larger member's welfare falls

in comparison to the Nash tariff equilibrium. Hence the smaller partner would need to compensate the larger partner to form a trade bloc.

The fact that small countries gain from trade bloc membership while large countries often lose provides a rationale for the numerous concessions by small countries on non-trade issues which have recently been seen to accompany preferential trade agreements. For example, the side agreements on the environment and labour standards which Mexico signed when joining NAFTA can be viewed as a transfer from Mexico to the United States to induce the United States to sign a welfare-reducing trade agreement.

Chapter 4, which is joint work with David R. Collie and Morten Hviid, presents a model of strategic trade policy under integrated markets and derives optimal trade policies under assumptions of both complete and incomplete information, using a trade policy instrument, described earlier in this introduction, which combines an export subsidy (tax) with an equal import tariff (subsidy). With the assumption of complete information it is shown that the optimal policy is an import tariff (export subsidy) when a country is a net importer (exporter). In the Nash equilibrium in trade policies the low cost country gives an export subsidy which is fully countervailed by the import tariff of the other country. The introduction of incomplete information about costs adds an incentive for both governments to use their trade policy as a signal of their firms' costs. This signalling effect increases the export subsidy and decreases the import tariff. In the simultaneous signalling game, with symmetry, the expected welfare in the separating equilibrium is higher than

under free trade for both countries. As well as contributing to the literature on trade policy under integrated markets, which is still rather limited, this chapter also provides the groundwork for the analysis of trade bloc formation under integrated markets in the following chapter.

Chapter 5 considers models of trade bloc formation similar to those analysed in Chapter 2, except that now world markets are assumed to be integrated and the trade policy instrument introduced in Chapter 4 is again used. The first model assumes that each country contains a single firm with common, constant marginal cost. It is shown that, under the assumptions of the model, tariffs and welfare are independent of the size of trade blocs. Hence there is no incentive for trade bloc formation. The model is then adapted so that costs fall as membership of a trade bloc increases. It is shown that when the world is divided into two trade blocs, the trade blocs will set equal trade policies. Thus the large (relatively low cost) bloc will set an export subsidy which is fully countervailed by the import tariff set by the smaller bloc. It is also shown that the grand coalition, in which all firms belong to a single cost reducing trade bloc, is unstable for a large range of parameter values. In these cases there is an incentive for a group, containing less than half of the total countries in the world, not to join the grand coalition but rather to form a separate trade bloc. The result that a country would never want to be in the larger of two blocs is initially surprising and contrasts with results found under segmented markets, but can be explained by considering the effect of the trade policy instrument on government revenue. Government revenue is positive for an importing bloc, which sets a positive import tariff, but negative for an

exporting bloc, which pays a subsidy on all exports. Thus the trade policy instrument used effectively penalises low cost, exporting blocs. It is further argued that where countries have an incentive to belong to a small trade bloc, the two bloc coalition structure is likely to prove unstable and a larger number of small blocs is likely to form.

Chapter 2.

Trade Bloc Formation Under Segmented Markets

2.1. Introduction

In recent years there has been growing interest in regional integration. Many developments, including the completion of the European Single Market under the '1992' programme, the formation of NAFTA and the recent enlargement of the EU, have suggested that regional trade arrangements are an increasingly important component of the global trading system. It also seems likely that the move towards regional trade blocs will continue, with many Eastern European countries applying to join the EU and a number of countries in Central and South America pursuing NAFTA membership. Although the successful completion of the Uruguay Round has strengthened the multilateral trading system and partially allayed fears that regionalism is becoming more important than multilateralism, trade blocs are still clearly of great importance in international trade.⁷

Much of the recent literature on trade blocs, as in other areas of international trade theory, has focused on the importance of imperfect competition, market structure and economies of scale. Krugman (1991) showed that, in a model with differentiated products and preference for variety, non-cooperative tariff setting could lead to global welfare being minimised with three customs unions, although Bond and Syropoulos (1996) and Sinclair and Vines (1994) suggest that this result is not robust to changes in the pattern of comparative advantage or the type of trade blocs (from customs unions to free trade areas) respectively. Other models considered by Sinclair

⁷ Fratzscher (1996) observes that 94% of world trade is conducted between current or potential members of the EU, NAFTA and ASEAN.

and Vines (1994) and Collie (1997) have looked at policy setting by trade blocs in oligopolistic industries. However, all these papers assume that trade blocs are symmetric, and none pay any attention to the process by which blocs are formed. A few papers, most notably Yi (1996), have developed models of endogenous trade bloc formation. This chapter extends the existing literature on endogenous trade bloc formation under segmented markets in two main ways. First, the incentives for excluding countries from a trade bloc are considered when the number of countries in the world is small, and second, a cost reducing effect of trade bloc membership is introduced.

Sinclair and Vines (1994) consider a model of multi-country oligopoly based on the two-country models of Brander and Krugman (1983) and Brander and Spencer (1984). Firms located in different countries produce undifferentiated products and compete in quantities. In this case tariffs are used to shift profits, and it is shown that a trend to fewer, larger customs unions could well lead to lower levels of protection, and always will do so once the number of symmetric unions has fallen to a certain level. The main factor driving this result is that customs union enlargement reduces the number of 'foreign' firms with rents to shift. With free trade areas in this model, trade bloc enlargement will always reduce tariffs.

Collie (1997) also considers trade blocs when firms compete as Cournot oligopolists, but in his model the trade policy instrument used is export subsidies rather than tariffs. The model is a multi-country extension of Brander and Spencer (1985). It is assumed that there is a single oligopolistic industry based in the

industrialised countries, all the output from which is exported to the developing rest of the world. The lack of trade between industrialised countries ensures that no trade diversion occurs and the model therefore concentrates on profit shifting. Countries and trade blocs are again assumed to be symmetric. As tariffs are not considered, the blocs could be either customs unions or free trade areas.

Collie's (1997) model suggests that the promotion of regional integration, leading to fewer, larger trade blocs, is desirable as, for any country, welfare for any country is an increasing function of the number of countries in its trade bloc. However, there is never an incentive for any individual country to join a trade bloc as increasing the number of countries in a bloc reduces the effectiveness of its strategic export subsidies. For instance, in a simple case with three countries, if two of the countries form a trade bloc they are made worse off, while the outsider is made better off. Thus there is a clear prisoners' dilemma: the formation of trade blocs raises welfare, but there is no incentive for individual countries to join them.

The literature dealing with trade bloc formation is relatively small. Riezman (1985) uses core theory to analyse customs union formation in a three country model. Kowalczyk and Sjöström (1994) also use core theory to analyse the relationship between customs union formation and moves towards multilateral free trade. The approach used in this chapter is much more similar to that of Yi's (1996) model of endogenous formation of customs unions. Symmetric countries produce goods, at a common, constant marginal cost, which are imperfect substitutes for each other.

Firms compete as Cournot oligopolists in segmented markets. Customs unions set their optimal common external tariffs to maximise the aggregate welfare of members.

Yi (1996) derives the following results about the welfare effects of bloc expansion on both members and non-members. The expansion of a bloc, or the merger of two or more blocs, makes outsiders worse off due to a fall in their export profits. The joint welfare of bloc members rises when a bloc expands or blocs merge, but not all members necessarily gain. Specifically, it is shown that existing bloc members might be made worse off by an expansion, or members of a relatively large bloc might lose from a merger. The effect of an expansion or merger on global welfare is ambiguous, although global free trade maximises world welfare. In any customs union structure, each member of a larger bloc is better off than each member of a smaller bloc.

Two possible rules of bloc formation are considered: open regionalism and unanimous regionalism. Under open regionalism, any country which wants to join a bloc is free to do so, so long as it abides by the rules followed by other bloc members. Under unanimous regionalism, all existing bloc members must agree before a new member can be admitted. Open regionalism is considered as both a simultaneous move game and a sequential move game. When all countries move simultaneously, the unique Nash equilibrium is global free trade, which is also a subgame perfect equilibrium (SPE) in the sequential move game. However, in the latter case this is typically not a unique SPE. A symmetric customs union structure with more than one bloc can never be stable, but there might be SPE asymmetric coalition structures.

With unanimous regionalism, there is a unique asymmetric equilibrium association structure. There can be no more than three customs unions, and for a reasonable number of countries no more than two.⁸ If the number of countries in the world is small and the degree of product differentiation high, free trade might be optimal. This situation arises when the gains from free trade outweigh the potential gains from rent shifting.

The assumption of unanimous regionalism seems more appropriate for analysing trade bloc formation than that of open regionalism. Under the latter assumption, any country must be free to join any trade bloc which is formed. However, in reality this is not true. A number of countries wish to join either the EU or NAFTA, but are unable to do so without the approval of the existing members of these blocs. Hence Yi's assumption of unanimous regionalism seems much more realistic. The assumption of unanimous regionalism can be thought of as encompassing a notion of internal stability, but without any need for external stability. Internal stability implies that no country within a trade bloc wishes to leave the bloc, or equivalently no country can be forced to join a trade bloc if it would prefer to remain outside. However, with no requirement for external stability, it is possible that countries outside a trade bloc would gain from joining the bloc, were they allowed to do so. This would seem to be consistent with real world observations of how customs unions and free trade areas are formed and restrict their membership.

⁸ For any possibility of three customs unions being an equilibrium, the world must consist of more than 262,144 countries.

The model in Section 2.2 is similar to Yi's (1996) model with unanimous regionalism, except that products are assumed to be homogeneous. Unlike in Yi's paper, solutions are found for the optimal number of countries in the customs unions formed in equilibrium, given the number of countries in the world. As in Yi (1996), it is found that a majority of countries join the first bloc to form; in fact, very few are excluded. The most important addition to Yi's results in this section is the consideration of the incentives for a customs union or free trade area, which excludes at least one country, to form when the number of countries in the world is small, in preference to global free trade. It is shown that with no more than four countries, global free trade is always optimal, whereas with five or more countries, there is always an incentive for a trade bloc to form, excluding (at least) one country.

A potentially important effect of regional integration, which has generally been neglected in previous work, is the potential for a fall in the costs faced by firms located in countries belonging to a trade bloc. A further aim of this chapter is to examine the consequences of this, and hence Section 2.3 changes the assumption made about firms' costs. The assumption of common marginal costs is replaced by marginal costs decreasing in the size of the trade bloc in which the firm is based. Hence, when the world is divided into two blocs, firms based in countries in the larger bloc have lower costs than firms located in the smaller bloc. There are a number of reasons why this might be true, including the harmonisation of standards accompanying some regional trade agreements and an increase in research joint ventures, but perhaps the most important effect, given the partial equilibrium nature

of the model, is a likely fall in the cost of inputs arising from the abolition of tariffs between partners.

The assumption of costs decreasing in the number of countries belonging to a trade bloc actually has little effect on the results of the model. The optimal tariff rate set by a bloc of any size falls slightly when the cost reducing effect is introduced, and the welfare of a member of a bloc of any size increases. However, there is no significant effect on the equilibrium structure of trade blocs.

The rest of this Chapter proceeds as follows. Section 2.2 presents the model of trade bloc formation under segmented markets with common, constant costs. Section 2.3 suggests reasons why trade bloc membership might lead to a reduction in a firm's costs, and introduces a cost function which includes this effect into the model. Finally, Section 2.4 concludes.

2.2. Model with constant costs

This section and Section 2.3 develop models of trade bloc formation under segmented markets, first with common constant costs and then with costs decreasing in the number of countries belonging to a trade bloc. The formation of trade blocs is modelled as a noncooperative sequential game, based on Bloch's (1995) model of endogenous formation of associations in oligopolies and Yi's (1996) model of endogenous trade bloc formation with unanimous regionalism. Countries are indexed

$i = 1, 2, \dots, n$. One country i is selected as the initiator and proposes an association, $A(i)$, consisting of a subset of the countries in the world.⁹ All prospective members of association $A(i)$ respond in turn, and the association is only formed if all these countries agree. In this case the country outside the association with the lowest index number is chosen as the new initiator. If a prospective member of $A(i)$ rejects the offer, it becomes the initiator in the new round. The game has an infinite horizon and countries do not discount payoffs. In the case of an infinite play of the game, all countries receive a payoff of zero. The process continues until an association structure emerges, which is a partition of all the countries in the world into disjoint associations.

This game allows for the formation of asymmetric associations, and it is possible that in equilibrium, countries in one trade bloc would rather become members of a different bloc, if entry into that other bloc were allowed.¹⁰ This situation arises because of the ability of any member of a trade bloc to prevent the admission to the bloc of a country which it does not want to join.¹¹

Formally, the model can be described as follows. First, the multi-stage game outlined above allows countries to form trade blocs. Subsequently, trade blocs set tariffs to maximise members' welfare. Finally, firms compete in quantities in segmented national markets. Although attention is later restricted to the case where a

⁹ Given the symmetry between countries, it could be assumed without loss of generality that country 1 is always selected.

¹⁰ In Bloch's (1995) model, the firms in the larger coalition earn higher profits, so all firms would prefer to belong to this coalition.

¹¹ Given the assumption of symmetry between countries, either all countries in a bloc will want another country to join or all will want to block entry.

maximum of two trade blocs can form, the model is first set out more generally to allow for any number of trade blocs and results on optimal tariffs are derived in this general setting.

The world consists of n symmetric countries, $i = 1, \dots, n$, each of which contains one firm producing a homogeneous product with common, constant marginal costs. It is assumed that there are no transport costs. The countries form customs unions or free trade areas (associations). The notation used in referring to associations follows Bloch (1995). The association to which country i belongs is denoted by $A(i)$, with the country identified by the contents of the brackets. Each individual trade bloc is identified by a subscript, which refers to the order in which the blocs are formed in the game described above. Thus the associations are indexed $r = 1, \dots, R$, with association A_1 the first to form and association A_R the last to form. The number of countries belonging to association r is denoted by a_r . Hence the association structure S is given by

$$S = \{A_1, A_2, \dots, A_R\} \quad \sum_{r=1}^R a_r = n \quad (2.1)$$

All members of association r set the same tariff rate, τ_r , on imports from all non-members. This can be seen as the MFN tariff, as required by GATT rules¹². Trade between partner countries is not subject to tariffs.

¹² The MFN principle, stated in Article I of GATT, requires that each country grants all its trading partners the most favourable treatment it grants any country. One of the exceptions to this, under Article XXIV, is for the case of preferential trade agreements with zero tariffs on trade between partners.

As usual, in analysing this game the final stage is considered first. Firms are assumed to set quantities and each firm has a common constant marginal cost c . Demand in country i is given by the linear demand function $y_i = \alpha - \beta p_i$, where y_i and p_i are total demand and price in country i . Markets are segmented, so each firm makes separate decisions about how much to supply to each market. Price in country i is given by the inverse demand function:

$$p_i = \frac{\alpha}{\beta} - \frac{1}{\beta} y_i \quad (2.2)$$

Total consumption and total production in country i are given by, respectively,

$$y_i = \sum_j x_{ji} \quad (2.3)$$

and

$$x_i = \sum_j x_{ij} \quad (2.4)$$

where x_{ij} (x_{ji}) is the amount supplied by the firm in country i (j) to the country j (i) market.

The profits earned by the firm based in country i are given by

$$\pi_i = \sum_j (p_j - c - \tau_{ji}) x_{ij} \quad (2.5)$$

where τ_{ji} is the tariff imposed by country j on imports from country i . Using the fact that $\tau_{ji} = 0$ if $j \in A(i)$ and $\tau_{ji} = \tau_j$ if $j \notin A(i)$, where τ_j is the tariff set by each member of bloc $A(j)$, (2.5) can be rewritten as:

$$\pi_i = \sum_{j \in A(i)} (p_j - c) x_{ij} + \sum_{j \notin A(i)} (p_j - c - \tau_j) x_{ij} \quad (2.6)$$

where the first term on the right hand side represents profits in countries which belong to the same trade bloc as country i , and the second term represents profits in non-member countries. Using symmetry between members of a given trade bloc, (2.6) can be rewritten as

$$\pi_i = a_i (p_i - c) x_{ii} + \sum_{j \notin A(i)} (p_j - c - \tau_j) x_{ij} \quad (2.7)$$

It should be noted that, given the assumptions of segmented markets and constant marginal costs, maximising the above expression for total profits is equivalent to maximising profits in each market individually.

Now consider the market in country i , which is a member of bloc $A(i)$. Note that, given the assumption of MFN tariffs, all firms located in blocs $A(j) \neq A(i)$ are

treated symmetrically. From (2.7), the first order conditions for maximising profits earned in country i by firms located inside and outside bloc $A(i)$, respectively, will be:

$$\frac{\partial \pi_i}{\partial x_{ii}} = a_i(p_i - c) + a_i \frac{\partial p_i}{\partial x_{ii}} x_{ii} = 0 \quad (2.8)$$

and

$$\frac{\partial \pi_j}{\partial x_{ji}} = (n - a_i)(p_i - c - \tau_i) + (n - a_i) \frac{\partial p_i}{\partial x_{ji}} x_{ji} = 0 \quad (2.9)$$

Using (2.8) and (2.9), and noting that $\partial p_i / \partial x_{ii} = \partial p_i / \partial x_{ji} = -1/\beta$, the following expressions can be obtained for the output produced by each firm for the market in country i :

$$x_{ii} = \frac{\alpha}{2} - \frac{1}{2} \sum_{k \neq i} x_{ki} - \frac{\beta c}{2} \quad (2.10)$$

$$x_{ji} = \frac{\alpha}{2} - \frac{1}{2} \sum_{k \neq j} x_{ki} - \frac{\beta c}{2} - \frac{\beta \tau_i}{2} \quad (2.11)$$

In total, there are a_i 'home' firms selling x_{ii} in country i and $(n - a_i)$ foreign firms selling x_{ji} . Equations (2.10) and (2.11) can be used to find the following pair of simultaneous equations for the two output levels:

$$(a_i + 1)x_{ii} = \alpha - (n - a_i)x_{ji} - \beta c \quad (2.12)$$

$$(n - a_i + 1)x_{ji} = \alpha - a_i x_{ii} - \beta c - \beta \tau_i \quad (2.13)$$

Solving these equations gives the following expressions for each firm's sales in country i :

$$x_{ii} = \frac{\alpha - \beta c}{n + 1} + \frac{n - a_i}{n + 1} \beta \tau_i \quad (2.14)$$

$$x_{ji} = \frac{\alpha - \beta c}{n + 1} - \frac{a_i + 1}{n + 1} \beta \tau_i \quad (2.15)$$

Total consumption in country i is $y_i = a_i x_{ii} + (n - a_i)x_{ji}$, and substituting (2.14) and (2.15) into this expression gives

$$y_i = \frac{n}{n + 1} (\alpha - \beta c) - \frac{n - a_i}{n + 1} \beta \tau_i \quad (2.16)$$

Price in country i can be found using the inverse demand function (2.2), giving

$$p_i = \frac{\alpha}{(n+1)\beta} + \frac{n}{n+1}c + \frac{n-a_i}{n+1}\tau_i \quad (2.17)$$

Welfare in country i is defined as the sum of domestic consumer surplus, profits earned by the domestic firm in both its own bloc and all other blocs and tariff revenue on imports from non-partner countries. Thus welfare is:

$$W_i = \frac{1}{2\beta} y_i^2 + a_i(p_i - c)x_{ii} + (n - a_i)(p_j - c - \tau_j)x_{ij} + (n - a_i)\tau_i x_{ji} \quad (2.18)$$

To find the optimal tariff for country i as a function of the number of countries in its bloc, a_i , W_i must be differentiated with respect to τ_i . The expression found below does not depend on the structure of other blocs, or the tariffs which they set. Hence the optimal tariff for bloc $A(i)$ is independent of what happens outside this bloc. This is unsurprising given the usual strategic independence between countries when analysing trade policy with Cournot competition and constant marginal costs under segmented markets.

$$\frac{\partial W_i}{\partial \tau_i} = \frac{1}{\beta} y_i \frac{\partial y_i}{\partial \tau_i} + a_i(p_i - c) \frac{\partial x_{ii}}{\partial \tau_i} + a_i \frac{\partial p_i}{\partial \tau_i} x_{ii} + (n - a_i)x_{ji} + (n - a_i)\tau_i \frac{\partial x_{ji}}{\partial \tau_i} \quad (2.19)$$

Using equations (2.14) to (2.17), equation (2.19) can be rewritten as:

$$\frac{\partial W_i}{\partial \tau_i} = \frac{(2a_i + 1)(n - a_i)}{(n + 1)^2}(\alpha - \beta c) - \frac{(n - a_i)(2a_i^2 + 3a_i + n + 2)}{(n + 1)^2}\beta\tau_i \quad (2.20)$$

To find the optimal tariff for a country in bloc i , equation (2.20) must be set equal to zero. Hence we find the optimal tariff to be:

$$\tau_i^* = \frac{2a_i + 1}{2a_i^2 + 3a_i + n + 2} \frac{\alpha - \beta c}{\beta} \quad (2.21)$$

Having found this optimal tariff, the effects of changing the values of n and a_i can be analysed. It is clear that an increase in n , the number of countries in the world, will reduce any bloc's external tariff, given that the number of countries belonging to that bloc remains unchanged. A more interesting issue is that of the effect of an increase in a_i , the size of the bloc being considered. Differentiating (2.21) with respect to a_i gives

$$\frac{\partial \tau_i}{\partial a_i} = \frac{-4a_i^2 - 4a_i + 2n + 1}{(2a_i^2 + 3a_i + n + 2)^2} \frac{\alpha - \beta c}{\beta} \quad (2.22)$$

For a given value of n , this equation allows the effects of an increase in a_i to be considered. For $n \geq 4$, the derivative above is positive for a_i small but $a_i \geq 1$, but quickly becomes negative as a_i increases. Thus there might initially be an increase in the optimal tariff for a small trade bloc as its size increases, but after reaching a certain size a subsequent expansion will always result in lower tariffs being set. The initial rise in tariffs is the result of an increase in market power as small countries set their tariffs cooperatively. However, an increase in membership of the trade bloc not

only increases members' market power, but also tends to reduce the effectiveness of tariffs as a profit-shifting device due to the reduction in the number of outside firms to shift profits from. As the size of a trade bloc rises, the second effect quickly starts to dominate, explaining why optimal tariffs fall. For instance, with $n = 100$ the tariff set by a bloc increases as membership rises until $a_i = 7$, after which any subsequent expansion will reduce the level of the optimal tariff. This is illustrated in Figure 2.1, which shows the common external tariff each customs union will set as a function of the number of members.¹³ It is assumed here, without loss of generality, that each firm's marginal cost c is equal to one and the parameters of demand α and β equal 100 and one respectively, while n is set equal to 100.

Next the incentive to form a trade bloc which excludes one country, as opposed to choosing global free trade, is considered. To do this, welfare under free trade is compared to welfare of a bloc which contains $n - 1$ members while excluding the final country. Using equations (2.14) to (2.17) and (2.21) in (2.18), the expressions for welfare given below can be derived. The notation $W_i(\gamma;\delta)$ refers to the welfare of country i belonging to a bloc which contains γ countries and excludes δ countries.

$$W_i(n;0) = \frac{n(n+2)}{2(n+1)^2} \frac{(\alpha - \beta c)^2}{\beta} \quad (2.23)$$

¹³ Figure 2.1 illustrates the case where there are two trade blocs and each country belongs to one or the other.

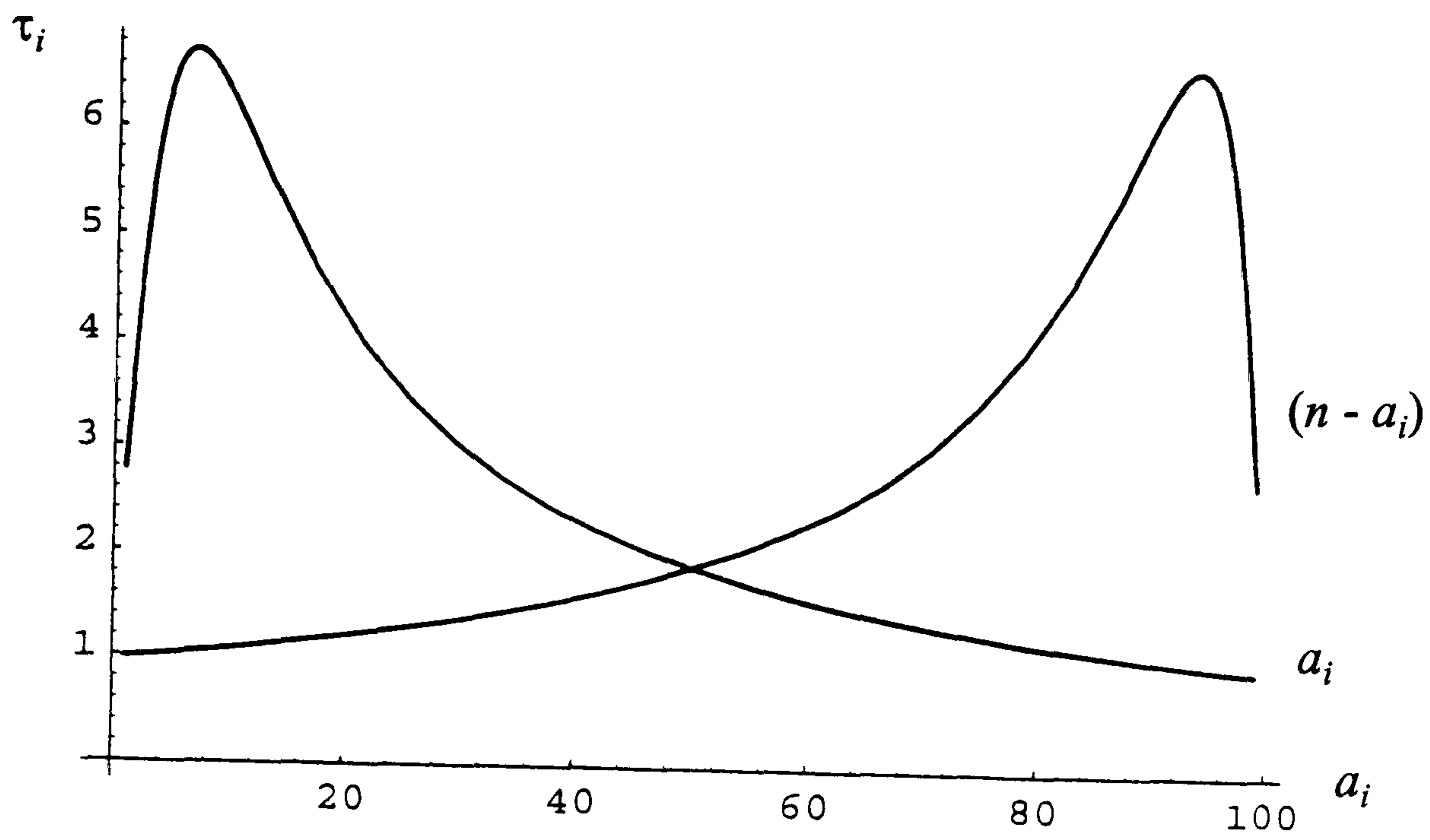


Figure 2.1. Tariffs set by blocs of size a_i and $(n - a_i)$, $n = 100$

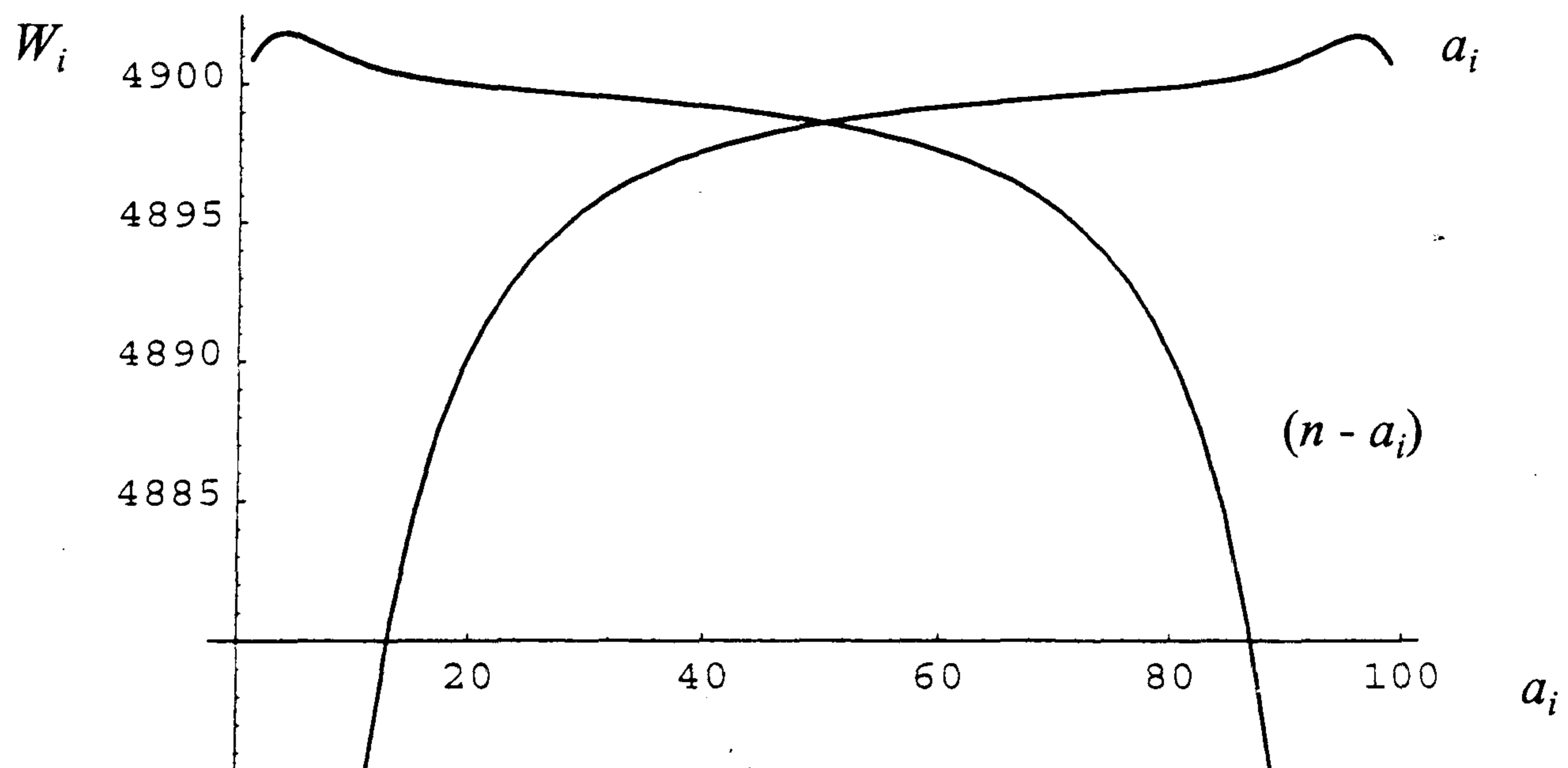


Figure 2.2. Welfare of members of blocs of size a_i and $(n - a_i)$, $n = 100$

$$W_i(n-1;1) = \frac{2n^4 + 28n^3 + 101n^2 - 14n - 47 (\alpha - \beta c)^2}{2(2n^2 + 1)(n + 7)^2 \beta} \quad (2.24)$$

Using the two equations above, it is possible to arrive at the following proposition:

Proposition 2.1. *Under segmented markets with constant costs, global free trade is optimal when there are no more than four countries. When the world consists of at least five countries, the first customs union to form will exclude at least one country.*

Proof. From equations (2.23) and (2.24), the following condition can be obtained for welfare in a bloc which excludes one country to exceed welfare under global free trade:

$$W_i(n-1;1) > W_i(n;0) \Leftrightarrow \Delta \equiv 4n^4 + 4n^3 - 51n^2 - 206n - 47 > 0$$

This condition clearly holds for large values of n , whereas for very small values of n it does not hold. The critical value of n above which the condition will hold lies between 4 and 5, as is illustrated by considering the values of Δ at $n = 4$ and $n = 5$:

$$n = 4 \Rightarrow \Delta = -407$$

$$n = 5 \Rightarrow \Delta = 648$$

Together with the fact that $d\Delta/dn = 16n^3 + 12n^2 - 102n - 206 > 0$ for $n \geq 3$, this is sufficient to show that Δ will always be positive for $n \geq 5$. Hence global free trade is

optimal with $n \leq 4$, while with $n \geq 5$ there is an incentive for a trade bloc to form which excludes at least one country. ■

Using equations (2.23) and (2.24), the actual values of welfare for country i under global free trade and in a trade bloc containing $n - 1$ countries can be found for $n = 4$ and $n = 5$, allowing the differences in welfare to be calculated explicitly:

$$W_i(4;0) = \frac{12 (\alpha - \beta c)^2}{25 \beta} \qquad W_i(3;1) = \frac{347 (\alpha - \beta c)^2}{726 \beta}$$

$$W_i(4;0) - W_i(3;1) = \frac{37 (\alpha - \beta c)^2}{18150 \beta}$$

$$W_i(5;0) = \frac{35 (\alpha - \beta c)^2}{72 \beta} \qquad W_i(4;1) = \frac{1193 (\alpha - \beta c)^2}{2448 \beta}$$

$$W_i(5;0) - W_i(4;1) = \frac{-451 (\alpha - \beta c)^2}{10116 \beta}$$

Hence $W_i(4;0) > W_i(3;1)$ and $W_i(5;0) < W_i(4;1)$, confirming the result found above.

The result that free trade is stable when there are no more than four countries in the world, but excluding at least one country is optimal when there are five or more countries, is similar to results found in the industrial organisation literature dealing with cartel formation. Selten (1973) considers a three stage cartel formation game, in which firms first decide whether to participate in cartel negotiations, then potential

cartel members submit proposals for quotas for each member and finally firms set outputs subject to any quotas. It is shown that a cartel containing all firms in an industry is stable when there are no more than four firms. Hviid (1992) presents a model in which firms first decide whether to join a cartel, then if a cartel forms it sets its output before any outsiders make their output decisions. Again, under full information, a cartel containing all firms in the industry will only be an equilibrium when there are no more than four firms.

To understand why a trade bloc which excludes some countries might be optimal for its members, it is useful to consider the effects on various components of countries' welfare resulting from a move from global free trade to the case where $n - 1$ countries belong to a trade bloc, while one country is excluded. The firm in the excluded country now faces positive tariffs in all its export markets, reducing the profits it earns in those $n - 1$ countries, which outweighs the firm's gains in its own country's protected market. However, the firms in the large bloc now earn higher profits in each others' markets and lower profits in the single excluded country. Consumer surplus falls everywhere, but this effect is greater in the excluded country, where $n - 1$ firms face tariffs and the equilibrium price rises by more, than in the large bloc with a single firm affected by tariffs. Meanwhile, all countries now have positive tariff revenue.

Generally, it can be seen that the effects described above result in larger gains and smaller losses for the $n - 1$ countries in the large trade bloc than for the single excluded country. Hence, as has already been seen, there are usually gains to be made

from forming a trade bloc which excludes at least one country. Table 2.1 below emphasises these results, showing that in each case with $n \geq 5$, the members of the larger trade bloc gain over free trade and the members of the smaller bloc lose.¹⁴ Overall global welfare is reduced by the world splitting into two blocs in each case, as can be seen by the last two columns of the table which give the mean welfare of a country in the case with two blocs (W_{ave}) and the welfare of a representative country under global free trade (W_{ft}), respectively.

Finally in this section, the optimal number of countries belonging to the first bloc to form is considered. It is assumed that the world is divided into no more than two blocs, which is not a restrictive assumption as Yi (1996), in a similar model which also allows for the possibility of product differentiation, shows that no more

n	a_1	a_2	τ_1	τ_2	W_1	W_2	W_{ave}	W_{ft}
4	4	0	-	-	4684.5	-	4684.5	4684.5
5	4	1	17.471	24.75	4776.4	4098.8	4640.9	4764.4
20	18	2	5.0594	13.75	4902.1	4628.6	4874.7	4889.4
50	47	3	2.0397	8.7721	4903.1	4776.5	4895.5	4898.6
100	96	4	1.0151	6.1027	4901.8	4833.4	4899.1	4900.0

Table 2.1: Some numerical examples with common, constant marginal costs

¹⁴ For the numerical results in Table 2.1, the following parameter values are assumed: $\alpha = 100$, $\beta=1$, $c = 1$. The results are not significantly different for other parameter values which ensure positive outputs for all firms in all markets.

than two trade blocs will ever form if the number of countries in the world does not exceed 262,144. Hence if attention is restricted to cases with a reasonable number of countries (the numerical simulations in this chapter only consider values of n up to 100), the assumption of no more than two blocs is unlikely to affect the results.

Given the expressions for outputs, demand, prices and optimal tariffs which have already been derived, the final stage in finding the optimal number of firms in the first bloc involves differentiating country i 's welfare W_i with respect to a_i , and setting the resulting expression equal to zero. It is not possible to find a general algebraic solution to the resulting equation, which is a seventh order polynomial, but it is possible to find solutions for a_i corresponding to any value of n .¹⁵ Of the seven roots, only one is real and lies in the range $0 \leq a_i \leq n$. Thus for any number of countries in the world, there is only one feasible equilibrium for the number of countries in the first bloc.¹⁶ Figure 2.3 shows the optimal value of a_i for $1 \leq n \leq 100$, while Figure 2.4 shows the proportion of countries which are in the first bloc to form (a_i/n) for the same range of n . From these two figures, it can be seen that the first bloc to form will include most of the countries in the world, but will exclude some countries. If the integer constraint on a_i is ignored, the first bloc will always contain over 90 per cent of the countries in the world. This is consistent with the result found by Yi (1996), that the first bloc to form will always contain a majority of the countries in the world.

¹⁵ This equation is given in the Appendix to this chapter.

¹⁶ Numerical simulations confirm that welfare is indeed maximised when the bloc contains this number of countries.

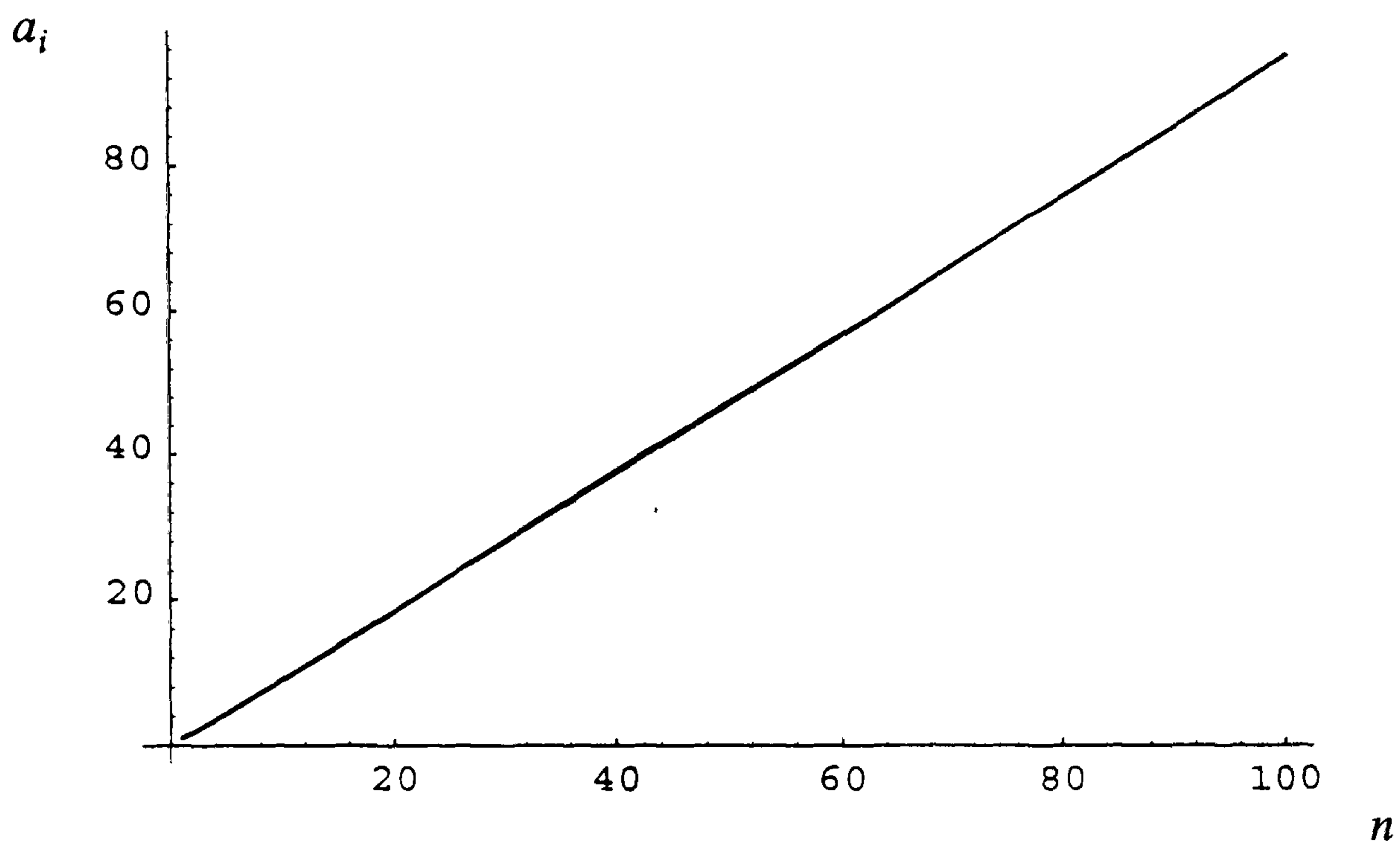


Figure 2.3. The number of countries in the first bloc to form

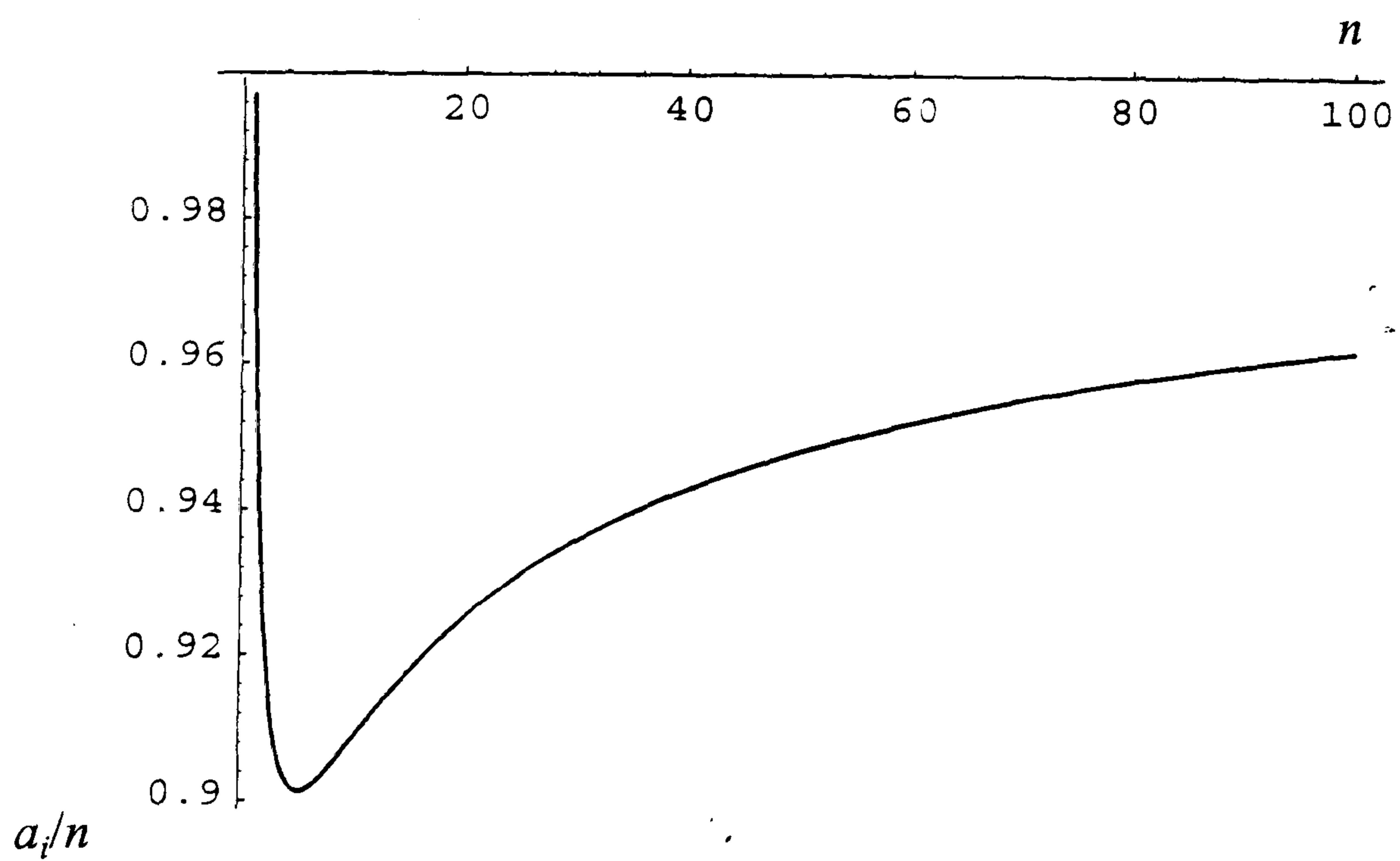


Figure 2.4. The proportion of countries in the first bloc to form

For any value of n , it is possible to calculate the number of countries in each of the two blocs. Some examples for different values of n , together with tariffs and welfare for members of the two blocs, are shown in Table 2.1. Constraining a_i to be an integer, it is found that with $n = 20$, the blocs have 18 and two members respectively; with $n = 50$, they have 47 and three members; and with $n = 100$, they have 96 and four members. As is shown in Figure 2.4, once n exceeds five the proportion of countries in the larger bloc rises with n . Constraining a_i to be an integer is particularly important to the results for small values of n , when the first customs union to form would, in the absence of this integer constraint, like to exclude less than one country.

The intuition behind the asymmetric bloc structure is as follows. An increase in the number of countries in a bloc has a number of effects. Firstly, each firm within the bloc has a larger tariff-free 'home' market, allowing a larger volume of exports to its partners in the bloc. Secondly, there are more firms selling in the domestic market of any bloc member. This tends to lower the price faced by domestic consumers, hence increasing consumer surplus, but the increased competition has a negative effect on the domestic firm's profits. Finally, there are less countries outside the bloc, meaning that any bloc member has less countries whose imports yield tariff revenues. Thus the overall effect of an increase in the number of countries in a bloc on welfare is ambiguous. However, the equilibrium customs union structure makes it clear that the first two, positive, effects on welfare dominate as membership increases until almost all the countries are included in a bloc, when the last two, negative, effects become more important.

2.3. Model with decreasing costs

This section adapts the model in Section 2.2 by changing the assumption made about firms' cost functions. Specifically, it is now assumed that the marginal cost of the firm in country i is decreasing in the number of countries which are members of $A(i)$, the trade bloc to which country i belongs. There are a number of justifications for this assumption. Perhaps the most important is that, given the partial equilibrium nature of the model, the effect of trade bloc formation on inputs into the production of the good needs to be taken into account. As more countries join a trade bloc, more inputs can be bought tariff-free from suppliers in partner countries and this is likely to cause a direct reduction in a firm's marginal cost. A second argument for the assumption of decreasing costs is that closer economic integration could lead to a number of measures which could cause a significant reduction in the costs of any firm supplying a number of different markets.¹⁷ For example, the European '1992' programme included measures to reduce costs incurred in crossing national borders and also measures to harmonise standards across member states, thus reducing production costs. Finally, an indirect effect of closer economic integration could be an increase in cooperation between firms, for instance in forming joint research ventures.¹⁸ This last justification for a reduction in costs resulting from increased membership of a trade bloc is similar to that considered by Bloch (1995) in his analysis of endogenous association formation in oligopolistic industries.

¹⁷ However, some of the cost reduction could be related to fixed costs, assumed to be zero in this model, rather than marginal costs.

¹⁸ It is assumed that while firms might cooperate in research, no collusion is possible in the market.

The specific functional form chosen for the marginal cost of firm i belonging to association $A(i)$ of size a_i is:

$$c_i = \lambda + \frac{\mu}{a_i} \quad (2.25)$$

Thus it can be seen that c_i is decreasing in a_i , but the additional effect of each subsequent member joining a trade bloc is declining. This functional form is preferred to that used by Bloch (1995), $c_i = \lambda - \mu a_i$, because of the diminishing effect that each additional bloc member has on the cost reduction. This seems more reasonable than a constant effect for the following reasons. Firstly, the more countries that belong to a trade bloc, the more likely it is that the lowest cost supplier of any input is already located within the bloc, thus reducing the potential gains from reducing the price of inputs when additional countries join. Secondly, the gains from harmonising standards (most likely derived from the possibility of longer production runs and consequent economies of scale) are likely to be less significant as membership of a customs union continues to rise. Finally, there are also likely to be diminishing returns to the number of countries participating in joint research ventures.

In this section it is assumed from the start that only two trade blocs may form; that is, if bloc A_1 forms with a_1 members, all the other $(n - a_1)$ countries in the world are members of bloc A_2 . A more general framework would be far more complicated to set up than in the previous section, as each firm's marginal cost depends on the number of partners belonging to its trade bloc. Restricting attention to two blocs from

the start means that every firm's marginal cost is known. Profits for the firm in country i are given by:

$$\pi_i = a_i(p_i - c_i)x_{ii} + (n - a_i)(p_j - c_i - \tau_j)x_{ij} \quad (2.26)$$

Hence the first order conditions for the maximisation of profits by the firm in country i are

$$\frac{\partial \pi_i}{\partial x_{ii}} = a_i \left(p_i - \lambda - \frac{\mu}{a_i} \right) + a_i \frac{\partial p_i}{\partial x_{ii}} x_{ii} = 0 \quad (2.27)$$

and

$$\frac{\partial \pi_i}{\partial x_{ij}} = (n - a_i) \left(p_j - \lambda - \frac{\mu}{a_i} - \tau_j \right) + (n - a_i) \frac{\partial p_j}{\partial x_{ij}} x_{ij} = 0 \quad (2.28)$$

Using (2.27) and (2.28) and noting that $\partial p_i / \partial x_{ii} = \partial p_j / \partial x_{ij} = -1/\beta$, the following expressions can be found for the output of a firm located in each bloc for each market:

$$x_{11} = \frac{\alpha - \beta\lambda}{n+1} - \left(\frac{n - 2a_1 + 1}{a_1(n+1)} \right) \beta\mu + \frac{n - a_1}{n+1} \beta\tau_1 \quad (2.29)$$

$$x_{12} = \frac{\alpha - \beta\lambda}{n+1} - \left(\frac{n - 2a_1 + 1}{a_1(n+1)} \right) \beta\mu - \frac{n - a_1 + 1}{n+1} \beta\tau_2 \quad (2.30)$$

$$x_{21} = \frac{\alpha - \beta\lambda}{n+1} + \left(\frac{n - 2a_1 - 1}{(n+1)(n-a_1)} \right) \beta\mu - \frac{a_1 + 1}{n+1} \beta\tau_1 \quad (2.31)$$

$$x_{22} = \frac{\alpha - \beta\lambda}{n+1} + \left(\frac{n - 2a_1 - 1}{(n+1)(n-a_1)} \right) \beta\mu + \frac{a_1}{n+1} \beta\tau_2 \quad (2.32)$$

Total consumption in country i is $y_i = a_i x_{ii} + (n - a_i) x_{ji}$, and substituting equations (2.29) to (2.32) into this expression gives:

$$y_i = \frac{n(\alpha - \beta\lambda) - 2\beta\mu - (n - a_i)\beta\tau_i}{n+1} \quad (2.33)$$

Price in country i can be found by substituting (2.33) into the demand equation (2.2):

$$p_i = \frac{\alpha}{(n+1)\beta} + \frac{n\lambda + 2\mu}{n+1} + \frac{(n - a_1)\tau_i}{n+1} \quad (2.34)$$

Welfare in country i is defined, as in Section 2.2, as the sum of consumer surplus, profits earned by the domestic firm and tariff revenue and as before the optimal tariffs set by the two blocs are found by differentiating the welfare of a representative country in each bloc with respect to that bloc's tariff. Hence the tariffs set by the two blocs will be:

$$\tau_1^* = \frac{(2a_1 + 1)(\alpha - \beta\lambda)}{(2a_1^2 + 3a_1 + n + 2)\beta} - \frac{(n - 2a_1)^2 + 2a_1 + 1}{(n - a_1)(2a_1^2 + 3a_1 + n + 2)}\mu \quad (2.35)$$

$$\tau_2^* = \frac{[2(n - a_1) + 1](\alpha - \beta\lambda)}{[2(n - a_1)^2 + 4n - 3a_1 + 2]\beta} - \frac{(n - 2a_1)^2 + 2(n - a_1) + 1}{a_1[2(n - a_1)^2 + 4n - 3a_1 + 2]}\mu \quad (2.36)$$

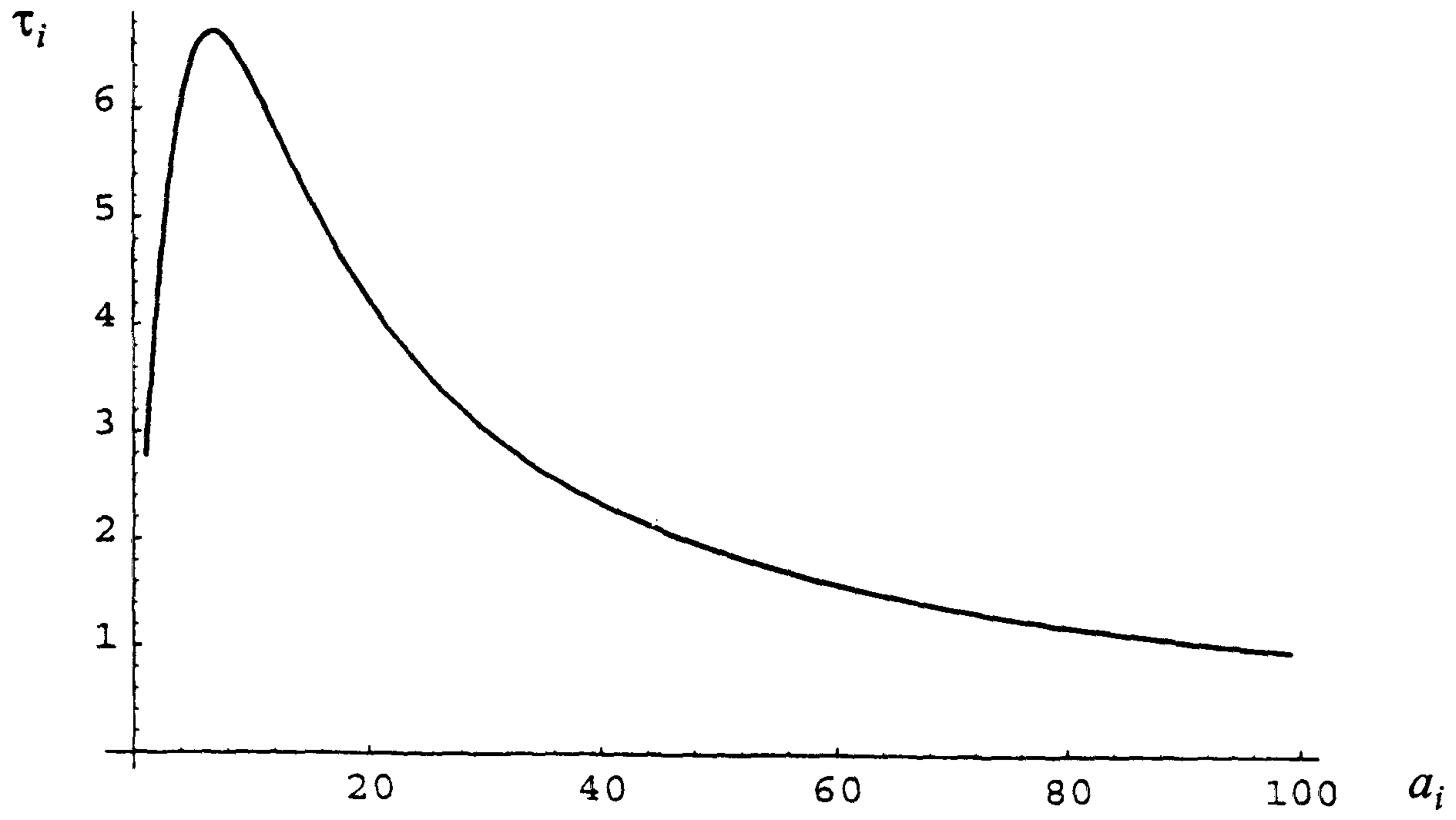
The tariff rates found above can be substituted back into the countries' welfare functions. Differentiating the welfare of a member of bloc 1 with respect to the size of that bloc then allows us to determine the optimal size of the first bloc to form. Unfortunately, as was the case for the model with constant costs, a general algebraic solution cannot be found.¹⁹ As in Section 2.2, the results presented here are obtained by numerical methods. The results presented here concentrate on a world consisting of 100 countries, with the values of α and β set at 100 and 1 respectively, while different values of λ and μ are considered.²⁰ In all cases the sum of λ and μ is equal to one. Hence the results can be interpreted as being for the case where each firm has a marginal cost of one when the country it is located in does not belong to any trade bloc, while a higher value of μ relative to λ implies that trade bloc membership has a stronger effect in reducing firms' costs.

Figure 2.5 shows optimal tariff rates set by a trade bloc with a_i members in three cases: (a) $\lambda = 1, \mu = 0$; (b) $\lambda = 0.8, \mu = 0.2$; and (c) $\lambda = 0.5, \mu = 0.5$. These cases

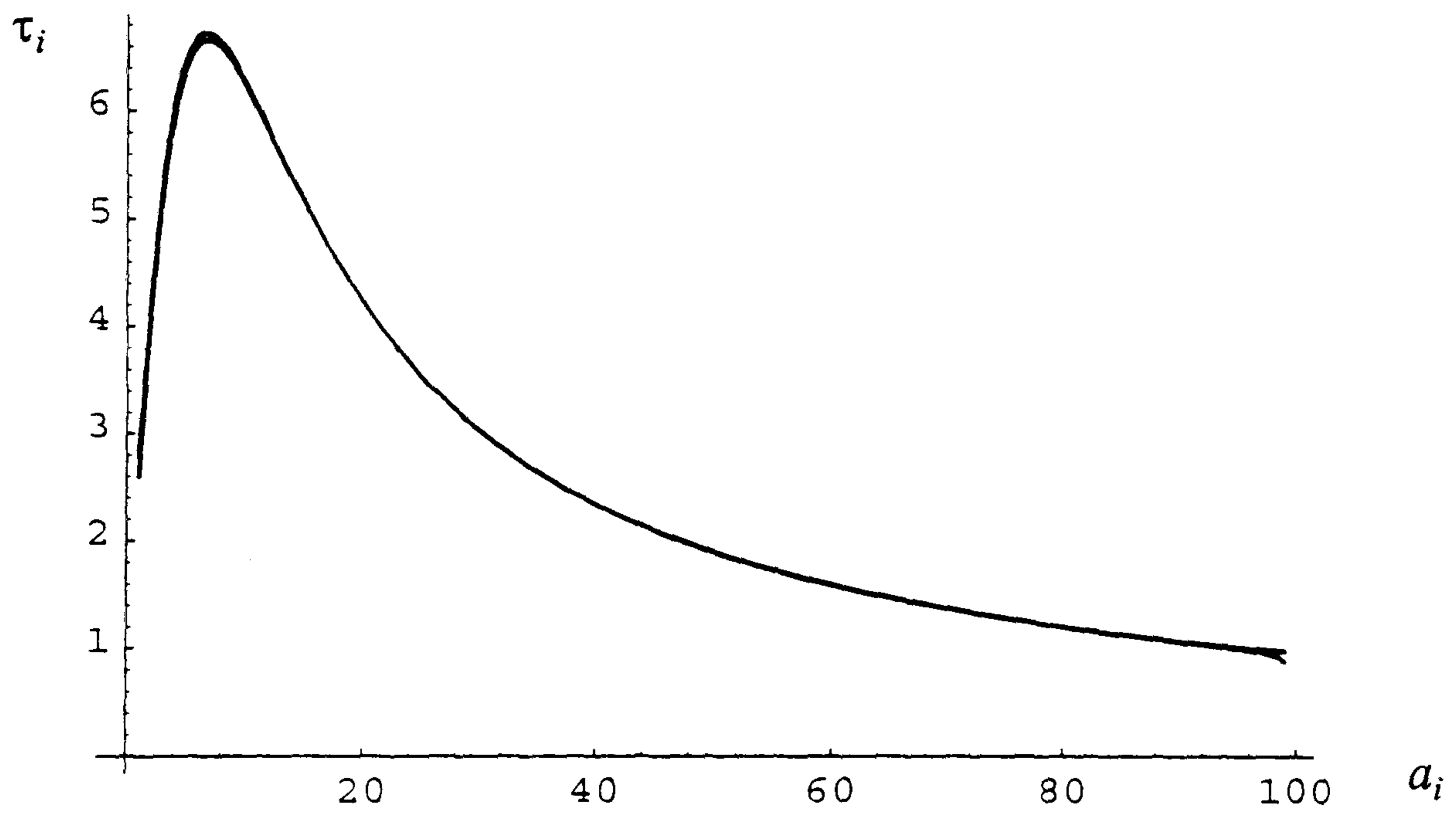
¹⁹ The equation which needs to be solved is reproduced in the Appendix.

²⁰ The parameter values are chosen to ensure that all firms set positive outputs in all markets. Other parameter values which satisfy this condition yield similar results.

(a) $\lambda = 1, \mu = 0$ (no cost reduction)



(b) $\lambda = 0.8, \mu = 0.2$



(c) $\lambda = 0.5, \mu = 0.5$

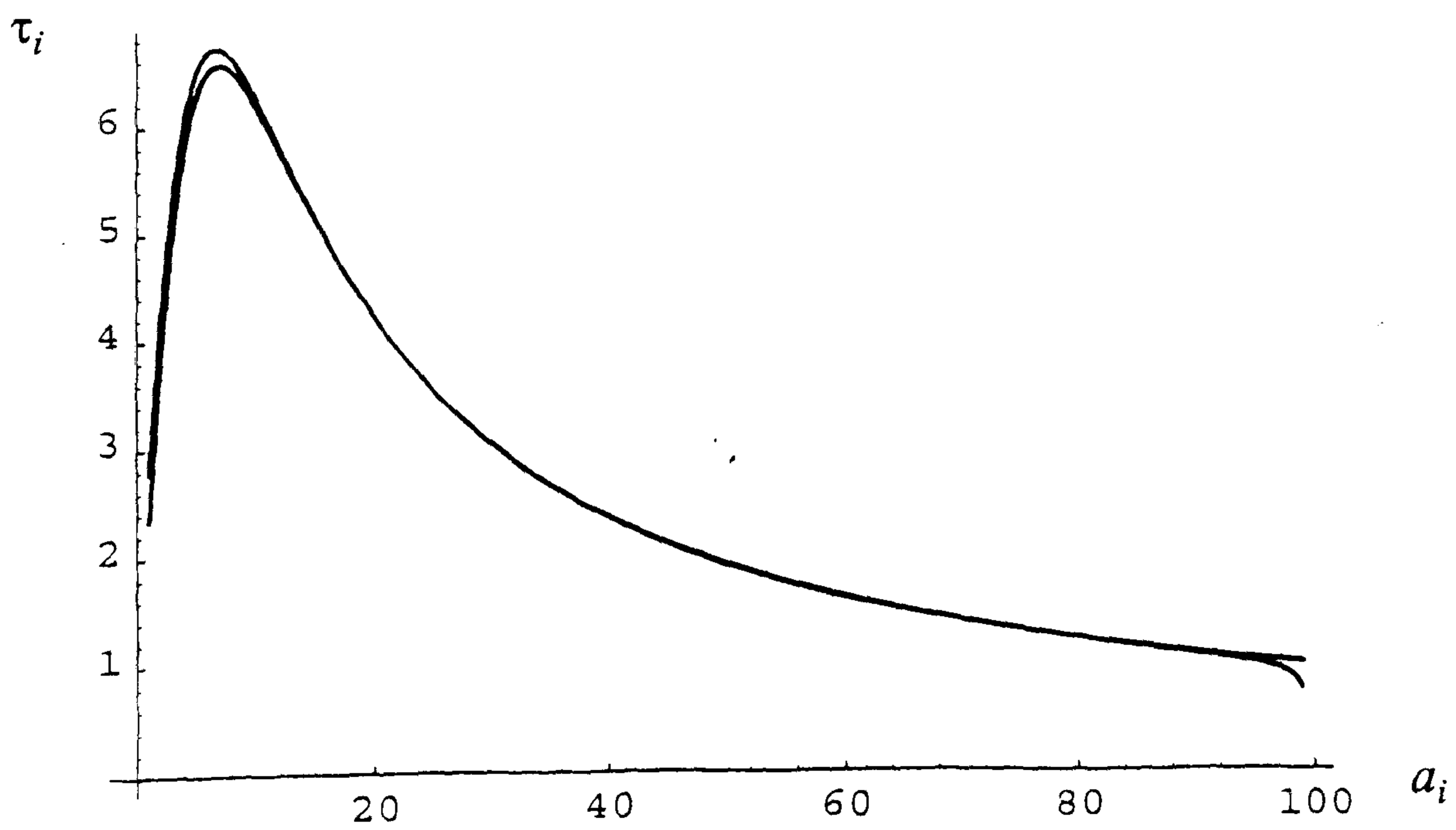
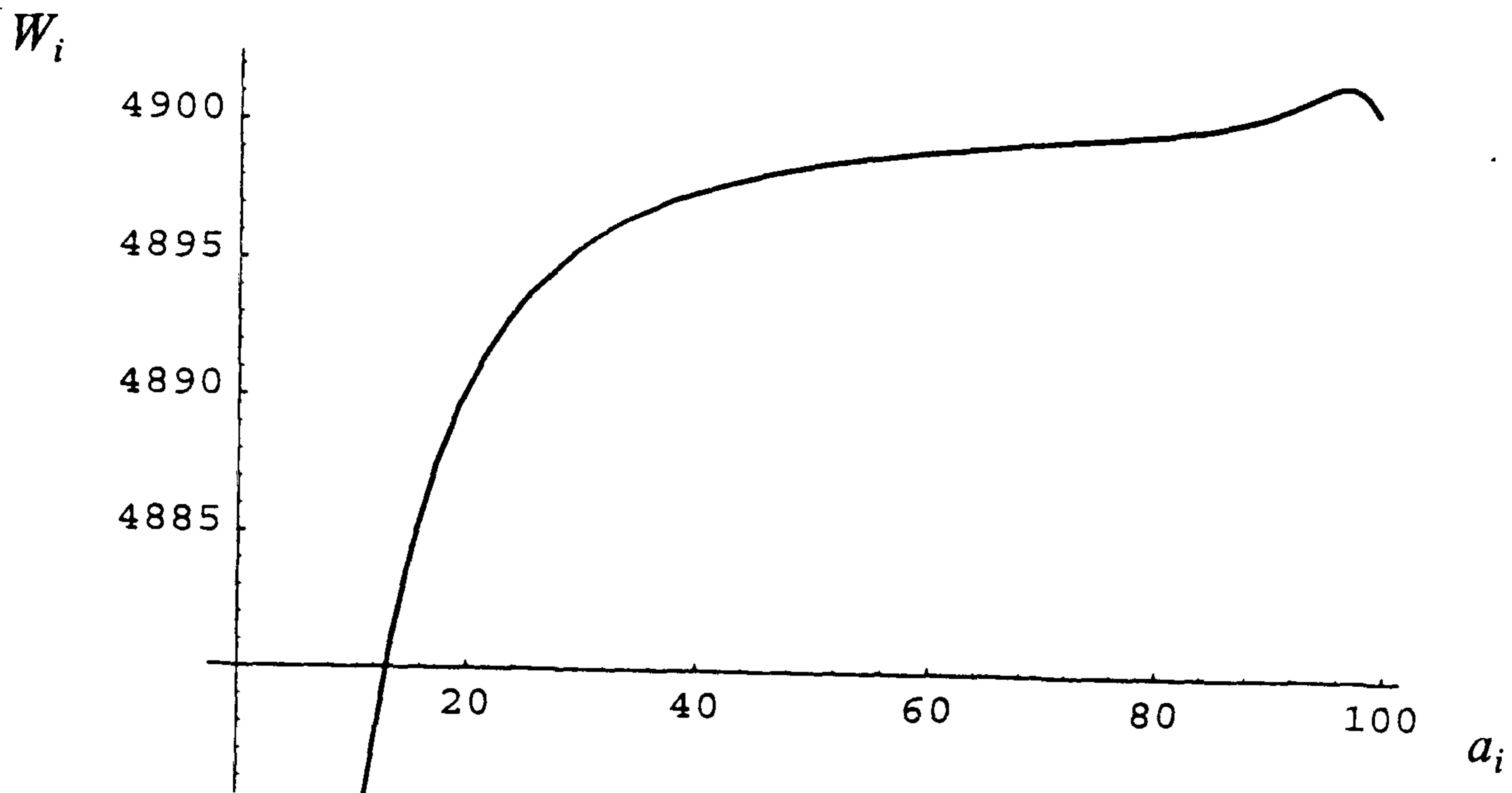
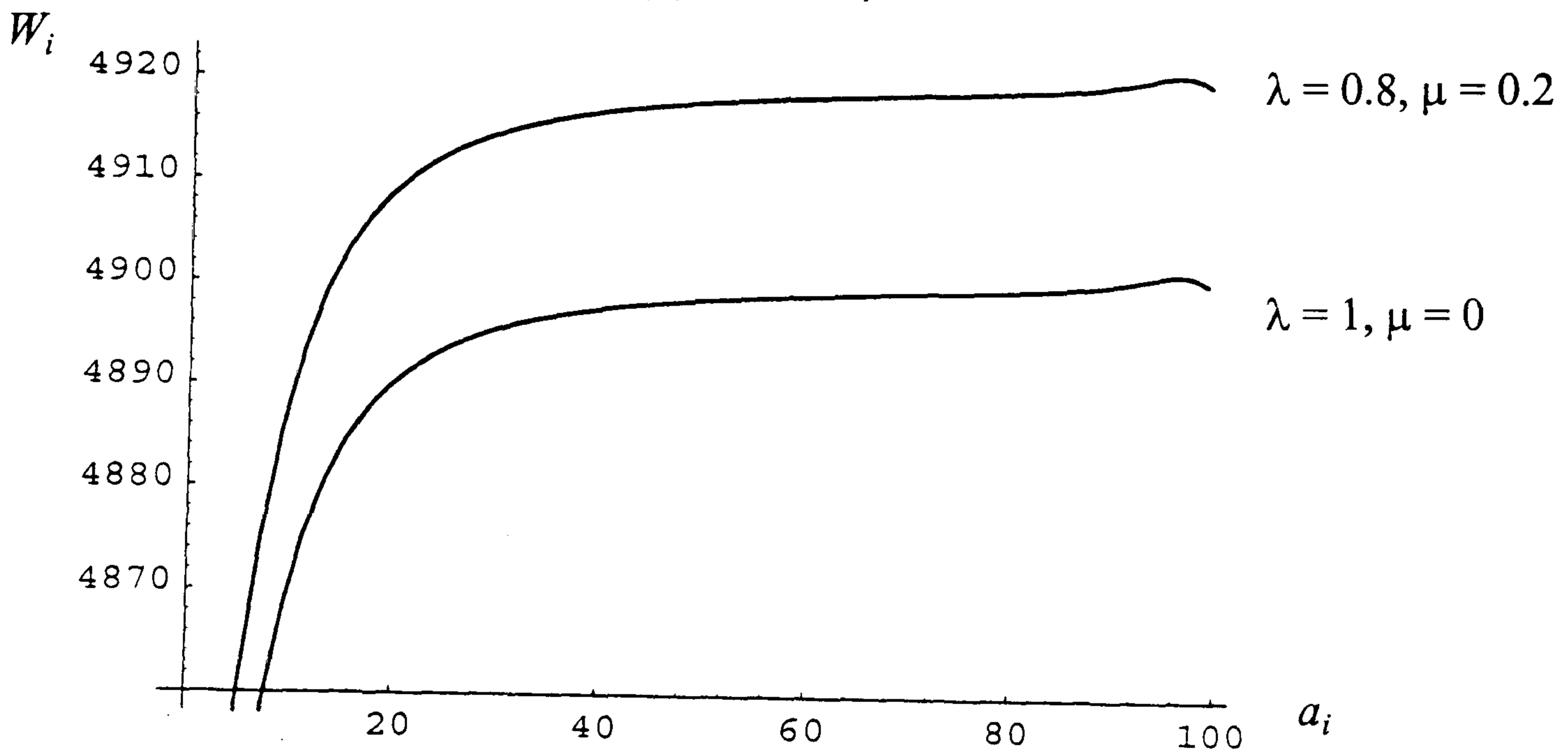


Figure 2.5. Tariffs set by a bloc of size a_i , $n = 100$

(a) $\lambda = 1, \mu = 0$ (no cost reduction)



(b) $\lambda = 0.8, \mu = 0.2$



(c) $\lambda = 0.5, \mu = 0.5$

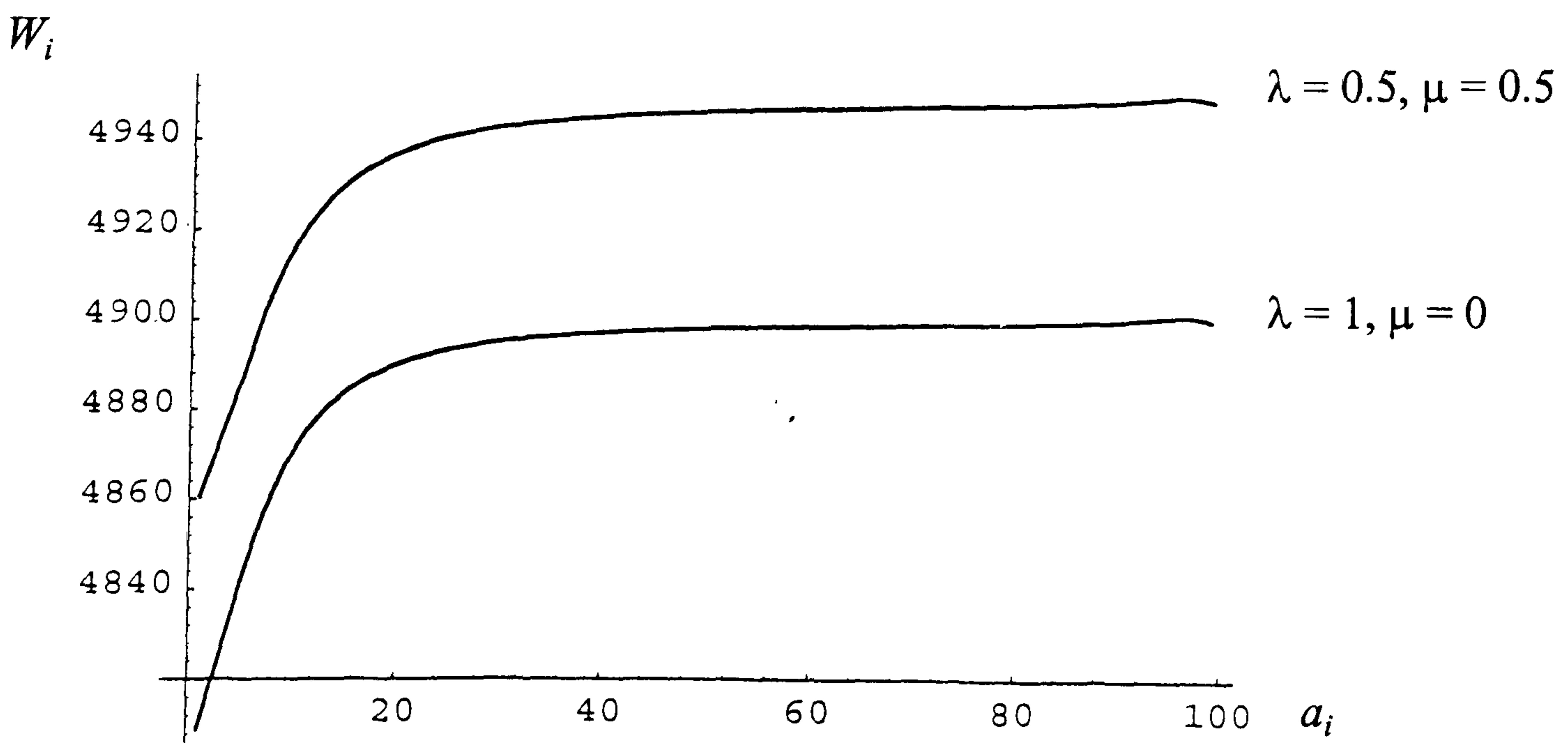


Figure 2.6. Welfare of a member of a bloc of size $a_i, n = 100$

range from membership of a trade bloc having no effect to membership of a large trade bloc reducing a firm's costs by almost half. In the two cases where there is a cost reduction, the tariffs with no cost reduction are also shown for comparison. It can be seen that there is very little difference between the tariffs set in these three cases.²¹ In each case increasing membership of a bloc leads to a rise in tariffs until $a_i = 7$, then a fall as the size of the bloc rises further. Tariffs are slightly lower for higher values of μ relative to λ , as would be expected as in general a country's optimal tariff is lower when the marginal cost of imports is lower.²² Figure 2.6 shows, for the same parameter values, the welfare attained by a member of a trade bloc of any given size. Again the case with no cost reduction can be compared to the other two cases. The lower lines in Figures 2.6 (b) and (c) correspond to the line showing welfare in Figure 2.6 (a), so welfare is higher for a bloc of any size when the cost reducing effect is introduced. In each case, welfare is maximised when the trade bloc contains 96 members.²³ Thus, while the welfare of a member of a bloc of any size is increased by the cost reducing effect of bloc membership, the optimal size of the first bloc to form is unaffected.

Table 2.2 gives equilibrium trade bloc sizes and welfare for members of each bloc for various values of n , for the case where $\lambda = \mu = 0.5$. In other words, this is the

²¹ Although it cannot be seen clearly from Figure 2.5, in the two cases with the cost reduction the tariffs lie slightly below those without the cost reduction.

²² For lower values of α , holding other parameter values constant, the effect of the cost reduction on tariffs is more pronounced, and numerical simulations suggest that a very small bloc's optimal trade policy might actually be to subsidise imports from a large, low cost bloc. However, the parameter values which produce this effect are not consistent with all firms setting positive outputs in this model. In particular, the parameter values imply that firms located in the small bloc would sell negative quantities in the large bloc. For this reason, this case is not analysed in detail.

²³ If the integer constraint is ignored, there are only very slight differences in the value of a_i which maximises welfare, ranging from approximately 96.13 to 96.16.

case where membership of a large trade bloc can reduce a firm's marginal cost by almost half of its original level. Comparing this table to Table 2.1, it can immediately be seen that for the values of n considered, the cost reducing effect of trade bloc formation has no impact on the optimal size of the first bloc to form. Free trade will still be achieved for values of n less than or equal to four, above which value a large bloc will gain by excluding at least one country. Any trade bloc containing more than one country will set lower tariffs in this case, due to the reduction in member firms' marginal costs. The cost function used in this section results in an increase in welfare for each country, compared to the case with common constant costs, for any value of n . However it is still true that members of the larger bloc gain and members of the smaller bloc lose relative to free trade, while the mean welfare of countries is lower in the equilibrium with two blocs than under global free trade. It can also be seen that, compared to the previous case, the welfare gain for the first bloc to form is greater than the welfare gain for the second bloc. This is as a result of the fact that the first,

n	a_1	a_2	τ_1	τ_2	W_1	W_2	W_{ave}	W_{ft}
4	4	0	-	-	4740.2	-	4740.2	4740.2
5	4	1	17.382	24.75	4813.5	4108.7	4672.5	4802.9
20	18	2	4.9838	13.618	4949.5	4662.8	4920.8	4936.4
50	47	3	1.9766	8.5548	4951.9	4818.1	4943.9	4947.2
100	96	4	0.9628	5.8313	4951.1	4878.3	4948.1	4949.1

Table 2.2: Some numerical examples with $\lambda = \mu = 0.5$

larger bloc benefits more from the cost reducing effect of bloc membership and hence firms in that bloc gain a competitive advantage over other firms.

The results given in Table 2.2, together with the more detailed analysis above of the case with $n = 100$, lead to the conclusion that the cost function used in this section has little effect on the results of the model, relative to the model with common, constant marginal costs in Section 2.2. Although the welfare of all countries increases when trade bloc membership reduces the marginal costs of firms located within the bloc, there is no change in the equilibrium bloc structure and the comparative welfare results are unaffected. This should not be surprising, at least for relatively high values of n . The cost function used in this section implies that most of the effect from trade bloc membership on firms' marginal costs comes from the first few partner countries, while each subsequent partner has a diminishing effect on costs. Hence when n and a_1 are large, the cost reducing effect of an additional member of the large trade bloc is very small. However it is still noteworthy that the results do not change for small values of n . Global free trade remains optimal when there are no more than four countries, but the presence of a fifth country leads to an incentive for four of the countries to form a trade bloc which excludes the other country.

2.4 Conclusions

This chapter has presented two models of trade bloc formation under segmented markets. In the first model, with all firms having common, constant marginal costs, it is found that a majority of countries join the first bloc to form; in fact, very few are excluded. When the world consists of no more than four countries, global free trade is optimal, while at least one country will be excluded when there are five or more countries in the world.

The second model introduced the assumption that a firm's marginal cost is decreasing in the number of countries belonging to the trade bloc in which it is located. This assumption has little effect on the results of the model. The optimal tariff rate set by a bloc of any size falls slightly when the cost reducing effect is introduced, and the welfare of a member of a bloc of any size increases. However, there is little or no effect on the equilibrium structure of trade blocs.

The results in this chapter suggest that where trade bloc membership reduces the costs of firms located in member countries, the main effect will be to increase the welfare of all countries. While there is no effect on the equilibrium trade bloc structure, every country gains regardless of whether it is in the large bloc, which now has a cost advantage, or the small bloc, with relatively high marginal costs. Of course the global gains from trade bloc membership are largest when there is a single, global trade bloc. Hence the gains from trade bloc membership do not alter the conclusion that free trade is optimal, provided the cost reducing effect of trade bloc membership

passes on to the case of global free trade. This is not automatic, as it is arguable that gains from harmonisation of standards or research joint ventures are more likely to arise when a subset of countries cooperates in a regional trade agreement. If these gains are not available through global free trade, then comparison of the results in Tables 2.1 and 2.2 shows that for values of n of 20, 50 and 100, the average welfare of any country when the world divides into two cost-reducing trade blocs is higher than each country's welfare under free trade when costs remain constant. However, members of the smaller trade bloc are better off in the latter case than in the former.

One possible reason why the reduction in costs does not alter the equilibrium trade bloc structure is the specific cost function used, which results in a decreasing effect of each additional bloc member. This means there is very little additional incentive for an already large bloc to accept another member. An alternative case to consider would be one in which each additional member has a constant effect on reducing costs. However, this assumption seems less reasonable, for reasons discussed in Section 2.3. It should also be noted that the assumption about costs used here is not always innocuous, as illustrated by the results in Chapter 5.

Appendix 2

The value of a_1 which maximises the welfare of a member of bloc A_1 in the model with constant costs is the value of a_1 which solves the following equation:

$$\begin{aligned} \Psi(a_1) \equiv & \left\{ (\alpha - \beta c)^2 [16 + 32a_1^7 + 144n + 390n^2 + 506n^3 + 366n^4 + 144n^5 + 24n^6 - \right. \\ & 96a_1^6(1 + 2n) + 24a_1^5(11 + 24n + 20n^2) - 8a_1^4(13 + 116n + 156n^2 + 80n^3) + \\ & 12a_1^3(1 + 16n + 94n^2 + 104n^3 + 40n^4) + \\ & a_1^2(44 + 164n + 158n^2 - 408n^3 - 552n^4 - 192n^5) + \\ & \left. a_1(-112 - 432n - 711n^2 - 632n^3 - 204n^4 + 48n^5 + 32n^6) \right\} / \\ & \left\{ \beta(2 + 3a_1 + 2a_1^2 + n)^2 [2a_1^2 + 2(1 + n)^2 - a_1(3 + 4n)]^3 \right\} = 0 \end{aligned}$$

The above function $\Psi(a_1)$ is positive when $a_1 = 0$, negative when $a_1 = n$ and monotonic on the range $0 \leq a_1 \leq n$.

The value of a_1 which maximises the welfare of a member of bloc A_1 in the model with decreasing costs is the value of a_1 which solves the following equation:

$$\begin{aligned} & \left\{ [\alpha + 4\alpha a_1 - \beta(\lambda + 4a_1\lambda + 4\mu)] [\alpha(a_1 + 2a_1^2 + n) - \beta(2a_1^2\lambda + 3\mu + a_1(\lambda + 4\mu) + \lambda n - \mu n)] \right\} / \\ & (2 + 3a_1 + 2a_1^2 + n)^2 - \\ & \left[(3 + 4a_1) (\alpha(a_1 + 2a_1^2 + n) - \beta(2a_1^2\lambda + 3\mu + a_1(\lambda + 4\mu) + \lambda n - \mu n))^2 \right] / (2 + 3a_1 + 2a_1^2 + n)^3 + \end{aligned}$$

$$\begin{aligned}
& 4(1+a_1)^2[\alpha + \beta(\mu - \lambda)][2\alpha a_1 - \beta(2a_1(\lambda - \mu) + \mu(2+n))] / a_1(2+3a_1+2a_1^2+n)^2 - \\
& 2(1+a_1)^2(3+4a_1)[-2\alpha a_1 + \beta(2a_1(\lambda - \mu) + \mu(2+n))]^2 / a_1(2+3a_1+2a_1^2+n)^3 + \\
& 2(1+a_1)(-2\alpha a_1 + \beta[2a_1(\lambda - \mu) + \mu(2+n)])^2 / a_1(2+3a_1+2a_1^2+n)^2 - \\
& (1+a_1)^2(-2\alpha a_1 + \beta[2a_1(\lambda - \mu) + \mu(2+n)])^2 / a_1^2(2+3a_1+2a_1^2+n)^2 - \\
& [(\alpha - \beta[\lambda + \mu(-4 - 4a_1 + n)])(\alpha(1+2a_1)(a_1 - n) + \\
& \beta[-2a_1^2(\lambda - 2\mu) + \mu + \lambda n + \mu n^2 + a_1(\lambda - 2\mu)(2n - 1)])] / [(n - a_1)(2+3a_1+2a_1^2+n)^2] + \\
& [2(-3+4a_1-4n)(a_1 - n)(\alpha a_1 - \beta[2a_1^2\mu + \mu(n+1)^2 + a_1(\lambda - 4\mu - 3\mu n)])^2] / \\
& (a_1^2[2a_1^2 + 2(n+1)^2 - a_1(3+4n)]^3) - \\
& [\alpha a_1 - \beta(2a_1^2\mu + \mu(n+1)^2 + a_1(1-4\mu - 3\mu n))]^2 / a_1^2[2a_1^2 + 2(n+1)^2 - a_1(3+4n)]^2 + \\
& 2(a_1 - n)(\alpha a_1 - \beta[2a_1^2\mu + \mu(n+1)^2 + a_1(\lambda - 4\mu - 3\mu n)])^2 / a_1^3[2a_1^2 + 2(n+1)^2 - a_1(3+4n)]^2 - \\
& [2(-\alpha + \beta[\lambda + \mu(-4 + 4a_1 - 3n)])(a_1 - n)(-\alpha a_1 + \beta[2a_1^2\mu + \mu(n+1)^2 + a_1(\lambda - 4\mu - 3\mu n)])] / \\
& (a_1^2[2a_1^2 + 2(n+1)^2 - a_1(3+4n)]^2) + \\
& [(3+4a_1)(\alpha(2a_1+1)(a_1 - n) + \beta[-2a_1^2(\lambda - 2\mu) + \mu + \lambda n + \mu n^2 + a_1(\lambda - 2\mu)(2n - 1)]) \\
& (\alpha(a_1 - n) + \beta[\mu + 2a_1^2\mu + \lambda n - 2\mu n - a_1(\lambda - 4\mu + \mu n)])] / [(a_1 - n)(2+3a_1+2a_1^2+n)^3] + \\
& [(\alpha(a_1 - n) + \beta[\mu + 2a_1^2\mu + \lambda n - 2\mu n - a_1(\lambda - 4\mu + \mu n)])(\alpha(-1+4a_1+4a_1^2-2n)(a_1 - n)^2 + \\
& \beta[-4a_1^4(\lambda - 2\mu) + 2\mu + 2\mu n + \lambda n^2 - 4\mu n^2 + 2\lambda n^3 - 6\mu n^3 + 4a_1^3(\lambda - 2\mu)(2n - 1) +
\end{aligned}$$

$$a_1^2(\lambda + 4\mu + 10\lambda n - 8\mu n - 4\lambda n^2 + 14\mu n^2) - 2a_1(-3\mu + \lambda n - 6\mu n + 4\lambda n^2 - 7\mu n^2 + 2\mu n^3)]\Big] /$$

$$\left\{ (a_1 - n)^2 (2 + 3a_1 + 2a_1^2 + n)^3 \right\} / \beta = 0$$

Chapter 3.

Trade Bloc Formation with Asymmetric Countries

3.1. Introduction

In recent years a number of preferential trade arrangements, including NAFTA and agreements between the EU and Eastern European countries, have been established which incorporate side agreements covering non-trade issues. Typically these agreements contain many concessions by small countries over issues such as intellectual property rights and environmental standards, but few concessions by larger countries. However, as noted by Perroni and Whalley (1994), the trade agreements are generally sought by the small countries, who see themselves as the main beneficiaries of such deals despite the concessions they are forced to make.

The argument put forward by Perroni and Whalley (1994) to explain this phenomenon is that the small countries are worried about the risk of global trade war and see preferential trade arrangements as insurance against this outcome. Hence they are willing to accept the side agreements as payment for the insurance. However, while this argument might have seemed persuasive while serious doubts persisted over the successful completion of the Uruguay Round, the insurance argument seems less tenable now that the Round has been completed. The risk of global trade war would appear to have diminished, but many small countries still wish to join larger countries in preferential trade arrangements even if their domestic policies are to be constrained. The model presented in this chapter suggests that small countries might be the main beneficiaries from the formation of free trade areas and customs unions, and larger countries will often be made worse off. Thus small countries need to

compensate large countries in order to persuade them to form trade blocs, and this compensation could be provided by side agreements covering non-trade issues.

The model developed in this chapter is used to address many of the key issues in the ongoing debate about the advantages and disadvantages of trade blocs, both to member countries and the world as a whole, a comprehensive overview of which is provided by Panagariya (1998). Firstly, the effects of the formation or expansion of trade blocs on tariffs is considered. Secondly, the effects on members' and non-members' welfare are considered. Finally, the issue of whether countries will have any incentive to join a trade bloc is addressed.

The model follows much of the literature on strategic trade policy by assuming that firms act as Cournot oligopolists in segmented markets and tariffs can be used to shift profits between countries, as in Brander and Spencer's (1984) two-country model and Sinclair and Vines's (1994) model of trade blocs, as well as the models in the previous chapter. The most significant difference to the models of Sinclair and Vines (1994) and Chapter 2 is that countries differ in size, as measured by a demand parameter. In all other ways, countries are identical to each other. There is also some analysis of the case in which members of a customs union form a single market. Allowing for differences between countries is particularly important given recent developments in trade blocs, such as the formation of NAFTA and past and future expansions of the EU. Whereas most of the early members of the EU could be broadly characterised as similar countries, in terms of size and economic development, a number of smaller countries have since joined and any subsequent expansions to

include Eastern European countries clearly would not involve countries which could be treated as being symmetric to existing members. Meanwhile NAFTA consists of three countries, the United States, Canada and Mexico, with vastly different levels of income. Hence there are many real world issues which cannot be analysed within a symmetric framework.

The effects of trade bloc formation or expansion on tariffs and welfare have been much debated since Krugman (1991) suggested that the enlargement of customs unions would lead to an increase in protection against countries outside each bloc, so the world would be hurt by what appears to be the liberalising step of promoting (preferential) free trade. In a monopolistically competitive framework in which provinces are divided into symmetric customs unions, it is shown that a reduction in the number of customs unions raises the Nash equilibrium tariff set by each bloc, and world welfare is minimised when the world is divided into three symmetric customs unions. Among the many papers which followed from Krugman's, Sinclair and Vines (1994) show that the results are not robust to a change in the type of trade bloc considered from customs unions to free trade areas. With free trade areas, it is shown that the optimal tariff for each country, setting tariffs independently of other bloc members, falls as the size of the blocs rises, although welfare effects are not considered.

Sinclair and Vines (1994) also consider a multi-country oligopoly model based on Brander and Krugman (1983) and Brander and Spencer (1984) to analyse the effects of trade blocs. Firms located in different countries produce undifferentiated

products and compete in quantities. In this case tariffs are used to shift profits, and it is shown that a trend to fewer, larger customs unions could well lead to lower levels of protection, and always will do so once the number of symmetric unions has fallen to a certain level. The reason for this is that customs union enlargement reduces the number of 'foreign' firms with rents to shift. With free trade areas in this model, trade bloc enlargement will always reduce tariffs. The results in Section 3.3 support Sinclair and Vines's (1994) result on free trade area enlargement, showing that with asymmetric countries any expansion of a free trade area will reduce the tariffs set by all members of that bloc, while Section 3.4 identifies factors determining whether the formation of a customs union will lead to higher or lower tariffs.

Kennan and Riezman (1990), Riezman (1985) and Kose and Riezman (1998) use endowment-based three-country models to analyse the effects of trade bloc formation. Kennan and Riezman (1990) show that when partners are symmetric, the formation of a free trade area or customs union will always raise the partners' welfare. However, whereas the non-member always gains from a free trade area, it could be made worse off by a customs union.²⁴ Riezman (1985) uses core theory to look at the formation of customs unions. Depending on the pattern of endowments, the core could contain one or more two-country customs unions or global free trade. Kose and Riezman (1998) only consider the case of symmetric endowments. The formation of a two-country free trade area raises the welfare of all countries, but a two-country

²⁴ A case in which the partners are asymmetric is considered in an appendix of Kennan and Riezman (1990). It is shown that a free trade area can make one of its members worse off than it would be in the Nash equilibrium where all countries set their optimal tariffs. This is because the free trade area restricts a large country's ability to use tariffs to improve its terms of trade, and therefore results in a loss of market power.

customs union raises members' welfare further while making non-members worse off. In the three-country model analysed in Section 3.6, it is shown that only the smaller partner gains from the formation of a free trade area or customs union while the larger partner loses. As in Kose and Riezman (1998), the non-member is made better off by the formation of a free trade area but worse off by the formation of a customs union.

The rest of this chapter is organised as follows. Section 3.2 presents a general multi-country model of trade where firms compete in quantities and countries differ in market size. This model can be used to study free trade, the Nash tariff equilibrium and equilibria with free trade areas and customs unions. Sections 3.3, 3.4 and 3.5 look at some effects of the formation of free trade areas, customs unions with segmented markets and a customs union with a single market, respectively, on tariffs and countries' welfare. Section 3.6 looks in more detail at trade bloc formation in a three-country model, and the results are considered in relation to NAFTA. Finally, Section 3.7 concludes.

3.2. The general framework

The world consists of n countries, $i = 1, \dots, n$, of different sizes whose markets are segmented. Differences in country size are represented by different levels of demand. Specifically, demand in country i is given by $y_i = \alpha_i - \beta p_i$, where p_i is the market price in country i . It is assumed, without loss of generality, that country 1 is

the smallest country (has the lowest level of demand at any price) and country n the largest. Hence $\alpha_1 < \alpha_2 < \dots < \alpha_n$.

The demand equation above leads to the inverse demand function:

$$p_i = \frac{\alpha_i - y_i}{\beta} \quad (3.1)$$

It is assumed that a single firm is located in each country, producing a single homogeneous good. Firms compete as Cournot oligopolists. Technology is assumed to be identical everywhere, with each firm having common, constant marginal cost c . Each country can choose whether to set tariffs on imports from each other country, however there is one important constraint on these tariffs, which is that each country can only set one positive tariff rate. This can be thought of as the country's MFN tariff rate, as required under GATT rules.²⁵ Any country which is not subject to this MFN tariff rate faces a zero tariff rate, so preferential trade areas must comply with the requirement of Article XXIV of the GATT that trade between members is not restricted. Hence imports from country j to country i face a tariff of τ_{ij} , where $\tau_{ij} = \tau_i$ if j does not have a preferential trade agreement with i and $\tau_{ij} = 0$ if i and j belong to the same trade bloc.²⁶ The firm in country i earns profits:

²⁵ Article I of the GATT calls for each country to grant each other country the most favourable treatment which it grants to any country, except where differential treatment is specifically allowed, such as under Article XXIV which covers customs unions and free trade areas. Effectively this means that any country belonging to a trade bloc must set a single MFN tariff rate against imports from all non-members.

²⁶ Hence global free trade can be seen as a trade bloc containing all n countries.

$$\pi_i = \sum_j (p_j - c - \tau_{ji}) x_{ij} \quad (3.2)$$

where x_{ij} is the quantity sold in country j by the firm located in country i . The optimal output of the firm in country i for the market in country j can be found by differentiating (3.2) with respect to x_{ij} :

$$\begin{aligned} \frac{\partial \pi_i}{\partial x_{ij}} &= p_j - c - \tau_{ji} + \frac{\partial p_j}{\partial x_{ij}} x_{ij} \\ &= \frac{\alpha_j - y_j}{\beta} - c - \tau_{ji} - \frac{x_{ij}}{\beta} = 0 \end{aligned} \quad (3.3)$$

The equation above can be rearranged, using the fact that $y_j = \sum_i x_{ij}$, to give the following expression for output:

$$x_{ij} = \frac{\alpha_j}{2} - \frac{1}{2} \sum_{k \neq i} x_{kj} - \frac{\beta c}{2} - \frac{\beta \tau_{ji}}{2} \quad (3.4)$$

Summing across i leads to an expression for total sales in country j :

$$y_j = \frac{n}{n+1} \alpha_j - \frac{n}{n+1} \beta c - \frac{1}{n+1} \beta \sum_i \tau_{ji} \quad (3.5)$$

From (3.1), the price in country j is:

$$p_j = \frac{\alpha_j}{(n+1)\beta} + \frac{n}{n+1}c + \frac{1}{n+1} \sum_i \tau_{ji} \quad (3.6)$$

Sales of the country i firm in market j are:

$$x_{ij} = \frac{\alpha_j}{n+1} - \frac{\beta c}{n+1} - \beta \left(\tau_{ji} - \frac{1}{n+1} \sum_k \tau_{jk} \right) \quad (3.7)$$

Clearly, given the rules of tariff setting explained earlier, outputs and price in each country depend on the tariff level set by that country and the number of countries whose imports the tariff is applied to.

Case 1: Free trade

Under free trade, $\tau_{ij} = 0$ for all i and j . Using this in (3.7), (3.5) and (3.6) gives the following expressions for output, price and demand:

$$x_{ij} = \frac{\alpha_j - \beta c}{n+1} \quad (3.8)$$

$$y_i = \frac{n}{n+1} (\alpha_i - \beta c) \quad (3.9)$$

$$p_i = \frac{\alpha_i}{(n+1)\beta} + \frac{n}{n+1}c \quad (3.10)$$

Total profits earned by the firm located in country i and consumer surplus in country i are given by:

$$\Pi_i = \frac{1}{\beta} \sum_j \left(\frac{\alpha_j - \beta c}{n+1} \right)^2 \quad (3.11)$$

$$CS_i = \frac{1}{2\beta} \left(\frac{n}{n+1} (\alpha_i - \beta c) \right)^2 \quad (3.12)$$

In the absence of any tariffs, each country's welfare is simply the sum of its firm's profits and domestic consumer surplus.

Case 2: Nash tariff equilibrium

In this case, country i sets a single tariff rate τ_i on all imports (i.e. $\tau_{ij} = \tau_i \forall i \neq j$, $\tau_{ii} = 0$). The firm in country i 's output for each market, total consumption in country i and the price paid by consumers in i are:

$$x_{ii} = \frac{\alpha_i - \beta c}{n+1} + \frac{n-1}{n+1} \beta \tau_i \quad (3.13)$$

$$x_{ij} = \frac{\alpha_j - \beta c}{n+1} - \frac{2}{n+1} \beta \tau_j \quad (3.14)$$

$$y_i = \frac{n}{n+1} (\alpha_i - \beta c) - \frac{n-1}{n+1} \beta \tau_i \quad (3.15)$$

$$p_i = \frac{\alpha_i}{(n+1)\beta} + \frac{n}{n+1} c + \frac{n-1}{n+1} \tau_i \quad (3.16)$$

Total profits earned by the firm in country i , consumer surplus in i and tariff revenue in i are given respectively by:

$$\Pi_i = \frac{1}{\beta} \left[\left(\frac{\alpha_i - \beta c}{n+1} + \frac{n-1}{n+1} \beta \tau_i \right)^2 + \sum_{j \neq i} \left(\frac{\alpha_j - \beta c}{n+1} - \frac{2}{n+1} \beta \tau_j \right)^2 \right] \quad (3.17)$$

$$CS_i = \frac{1}{2\beta} \left(\frac{n}{n+1} (\alpha_i - \beta c) - \frac{n-1}{n+1} \beta \tau_i \right)^2 \quad (3.18)$$

$$TR_i = \tau_i (y_i - x_{ii}) = \frac{n-1}{n+1} \tau_i (\alpha_i - \beta c - 2\beta \tau_i) \quad (3.19)$$

Welfare in this case is defined as the sum of profits, consumer surplus and tariff revenue. Each country sets its tariff to maximise welfare, the first order condition for which is:

$$\frac{\partial W_i}{\partial \tau_i} = \frac{n-1}{n+1} \left[\frac{3}{n+1} (\alpha_i - \beta c) - \left(\frac{n+7}{n+1} \right) \beta \tau_i \right] = 0 \quad (3.20)$$

Solving the above equation gives a solution for country i 's optimal tariff:

$$\tau_i^N = \frac{3(\alpha_i - \beta c)}{(n+7)\beta} \quad (3.21)$$

Case 3: Preferential trade blocs with segmented markets

When a group of countries forms a trade bloc, it is assumed that all countries within the bloc abolish tariffs on trade with each other while maintaining a single MFN tariff rate for imports from non-member countries. Here we assume that the markets of member countries continue to be segmented, while the following subsection analyses the case where the members of a customs union form a single market. The first part of the analysis below is not affected by whether a trade bloc takes the form of a customs union (with a common external tariff for all members) or a free trade area (with each member setting its own external tariffs), but when optimal tariff rates are determined, a distinction must be made between the two cases.

The general model outlined above is used to consider the case where countries i and j are members of bloc $A(i)$, with a_i members. Country k is located in a different bloc $A(k)$ with a_k members. Output, consumption and price can again be found using equations (3.7), (3.5) and (3.6):

$$x_{ij} = \frac{\alpha_j - \beta c}{n+1} + \frac{n-a_i}{n+1} \beta \tau_j \quad \text{if } j \in A(i) \quad (3.22)$$

$$x_{ik} = \frac{\alpha_k - \beta c}{n+1} - \frac{a_k + 1}{n+1} \beta \tau_k \quad \text{if } k \notin A(i) \quad (3.23)$$

$$y_i = \frac{n}{n+1} (\alpha_i - \beta c) - \frac{n-a_i}{n+1} \beta \tau_i \quad (3.24)$$

$$p_i = \frac{\alpha_i}{(n+1)\beta} + \frac{n}{n+1} c + \frac{n-a_i}{n+1} \tau_i \quad (3.25)$$

Profits, consumer surplus and tariff revenue for i are given by²⁷:

$$\Pi_i = \sum_{j \in A(i)} \frac{1}{\beta} \left(\frac{\alpha_j - \beta c}{n+1} + \frac{n-a_i}{n+1} \beta \tau_j \right)^2 + \sum_{k \notin A(i)} \frac{1}{\beta} \left(\frac{\alpha_k - \beta c}{n+1} - \frac{a_k + 1}{n+1} \beta \tau_k \right)^2 \quad (3.26)$$

$$CS_i = \frac{1}{2\beta} \left(\frac{n}{n+1} (\alpha_i - \beta c) - \frac{n-a_i}{n+1} \beta \tau_i \right)^2 \quad (3.27)$$

$$TR_i = \frac{n-a_i}{n+1} \tau_i (\alpha_i - \beta c - (a_i + 1) \beta \tau_i) \quad (3.28)$$

²⁷ Equations (3.26) to (3.28) assume that no country's tariff is sufficiently high to exclude any firms from that country's market. This will always be true when a free trade area is formed, but not necessarily for a customs union. Appendix 3 derives the condition which must hold for a two-country customs union not to lead to any firms exiting a member country's market. When the tariff is sufficiently high to force firms to exit a market, as in the three country example of a joint-welfare maximising customs union analysed in Section 3.6 below, profits, consumer surplus and tariff revenue have to be calculated taking into account which firms sell in which markets.

Again, welfare is the sum of profits, consumer surplus and tariff revenue. In the case of a free trade area, each country individually sets its tariff to maximise its own welfare, given its membership of the free trade area. In the case of a customs union, all members must set a single common external tariff.

Case 4: A customs union with a single market

This subsection considers the case in which the countries which join a customs union form a single integrated market. If a group of countries join a customs union, it is assumed that price differences can no longer exist between these countries. Hence if a group of countries join bloc $A(i)$, they effectively become a single market. Summing the demands of the customs unions members, with each of the a_i members constrained to have a common price of p_u , means that the single market's demand is given by

$$y_u = \sum_{j \in A(i)} \alpha_j - a_i \beta p_u.$$

²⁸ This case corresponds to the case of 'complete integration' identified by Hansen and Nielsen (1997), characterised by a single demand function for the whole market, whereas the previous subsection corresponds to their case of 'partially integrated markets' where demand and price must be considered separately for each area.²⁹ Effectively, all the countries which join a customs union can be thought of as a single country on the demand side, although it is assumed that there remains a single firm located in each country.

²⁸ Summing the demand equations in this way assumes that all countries within the single market have positive demand at the common price p_u . However it should be noted that this might not be true when countries with very different market sizes (very different α 's) form a customs union with a single market.

²⁹ For a fuller account, see Hansen and Nielsen (1997, p.36).

The profit function for the firm in country i , which is one of the a_i members of customs union $A(i)$, is given by

$$\pi_i = (p_u - c)x_{iu} + \sum_{j \in A(i)} (p_j - c - \tau_j)x_{ij} \quad (3.29)$$

while the profit function for country k , located outside the customs union, is

$$\pi_k = (p_u - c - \tau_u)x_{ku} + (p_k - c)x_{kk} + \sum_{j \neq k, j \in A(i)} (p_j - c - \tau_j)x_{kj} \quad (3.30)$$

where x_{iu} and x_{ku} are the amounts sold in the customs union by the firms based in countries i and k respectively and τ_u is the customs union's common external tariff. Hence the first-order conditions for maximising profits in the integrated customs union market are:

$$\begin{aligned} \frac{\partial \pi_i}{\partial x_{iu}} &= p_u - c - \frac{\partial p_u}{\partial x_{iu}} x_{iu} \\ &= \frac{\sum_{j \in A(i)} \alpha_j}{a_i \beta} - \frac{y_u}{a_i \beta} - c - \frac{x_{iu}}{a_i \beta} = 0 \end{aligned} \quad (3.31)$$

and

$$\begin{aligned} \frac{\partial \pi_k}{\partial x_{ku}} &= p_u - c - \tau_u - \frac{\partial p_u}{\partial x_{ku}} x_{ku} \\ &= \frac{\sum_{j \in A(i)} \alpha_j}{a_i \beta} - \frac{y_u}{a_i \beta} - c - \tau_u - \frac{x_{ku}}{a_i \beta} = 0 \end{aligned} \quad (3.32)$$

Given that there are now a_i firms located within the customs union and $(n - a_i)$ firms outside, total output sold in the customs union is given by $y_u = a_i x_{iu} + (n - a_i) x_{ku}$. Using this together with (3.31) and (3.32), the following expressions can be found for the outputs of firms located inside and outside the customs union, respectively:

$$x_{iu} = \frac{\sum_{j \in A(i)} \alpha_j}{n+1} - \frac{a_i \beta c}{n+1} + \frac{a_i (n - a_i)}{n+1} \beta \tau_u \quad (3.33)$$

$$x_{ku} = \frac{\sum_{j \in A(i)} \alpha_j}{n+1} - \frac{a_i \beta c}{n+1} - \frac{a_i (a_i + 1)}{n+1} \beta \tau_u \quad (3.34)$$

Consumption and price in the integrated market are:

$$y_u = \frac{n}{n+1} \left(\sum_{j \in A(i)} \alpha_j - a_i \beta c \right) - \frac{a_i (n - a_i)}{n+1} \beta \tau_u \quad (3.35)$$

$$p_u = \frac{\sum_{j \in A(i)} \alpha_j}{a_i(n+1)\beta} + \frac{n}{n+1}c + \frac{n-a_i}{n+1}\tau_u \quad (3.36)$$

Using this expression in an individual country's demand equation allows the derivation of each member country's consumption:

$$y_i = \alpha_i - \frac{\sum_{j \in A(i)} \alpha_j}{a_i(n+1)} - \frac{n}{n+1}\beta c - \frac{n-a_i}{n+1}\beta\tau_u \quad (3.37)$$

Although the customs union members are assumed to form a single market, profits and consumer surplus can still be calculated for each member individually. However, tariff revenue cannot be calculated for individual members as each firm sets its output for the whole single market, meaning that it is not possible to say how much of each individual country's consumption comes from any given source. This means that it is unclear how much of the good is imported by each member country, so imports, and hence tariff revenue, can only be calculated for the union as a whole. Thus any analysis of welfare must be made with respect to the union members taken together rather than separately. The expressions below give the profits for each firm located in the customs union and consumer surplus and tariff revenue for the union as a whole.

$$\Pi_i = \frac{1}{a_i\beta} \left[\frac{\sum_{j \in A(i)} \alpha_j}{n+1} - \frac{a_i\beta c}{n+1} + \frac{a_i(n-a_i)}{n+1} \beta\tau_u \right]^2 + \sum_{j \notin A(i)} \frac{1}{\beta} \left(\frac{\alpha_j - \beta c}{n+1} - \frac{a_j + 1}{n+1} \beta\tau_j \right)^2 \quad (3.38)$$

$$CS_u = \frac{1}{2a_i\beta} \left(\frac{n}{n+1} \left(\sum_{j \in A(i)} \alpha_j - a_i\beta c \right) - \frac{a_i(n-a_i)}{n+1} \beta\tau_u \right)^2 \quad (3.39)$$

$$TR_u = \frac{n-a_i}{n+1} \tau_u \left[\sum_{j \in A(i)} \alpha_j - a_i\beta c - a_i(a_i+1)\beta\tau_u \right] \quad (3.40)$$

3.3. Some effects of free trade area formation

This section derives some results for the formation and expansion of free trade areas, while the following section analyses customs unions. Before determining the welfare effects on countries which join a trade bloc, it is important to first see how bloc membership affects a country's tariff rate against non-members.

The first case considered is that where a_i countries, which previously did not belong to any trade bloc, form a free trade area. It should be noted that, due to the strategic independence between markets in the model, only the markets in the countries forming the free trade area will be affected.³⁰ The two important

³⁰ Other countries are only affected due to changes in the profits they earn in the free trade area members' markets.

implications of this are first, that the existence of other trade blocs does not affect the results, and second, that profits earned in all other markets by firms in the a_i countries forming the bloc are unaffected. Hence when determining the optimal tariff set by any trade bloc member, the parts of welfare which need to be considered are profits earned in the members' markets (the first term on the right hand side of equation (3.26)), consumer surplus (3.27) and tariff revenue raised on imports from non-members (3.28).

Taking the partial derivative of country i 's welfare with respect to its tariff and setting it equal to zero gives the following expression for the optimal tariff for country i belonging to a free trade area with a_i members:

$$\tau_i^F = \frac{3(\alpha_i - \beta c)}{[2(a_i + 1)(n + 1) - 3(n - a_i)] \beta} \quad (3.41)$$

This leads to the following proposition:

Proposition 3.1. *Any expansion of a free trade area to include members which did not previously belong to any trade bloc will result in lower tariffs being set by both the new member(s) and existing members.*

Proof. Taking the derivative of the tariff set by country i belonging to a free trade area with a_i members with respect to a_i yields:

$$\frac{\partial \tau_i}{\partial a_i} = -\frac{3(\alpha_i - \beta c)}{(2n + 5)\beta a_i^2}$$

which is clearly negative for all positive values of a_i . Thus any increase in a_i , including from $a_i = 1$ (the case of a country previously not belonging to any bloc), will lower the tariff set by all members of the free trade area. ■

The result that free trade area expansion will reduce members' tariffs supports that found by Sinclair and Vines (1994), and the intuition behind the result is similar. Forming or joining a free trade area does not increase a country's market power when setting tariffs, as each country still sets tariffs independently, but it does reduce the number of countries from which tariffs can be raised. Hence the potency of tariffs as a profit-shifting device is reduced and optimal tariff rates fall. However the model used by Sinclair and Vines (1994), with symmetric countries, only considered free trade area expansion as a reduction in the number of symmetric blocs, and is less general than the result here that any expansion of any free trade area will lead to lower tariffs.

In order to see whether any trade blocs will ever be formed, the effects of bloc formation on the welfare of member countries must be analysed. The simplest case to consider is that where two countries, i and j , form a free trade area. As previously noted, the effects on these two countries' welfare are independent of the existence of any trade blocs involving other countries. The change in welfare for country i when forming a free trade area with country j is given by:

$$\Delta W_i^F = (\Pi_i^F - \Pi_i^N) + (CS_i^F - CS_i^N) + (TR_i^F - TR_i^N) \quad (3.42)$$

where the superscript F denotes free trade area and the superscript N denotes Nash tariff equilibrium. Using equations (3.17) to (3.19) and (3.26) to (3.28), together with the optimal tariff rates given in equations (3.21) and (3.41), the following expression can be obtained for the change in welfare for country i :

$$\begin{aligned} \Delta W_i^F = & \frac{3}{2} \left[\frac{n-2}{n+4} - \frac{3(n-1)}{n+7} \right] \frac{(\alpha_i - \beta c)^2}{(n+1)^2 \beta} + \\ & \left[\frac{3(n+2)(n-2)}{(n+4)^2} + \frac{12(n+4)}{(n+7)^2} \right] \frac{(\alpha_j - \beta c)^2}{(n+1)^2 \beta} \end{aligned} \quad (3.43)$$

Defining v as $v = \alpha_j - \alpha_i$, equation (3.43) can be rewritten as:

$$\begin{aligned} \Delta W_i^F = & \frac{3(5n^3 + 42n^2 + 69n + 32) (\alpha_i - \beta c)^2}{(n+4)^2 (n+7)^2 (n+1)^2 \beta} \\ & + \left[\frac{3(n+2)(n-2)}{(n+4)^2} + \frac{12(n+4)}{(n+7)^2} \right] \frac{[v^2 + 2v(\alpha_i - \beta c)]}{(n+1)^2 \beta} \end{aligned} \quad (3.44)$$

This expression can be used to see the effect of two countries forming a free trade area on the welfare of each of these countries individually and on joint welfare. These results are contained in Proposition 3.2.

Proposition 3.2. *The formation of a free trade area by any pair of countries raises the*

joint welfare of those countries, and of the world. The welfare of the small country will always rise, while the effect on the large country is ambiguous.

Proof. The first term on the right hand side of equation (3.44) is always positive. The second term is clearly positive for $v > 0$, so the smaller partner will always gain from the formation of a free trade area. For $v < 0$, in which case i is the larger country, the second term is always negative: the necessary condition for this to be so is $2(\alpha_i - \beta c) > -v$, or equivalently $(\alpha_i - \beta c) + (\alpha_j - \beta c) > 0$, which is always true by assumption.³¹ The overall sign of (3.44) when $v < 0$ depends on the values of n , α_i and v , so no general statement can be made about the welfare effect of free trade area formation on the larger partner. The effect on the joint welfare of countries i and j , where $\alpha_j = \alpha_i + v$, is unambiguously positive as the second term on the right hand side of (3.44) is of equal magnitude and opposite sign for the two countries. As previously stated, the first term is always positive, so the two partners' joint welfare must rise. The welfare of non-members rises due to the fall in external tariffs set by the free trade area partners, so world welfare also rises. ■

To understand the effects of forming the free trade area on one of the partners, it is useful to refer back to equation (3.43), the first term of which is negative and the second term positive. The first term can be interpreted as the 'home market' effect of forming the free trade area, as it includes the effects on consumer surplus, profits of the domestic firm in its own country and tariff revenue. Consumer surplus rises as the

³¹ If this assumption did not hold, the good would not be produced or consumed in at least the smaller country j .

lower tariff rate and the additional country not subject to that tariff both lead to increased competition, a lower price and higher total output, while the same effects reduce the profits earned by the firm based in each member country in its own market. Tariff revenue falls as the tariff rate falls on joining the free trade area and one less supplier is subject to the tariff. The fact that the home market effect is negative means that the negative effects of trade bloc formation on own-market profits and tariff revenue outweigh the gain in consumer surplus. The second term in equation (3.43) is the effect on the domestic firm's profits in its partner country, which is positive as the abolition of tariffs on trade between partners allows the firm in each of the countries which form the free trade area greater access to the market in the other country. It is clear from equation (3.43) that the larger is country i , the larger will be the negative effect of forming the free trade area, while the larger is its partner country j , the larger will be the positive effect. Hence the largest gains from forming a free trade area will accrue to a small country which joins a large partner, and conversely the smallest gains or largest losses will accrue to a large country with a small partner. The following result, derived from equation (3.43), shows that for sufficiently large values of n , when two countries form a free trade area the smaller country will always gain while the larger country will always lose.

$$\text{As } n \rightarrow \infty, (n+1)^2 \Delta W_i^F \rightarrow \frac{3}{\beta} \left[(\alpha_j - \beta c)^2 - (\alpha_i - \beta c)^2 \right]$$

Clearly this is positive for $i < j$ and negative for $i > j$. It can also be seen that, while it has already been shown that the formation of a two-country free trade area will always

raise the joint welfare of its members, for large values of n the joint gain approaches zero as the smaller country gains almost entirely at the expense of its larger partner.

The results in this section suggest that although the formation and expansion of free trade areas leads to lower tariffs and an increase in both the joint welfare of members and the welfare of non-members, it is far from clear that any free trade areas will be formed. It has been shown above that when the world consists of a large number of countries, the larger country will lose when any pair of countries forms a free trade area. Section 3.6 below shows that this is also true in a three-country world. Thus unless the smaller country, which always gains from the formation of a free trade area, is able to compensate its larger partner, it is unlikely that any free trade area will form. It is possible that this compensation could take the form of side agreements on non-trade issues, thus explaining why many recent trade agreements have been accompanied by side agreements typically offering concessions from the smaller countries to their larger partners.

3.4. Some effects of customs union formation

This section considers the formation of a customs union, within which markets remain segmented. The case of countries forming a customs union is more difficult to analyse than that of a free trade area. As customs union members set a common external tariff on imports from non-members, some tariff-setting rule is needed for the customs union as a whole, rather than for each member. Here it is assumed that a

customs union sets the tariff which maximises the joint welfare of its members, although alternative tariff setting rules could be used.³² Thus when determining the optimal tariff, its effect on each member's profits, consumer surplus and tariff revenue, as given by equations (3.26) to (3.28), must be considered, unlike in the case of free trade areas where each country only considered its own welfare when setting its tariff. In addition, the possibility of the tariff being high enough to prevent some countries from importing from non-members, as mentioned in footnote 27 and illustrated in the three-country case analysed in the next section, needs to be taken into account. If this does happen, it will only be in the smallest country or countries in the customs union that the tariff deters imports as the tariff level needed to prevent imports from outsiders is increasing in the size of the country.³³ If the tariff is then recalculated to account for the fact that outsiders no longer sell in the smallest member countries, the optimal tariff will in fact be higher than that given below as the smaller countries effectively weight the common external tariff downwards due to the adverse effect of a higher tariff on their consumer surplus and tariff revenue. Hence the tariff derived below could be interpreted as the lower bound on the common external tariff set by a customs union and the actual tariff rate will be higher if the condition set out in the appendix is not satisfied.

³² Given that countries differ in size, an alternative possibility might be for the larger country to have more power within the customs union, so the larger country in any two-country customs union might set the tariff which maximises its own welfare, ignoring any effects on the welfare of the smaller country. There are also circumstances under which the larger country might prefer to delegate tariff setting to its smaller partner, as shown by Gastios and Karp (1991,1995).

³³ Appendix 3 derives the necessary condition for the formation of a two-country customs union not to raise tariffs to a sufficient level to prevent outsiders from selling in the smaller partner.

The problem facing the joint-welfare maximising customs union is to set the common external tariff to maximise the sum of the profits earned by all members in their own and each others' markets, of members' consumer surplus and of tariff revenues earned on imports into the customs union.³⁴ The case considered is that of a customs union $A(i)$ with a_i members setting the common external tariff τ_i^C . Differentiating the aggregate welfare of the customs union members with respect to the common external tariff and setting equal to zero yields the following expression for the optimal tariff:

$$\tau_i^C = \frac{(2a_i + 1) \left[\sum_{j \in A(i)} \alpha_j - a_i \beta c \right]}{a_i (n + 2a_i^2 + 3a_i + 2) \beta} \quad (3.45)$$

Compared to the case of free trade areas, it is more difficult to analyse the effects on tariffs of an expansion of a customs union. Whereas the optimal tariff for a member of a free trade area only depended on how many members belonged to the bloc, the common external tariff set by a customs union depends not only on how many countries are members, but also on the sizes of those countries. Hence it is not possible to give a general result regarding the effect of expanding a customs union. However, it is possible to identify factors which make a country more or less likely to raise its tariff on joining a customs union. Proposition 3.3 below identifies factors which affect the likelihood of a country's optimal tariff increasing when it forms a customs union with one other country.

³⁴ As with the formation of a free trade area, profits earned outside the trade bloc are not affected by the actions taken by members.

Proposition 3.3. *When a country forms a customs union with a single partner, its optimal tariff is more likely to rise: (a) the more countries there are to raise tariffs from; (b) the smaller is the country; and (c) the larger is the country's partner.*

Proof. Country i 's optimal tariff when not belonging to any trade bloc and the optimal common external tariff when it forms a customs union with country j are given, respectively, by:³⁵

$$\tau_i^N = \frac{3(\alpha_i - \beta c)}{(n+7)\beta} \quad \text{and} \quad \tau_i^{C\{i,j\}} = \frac{5(\alpha_i + \alpha_j - 2\beta c)}{2(n+16)\beta}$$

The necessary condition for the second of these tariffs to be higher than the first is:

$$(n+61)(\alpha_i - \beta c) < 5(n+7)(\alpha_j - \beta c) \quad (3.46)$$

This condition is clearly more likely to be satisfied for higher values of n and α_j , and for lower values of α_i , leading to the proposition. ■

In order to see why the size of the partner countries is important in determining a customs union's optimal common external tariff, it is helpful to think of this tariff as a weighted average of the tariffs preferred by the two countries. As is

³⁵ Remember that the customs union's tariff rate would actually be higher if exports from non-members to the smaller partner country are prohibited by this tariff rate. This would reinforce the result in Proposition 3.3.

clear from equation (3.21), in the Nash equilibrium with no trade blocs the larger a country is, the larger the tariff it wants to set. Hence when two countries form a customs union, it is intuitive that the inclusion of larger countries is likely to lead to higher tariffs. The number of countries in the world is important as forming a customs union with one other country will significantly reduce the effectiveness of tariffs as a profit-shifting device when there are only a few countries to use tariffs against, but will be far less important when there are a very large number of countries left subject to tariffs.

Some additional results regarding the effects of two countries forming a customs union on tariffs can be found by rewriting the optimal tariff set by a two-country customs union and condition (3.46), the necessary condition for a customs union to result in a higher tariff being set by country i , in terms of v , defined as in the previous section by $v = \alpha_j - \alpha_i$. The tariff rate can be written as:

$$\tau_i^{C\{i,j\}} = \frac{5(2\alpha_i + v - 2\beta c)}{2(n + 16)\beta} \quad (3.47)$$

while an equivalent condition to (3.46) is:

$$(4n - 26)(\alpha_i - \beta c) + 5(n + 7)v > 0 \quad (3.48)$$

This condition is clearly satisfied for $n \geq 7$ and $v > 0$. This implies that if the world contains at least seven countries, when a customs union is formed by two countries,

the common external tariff will always be higher than the small country's tariff before joining the customs union. On the other hand, condition (3.48) is clearly violated for $n \leq 6$ and $v < 0$. Hence if the world consists of no more than six countries, the common external tariff set by any two-country customs union will be lower than the larger partner's tariff prior to forming the customs union.

Now the welfare effects of customs union formation between country i and country j , where $\alpha_j = \alpha_i + v$, are analysed. The change in welfare can again be broken down into effects on profits, consumer surplus and tariff revenue:

$$\Delta W_i^{C\{i,j\}} = \left(\Pi_i^{C\{i,j\}} - \Pi_i^N \right) + \left(CS_i^{C\{i,j\}} - CS_i^N \right) + \left(TR_i^{C\{i,j\}} - TR_i^N \right) \quad (3.49)$$

Using equations (3.17) to (3.19) and (3.26) to (3.28), and the tariff rates given by (3.21) and (3.47), the change in welfare can be shown to equal:

$$\begin{aligned} \Delta W_i^{C\{i,j\}} = & \left[\frac{25(n-2)}{2(n+1)^2(n+16)\beta} - \frac{3(3n^2+16n-59)}{2(n+1)^2(n+7)^2\beta} \right] (\alpha_i - \beta c)^2 \\ & + \left[\frac{10(n-2)}{(n+1)^2(n+16)\beta} + \frac{24(n+4)}{(n+1)^2(n+7)^2\beta} \right] v(\alpha_i - \beta c) \\ & + \left[\frac{15(n-2)}{8(n+1)^2(n+16)\beta} + \frac{12(n+4)}{(n+1)^2(n+7)^2\beta} \right] v^2 \end{aligned} \quad (3.50)$$

The expression above allows us to make the following observations about the welfare effects of forming a two-country customs union. Firstly, when v is positive, all three terms on the right hand side of (3.50) are positive. This implies that country i will always gain from forming a customs union with country j if j is larger. When v is negative, the second term on the right hand side of (3.50) becomes negative, and the overall sign of the expression is ambiguous. Hence the formation of a customs union with a smaller country j could raise or lower country i 's welfare. The results in Section 3.6 below show that in the three-country case which is considered, the formation of a customs union between countries 1 and 2 will reduce country 2's welfare. However, it can be seen from equation (3.50) that as n becomes very large, the formation of a customs union between two countries can only reduce welfare in the larger country when there is a very large difference in the sizes of the two countries. This contrasts with the case of a free trade area, where it was shown that when n is very large, the larger country will always lose from forming a two-country customs union. This suggests that if no compensation is allowed, two countries are more likely to form a customs union than a free trade area.

3.5. Some effects of single market formation

The case of a single market is similar to the previous case of customs union formation, in that the members of the single market again set their common external tariff to maximise the joint welfare of members. In this case, the welfare function to be maximised is:

$$W_u = a_i \Pi_i + CS_u + TR_u \quad (3.51)$$

where Π_i , CS_u and TR_u are as given by equations (3.38) to (3.40). Differentiating welfare with respect to the common external tariff τ_u and setting equal to zero yields the following expression for the optimal tariff:

$$\tau_u = \frac{(2a_i + 1) \left[\sum_{j \in A(i)} \alpha_j - a_i \beta c \right]}{a_i (n + 2a_i^2 + 3a_i + 2) \beta} \quad (3.52)$$

This tariff can be seen to be identical to that set by the customs union without a single market as derived in the previous section. Hence the results concerning tariffs in Proposition 3.3 still hold. To understand why the common external tariff is the same in both cases, it is helpful to compare equations (3.26) to (3.28) with (3.38) to (3.40). It can be seen that summing the former set of equations across customs union members gives the latter set of equations. Thus profits, consumer surplus and tariff revenue for the union as a whole are the same whether the union has segmented markets or a single market, so the optimal common external tariff is the same.

Although welfare for the union as a whole is the same in both these cases, the same is not true for individual countries. The important difference arises in consumer surplus. The price in the single market, given by (3.36), lies between the prices in individual customs union members with segmented markets, given by (3.25). Hence

large customs union members will benefit from a single market as such countries will face a lower price and enjoy higher consumer surplus, while small members will be worse off with a single market as consumers will face a higher price.³⁶ Thus it can be concluded that with a single market, large countries are more likely to gain from a customs union than when markets within the customs union are segmented.

3.6. The three-country case

In this section a three-country case is examined in more detail. First the benchmark cases of free trade and Nash optimal tariffs are examined, then free trade areas, and finally joint-welfare maximising customs unions. The results are considered in the context of NAFTA.

The analysis in this section is of the special case where $\alpha_i = i\alpha$, that is where the three countries have demand parameters α , 2α and 3α . While this is clearly less general than the previous sections, it allows clearer analytical results to obtain. The results in this section can be thought of as applying to a case in which there are three countries of very different sizes which might join free trade areas or customs unions with each other. This seems reasonable when considering NAFTA, where the small country 1 represents Mexico, the medium sized country 2 Canada and the large country 3 the United States.

³⁶ Note that profits earned by each firm are unchanged, while tariff revenue for each individual country is indeterminate as explained in Section 3.2. Here it is implicitly assumed that as well as the customs union's total tariff revenue remaining unchanged, either individual countries shares of this revenue are unchanged or at least any changes are small enough not to offset the changes in consumer surplus.

Case 1: Free trade

Equations (3.11) and (3.12) are used to provide the following expressions for welfare in the three countries, with the superscript FT denoting free trade:

$$W_1^{FT} = \frac{37\alpha^2 - 42\alpha\beta c + 15\beta^2 c^2}{32\beta}$$

$$W_2^{FT} = \frac{64\alpha^2 - 60\alpha\beta c + 15\beta^2 c^2}{32\beta}$$

$$W_3^{FT} = \frac{109\alpha^2 - 78\alpha\beta c + 15\beta^2 c^2}{32\beta}$$

Case 2: Nash tariff equilibrium

From equation (3.21), the optimal tariffs in the three countries, with the superscript N denoting Nash tariff equilibrium, are:

$$\tau_1^N = \frac{3(\alpha - \beta c)}{10\beta} \quad \tau_2^N = \frac{3(2\alpha - \beta c)}{10\beta} \quad \tau_3^N = \frac{3(3\alpha - \beta c)}{10\beta}$$

Using these tariffs and equations (3.17), (3.18) and (3.19), the following expressions can be found for welfare in the three countries:

$$W_1^N = \frac{53\alpha^2 - 90\alpha\beta c + 42\beta^2 c^2}{100\beta}$$

$$W_2^N = \frac{85\alpha^2 - 84\alpha\beta c + 21\beta^2 c^2}{50\beta}$$

$$W_3^N = \frac{365\alpha^2 - 246\alpha\beta c + 42\beta^2 c^2}{100\beta}$$

Comparison of welfare for the three countries under free trade and optimal tariffs reveals the following results:

$$W_1^{FT} > W_1^N \quad W_2^{FT} > W_2^N \quad W_3^{FT} < W_3^N$$

Hence countries 1 and 2 prefer free trade to the Nash tariff equilibrium, whereas the larger country 3 prefers the Nash equilibrium. This offers support to the result that in strategic trade policy models, as in neoclassical trade theory, large countries can gain from tariff wars.

Case 3a: Free trade areas

There are three possible free trade areas between pairs of countries in the three-country model. The main case considered here is a free trade area between countries 1 and 2, the two losers in the tariff war considered above. Tariffs in the two countries forming the free trade area are given by equation (3.29), while due to the strategic independence between markets, the optimal tariff decision facing country 3

is the same as in the Nash tariff equilibrium above. Hence the optimal tariffs when countries 1 and 2 form a free trade area, denoted by the superscript $F\{1,2\}$, are:

$$\tau_1^{F\{1,2\}} = \frac{\alpha - \beta c}{7\beta} \quad \tau_2^{F\{1,2\}} = \frac{2\alpha - \beta c}{7\beta} \quad \tau_3^{F\{1,2\}} = \frac{3(3\alpha - \beta c)}{10\beta}$$

Comparing these tariffs to those set by countries 1 and 2 in the Nash tariff equilibrium, it is clear that the formation of a free trade area results in a reduction in the tariffs both these countries set on imports from country 3, in line with Proposition 3.1.

Using these tariff rates together with equations (3.26), (3.27) and (3.28) gives the following results for welfare in countries 1 and 2:

$$W_1^{F\{1,2\}} = \frac{3791\alpha^2 - 5394\alpha\beta c + 2199\beta^2 c^2}{4900\beta}$$

$$W_2^{F\{1,2\}} = \frac{7841\alpha^2 - 8094\alpha\beta c + 2199\beta^2 c^2}{4900\beta}$$

Country 3 benefits from the formation of a free trade area by countries 1 and 2. Country 3's consumer surplus, domestic market profits and tariff revenue are all unchanged, while examination of the tariff rates before and after the formation of the free trade area and equations (3.17) and (3.26) shows that the reduction in the tariffs set by both free trade area partners is sufficient to increase the profits earned by the firm located in country 3 in these markets. Comparison of welfare in the three

countries in the Nash tariff equilibrium and in a free trade area leads to the following results:

$$W_1^{F\{1,2\}} > W_1^N \quad W_2^{F\{1,2\}} < W_2^N \quad W_3^{F\{1,2\}} > W_3^N$$

These results arise from the effects explained in Section 3.3 above. Each member country gains profits in its partner's market at the expense of profits in its own market as a result of the reciprocal abolition of tariffs on intra-bloc trade, while both countries increase consumer surplus and lose tariff revenue. The crucial factor determining why one country gains and the other loses is the difference in size between the two countries. The smaller country 1 gains unrestricted access to a larger market while losing market share in its own smaller market, whereas country 2 gains market share in a small market while losing out in its own larger market. In addition, the loss of tariff revenue is more significant in country 2, which was raising a larger tariff on more imports than country 1. Therefore it is perhaps unsurprising that the smaller country gains partly at the expense of the larger country. However, the joint welfare of the two countries increases when they form a free trade area, as does world welfare, in line with Proposition 3.2. But since country 2 loses from this move, the free trade area is only likely to be formed if there is a possibility of redistribution from country 1 to country 2.

When the two other possible free trade areas (country 3 with either country 1 or country 2) are analysed, similar results emerge. In each case, the two partners reduce their tariffs against the third country, while welfare rises in the smaller partner,

falls in the larger partner and rises in the third country. Again, joint welfare of the partners, and of the world, rises.

Case 3b: Joint welfare maximising customs union

The case of a customs union between countries 1 and 2 differs from that of a free trade area between the same countries only in that the two partners now set a common external tariff, τ^C , which is assumed to be the tariff which maximises joint welfare. As is shown in Appendix 3, the formation of any customs union in a three-country world will raise the small country's tariff enough to prevent the outsider from selling in that country. To illustrate this, note that the optimal common external tariff given by equation (3.33), assuming that all firms continue to sell in all markets, is $5(3\alpha - 2\beta c)/38\beta$. However, from equation (3.23) it can be seen that output from country 3 sold in country 1 equals $(\alpha - \beta c - 3\beta\tau_1)/4$, which will be negative given the tariff rate above. Hence to find the actual common external tariff set by the customs union it is first assumed that country 3 does not sell in country 1, leaving this market as a duopoly while three firms still compete in countries 2 and 3. The joint-welfare maximising tariff is calculated for this case, and then it is checked to ensure that this tariff level is indeed sufficiently high to exclude country 3 from the market in country 1. Given the change in market structure in country 1, and taking account of the changes in profits for all three countries and country 1's consumer surplus and tariff revenue (which is now zero), the first-order condition for maximising the joint welfare of the customs union members becomes:

$$\frac{\partial(W_1 + W_2)}{\partial\tau^c} = \frac{5(2\alpha - \beta c) - 19\beta\tau^c}{16\beta} = 0 \quad (3.39)$$

Solving the first-order condition above gives a tariff level of $5(2\alpha - \beta c)/19\beta$, which is again high enough to exclude the firm located in country 3 from selling in country 1. Hence this is the optimal common external tariff, and noting that country 3's optimal tariff will be the same as in the Nash equilibrium and free trade area cases, the tariff rates for the case where countries 1 and 2 form a joint welfare maximising customs union are:

$$\tau_1^{c\{1,2\}} = \tau_2^{c\{1,2\}} = \frac{5(2\alpha - \beta c)}{19\beta} \quad \tau_3^{c\{1,2\}} = \frac{3(3\alpha - \beta c)}{10\beta}$$

The common external tariff in this case can be seen to lie between the optimal tariff rates set by countries 1 and 2 in the Nash equilibrium, but it is higher than the rate set by either country when 1 and 2 form a free trade area. Hence a customs union is clearly more restrictive against the outside country than a free trade area. It is interesting to see whether a customs union is also more restrictive against exports from country 3 than the Nash tariff equilibrium, and this is investigated by comparing country 3's sales in countries 1 and 2 in the latter case to country 3's sales in the customs union (remembering that country 3 will in this case only export to country 2).³⁷ Using equations (3.14) and (3.23), and the optimal tariffs in the Nash tariff

³⁷ Under Article XXIV of the GATT, one of the conditions for countries forming a preferential trade bloc is that the bloc should be no more restrictive against outside countries than the member countries together were before forming a trade bloc. An obvious way of seeing whether this condition is satisfied is to compare imports from outside countries before and after the bloc is formed.

equilibrium and when countries 1 and 2 form a joint-welfare maximising customs union, the following result can be found:

$$x_{32}^{C\{1,2\}} = \frac{2\alpha - \beta c}{19} < \frac{3\alpha - 2\beta c}{10} = x_{31}^N + x_{32}^N$$

Hence the formation of the customs union reduces country 3's exports to a lower level than in the Nash tariff equilibrium. This raises doubts as to whether such a customs union would be allowed under Article XXIV of the GATT, which states that a trade bloc should not increase the level of protection against those countries which are not members.

Welfare in each country is defined as before as the sum of profits earned by the domestic firm, consumer surplus and tariff revenue.

$$W_1^{C\{1,2\}} = \frac{89047\alpha^2 - 121898\alpha\beta c + 47983\beta^2 c^2}{108300\beta}$$

$$W_2^{C\{1,2\}} = \frac{517141\alpha^2 - 543494\alpha\beta c + 152299\beta^2 c^2}{324900\beta}$$

$$W_3^{C\{1,2\}} = \frac{6518\alpha^2 - 4352\alpha\beta c + 727\beta^2 c^2}{1805\beta}$$

As with a free trade area, the formation of a customs union between 1 and 2 leads to a welfare gain for 1 and a loss for 2. However the gain for country 1 is bigger with a customs union than a free trade area, and although it is ambiguous which is larger for

country 2, the two countries together are better off forming a customs union than a free trade area. Meanwhile, the effect on country 3 of the other two countries forming a customs union is the opposite of the effect of free trade area formation. Due to the increased level of protection implied by a move from the Nash tariff equilibrium to a customs union, country 3's welfare falls, whereas the formation of a free trade area was shown to raise the outsider's welfare. Hence a customs union raises members' joint welfare at the expense of the outsider, while a free trade area makes members (in aggregate) and the outsider better off.

Case 4: A single market

The final case to analyse is that where countries 1 and 2 form a customs union with a single internal market. The tariff which maximises the union's welfare, τ_u , is found using equation (3.52), while the excluded country 3 will set its Nash equilibrium tariff as before. Hence the tariff rates are:

$$\tau_u = \frac{5(3\alpha - 2\beta c)}{38\beta} \qquad \tau_3 = \frac{3(3\alpha - \beta c)}{10\beta}$$

Welfare for the union members can be found by using these tariff rates along with equations (3.38) to (3.40). As was explained in Section 3.2, the assumption of a single market for the union members means that tariff revenue, and consequently welfare, cannot be calculated for the individual member countries, but only for the union as a whole. Welfare for the union of countries 1 and 2 and for country 3 are

given by the following expressions, where the superscript $u\{1,2\}$ denotes a customs union between countries 1 and 2 with a single market:

$$W_u^{u\{1,2\}} = \frac{79173\alpha^2 - 101232\alpha\beta c + 33022\beta^2 c^2}{36100\beta}$$

$$W_3^{u\{1,2\}} = \frac{6633\alpha^2 - 4512\alpha\beta c + 782\beta^2 c^2}{1805\beta}$$

Although the results in Section 3.5 suggest that usually welfare will be the same in a customs union with or without a single market, that does not hold true in this specific example because of the fact that the firm located in country 3 did not sell in country 1 in the case with segmented markets. Comparing the welfare of the union members and the other countries, with and without a single market, gives the following results:

$$W_u^{u\{1,2\}} - (W_1^{C\{1,2\}} + W_2^{C\{1,2\}}) = \frac{-71725\alpha^2 + 1900\alpha\beta c + 96913\beta^2 c^2}{324900\beta}$$

$$W_3^{u\{1,2\}} - W_3^{C\{1,2\}} = \frac{23\alpha^2 - 32\alpha\beta c + 11\beta^2 c^2}{361\beta}$$

From these expressions the sign of the difference in welfare for the customs union members 1 and 2 is ambiguous, but country 3 is better off when they form a single market.

The three-country model is appropriate for considering the economic rationale underlying the formation of NAFTA, taking Mexico to be the small country 1, Canada the medium-sized country 2 and the United States the large country 3. The results in this section suggest that the United States would be better off in the Nash equilibrium than either in a two-country free trade area with Canada or in a free trade area covering all three countries (taken to be equivalent to the case of free trade here), assuming that no side payments were given. However, the various side agreements, covering such issues as the environment and labour standards, which were introduced alongside NAFTA could be seen as welfare improving for the United States, and thus could constitute the compensation needed to induce the United States to form the free trade area. Thus the model in this paper offers an explanation as to why Mexico was prepared to make a number of concessions to gain entry to NAFTA while the United States was not required to reciprocate.

3.7. Conclusions

This chapter has considered the effects of the formation of free trade areas and customs unions in a world where countries differ in market size and firms act as Cournot oligopolists. It has been shown that the formation or expansion of a free trade area will always lead to a reduction in members' tariffs and a rise in the joint welfare of both members and non-members. The effect of the formation of a two-country customs union on each country's tariff is generally ambiguous. A country's tariff is more likely to rise when (a) there are more countries to raise tariffs from; (b) the

country is small; and (c) the country's partner is large. The welfare of the smaller country will always rise, while the effect on the larger country is ambiguous. If the customs union members form a single market, the larger country is likely to have higher welfare, and the smaller country lower welfare, than when markets remain segmented.

The results in this chapter suggest there is unlikely to be any incentive for forming a free trade area unless transfers between partners are possible, while the result for customs unions is less clear. The results for the three-country model show that while the formation of a two-country free trade area or customs union will raise the joint welfare of its members, in each case the larger member's welfare falls in comparison to the Nash tariff equilibrium. Hence the smaller partner would need to compensate the larger partner to form a trade bloc. Comparing the results for a free trade area and a customs union, joint welfare of the members is higher in the latter case. However, when a free trade area is formed the non-member also gains, whereas the non-member loses from the formation of a customs union.

The fact that small countries gain from trade bloc membership while large countries often lose provides a rationale for the numerous concessions by small countries on non-trade issues which have recently been seen to accompany preferential trade agreements. For example, the side agreements on the environment and labour standards which Mexico signed when joining NAFTA can be viewed as a transfer from Mexico to the United States to induce the United States to sign a welfare-reducing trade agreement.

Appendix 3.

This appendix derives the necessary condition for the formation of a two-country customs union not to raise the smaller country's tariff to such an extent that it will no longer import from outside the customs union. It is assumed that countries i and j form a customs union, with $\alpha_i < \alpha_j$. Sales of the firm located in a non-member country k in country i are, from equation (3.23):

$$x_{ki} = \frac{\alpha_i - \beta c}{n+1} - \frac{3}{n+1} \beta \tau^c \quad (\text{A3.1})$$

where τ^c , the customs union's common external tariff, is (from equation (3.30)):

$$\tau^c = \frac{5(\alpha_i + \alpha_j - 2\beta c)}{2(n+16)\beta} \quad (\text{A3.2})$$

Substituting (A3.2) into (A3.1) gives the following expression for sales by the country k firm in country i :

$$x_{ki} = \frac{(2n+1)(\alpha_i - \beta c) - 15(\alpha_j - \beta c)}{2(n+16)\beta} \quad (\text{A3.3})$$

From (A3.3), it is clear that $x_{ki} > 0$ when

$$(2n + 1)(\alpha_i - \beta c) > 15(\alpha_j - \beta c)$$

Remembering that $\alpha_i < \alpha_j$, this condition clearly cannot be satisfied for $n \leq 7$, so in a world consisting of no more than seven countries, the formation of a customs union between any pair of countries will raise the smaller country's tariff sufficiently to prevent outsiders from selling in that country. For larger values of n , the identity of the countries forming the customs union is important. For example, with $n = 10$, the above condition becomes $21(\alpha_i - \beta c) > 15(\alpha_j - \beta c)$. Clearly in this case two countries would need to be of similar sizes for the common external tariff not to be so high as to prevent outsiders from selling in the smaller country.

Chapter 4.

Strategic Trade Policy under Integrated Markets^{*}

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4.1. Introduction

The trade policy literature has identified two main cases where intervention in international trade may be welfare improving for a country. In conventional trade theory, a large country able to influence its terms of trade can gain by using an optimum tariff or export tax and, in the new trade theory, a country can use strategic trade policies to shift profits to the domestic firm and/or to extract rent from foreign firms. In both these cases, trade policy is generally a beggar-my-neighbour policy where intervention by one country increases its welfare at the expense of the other country. When both countries intervene, setting trade policy in a non-cooperative manner, the outcome will typically be a prisoners' dilemma where both countries are worse off and aggregate world welfare is undoubtedly lower than under free trade.³⁸ In contrast, this chapter presents a model of strategic trade policy under integrated markets, with incomplete information about costs, where non-cooperative trade policy setting yields higher welfare than under free trade for both countries.³⁹

Although the literature on strategic trade policy is now very extensive, see Brander (1995) for a recent survey, it has concentrated almost exclusively on the case of segmented markets, with only a few papers dealing with the case of integrated

³⁸ As Johnson (1953-54) has shown, in the case of the terms of trade argument, one country may gain compared to free trade but the other country will always lose. Similar results have also been obtained in strategic trade policy models.

³⁹ Other papers that look at Pareto-improving trade policy, such as Anis and Ross (1992), consider a policy change by one country that improves the welfare of both countries but they do not show that non-cooperative trade policy setting yields higher welfare for both countries than under free trade. Bagwell and Staiger (1989) present a model where export subsidies are used to signal product quality and where intervention by both countries can be welfare improving.

markets.⁴⁰ The assumption of segmented markets means that there is no possibility of arbitrage between markets so firms regard each country as a separate market. Together with the usual assumption of constant marginal cost this implies that one market can be analysed independently of any other markets which greatly simplifies the analysis of trade policy. However, the lack of any interaction between markets is a very unappealing feature of these models. The alternative assumption of integrated markets means that there is perfect arbitrage between markets, and hence firms sell in an integrated world market. In the absence of transport costs, perfect arbitrage implies that any price differences between markets must be entirely due to trade policies. Thus, with integrated markets it is not possible to analyse one market independently of the others, making the modelling of strategic trade policy under integrated markets more difficult than when markets are segmented. With world markets becoming more integrated, the assumption of segmented markets seems less tenable when firms regard the global economy as their market place. Consequently, the first aim of this chapter is to analyse strategic trade policy under integrated markets with complete information.

A recent innovation in the literature on strategic trade policy has been the introduction of incomplete information.⁴¹ In a Cournot duopoly model based upon Brander and Spencer (1985), Collie and Hviid (1993) show that an export subsidy can be used to signal information about the competitiveness of the domestic firm when the

⁴⁰ Notable exceptions that deal with trade policy under integrated markets are Markusen and Venables (1988), Venables (1994) and Fisher and Wilson (1995).

⁴¹ Apart from this paper, the rest of the literature on strategic trade policy under incomplete information assumes that markets are segmented.

foreign firm has incomplete information about the domestic firm's costs. Similarly, Collie and Hviid (1999) show that a tariff can be used to signal the uncompetitiveness of the domestic firm when incomplete information about costs is added to the Brander and Spencer (1984) model. Brainard and Martimort (1996) extend the Brander and Spencer (1985) model of profit-shifting export subsidies by assuming that the domestic government has incomplete information about the costs of the domestic firm. Assuming that the collection of government revenue is costly, they derive the optimal export subsidy and lump-sum payment scheme that ensures the truthful revelation of costs by the domestic firm. The model analysed by Qiu (1994) combines both signalling and truthful revelation under Cournot and Bertrand oligopoly. As Brander (1995) notes in his survey of strategic trade policy "(t)he existence of informational asymmetries seems both indisputable and important". Therefore, the second aim of this chapter is to introduce incomplete information about the costs of both firms into the model of strategic trade policy under integrated markets, and to analyse how both governments can use trade policy to signal about the costs of their domestic firm.

Section 4.2 highlights the differences between the assumptions of segmented and integrated markets, and introduces the trade policy instrument, a combination of an import tariff with an equal export subsidy, used in this chapter and Chapter 5. Section 4.3 presents the model of strategic trade policy under integrated markets with complete information, where two firms each located in a separate country compete as Cournot duopolists in an integrated world market. In Section 4.4, the optimal trade policy of a country is shown to be an import tariff if the country is a net importer and

an export subsidy if the country is a net exporter. When both countries set trade policy non-cooperatively, the outcome is the Nash equilibrium in trade policies where the country that has the firm with the lower costs will give an export subsidy which is fully countervailed by the import tariff set by the other country. The country that has the firm with the lower cost will be worse off while the other country will be better off than under free trade. Section 4.5 extends the model presented in Section 4.3 by adding incomplete information about the costs of the two firms. The separating equilibria of this signalling game are derived in Section 4.6. Taking the expected trade policy of the other country as given, it is shown that a country can use its trade policy to signal about the domestic firm's costs. The export subsidy (import tariff) in the separating equilibrium is larger (smaller) than the optimum under complete information. Section 4.7 derives the separating equilibrium of the simultaneous signalling game, and shows that the country with the low (high) cost firm will have the higher (lower) expected trade policy. In the symmetric case, the expected welfare of both countries in the separating equilibrium is higher than under free trade; this welfare gain arises from increased specialisation according to comparative advantage.

4.2. Integrated versus segmented markets.

Most of the literature on trade under imperfect competition assumes that markets are segmented, so it is important to underline the difference between that assumption and the alternative assumption of integrated markets used in this paper. The assumption of segmented markets means that all firms consider each country to

be, and are able to treat each country as, a separate market. Firms which compete in quantities make a separate output decision for each market, independently of their decisions in all other markets, and there is no possibility of arbitrage between markets. Hence, assuming constant returns to scale, the market in any country can be analysed independently of those in all other countries.

In contrast, when the alternative assumption of integrated markets is made, there is perfect arbitrage between markets. Firms sell in an integrated world market, and perfect arbitrage ensures that no price differences can exist between markets unless they are caused by transport costs and/or trade policies. Thus with integrated markets it is not possible to analyse the market in any one country independently of all other countries.

The assumption of integrated markets means that care must be taken when defining the trade policy instrument used by a trade bloc, as the arbitrage assumption implies some restrictions on the choice of trade policy. To see this, consider the case of two countries, indexed $i = 1, 2$, which produce and consume a single homogeneous good, and which each set a tariff τ_i on imports and a subsidy s_i on exports of this good. Assuming zero transport costs, the following arbitrage condition is necessary to prevent consumers in country 1 from being able to buy the good more cheaply in country 2:⁴²

⁴² If there were positive transport costs involved in trade between the two countries, the arbitrage conditions below would not need to hold. Assuming that the transport cost was equal for trade in either direction, prices between the two countries could differ by the amount of this transport cost in addition to any difference allowed by the trade policies.

$$p_1 \leq p_2 - s_2 + \tau_1$$

If this condition is not satisfied, it would be cheaper to buy the good in country 2 and transport it to country 1, receiving the export subsidy and paying the import tariff, rather than simply buying the good in country 1. A similar arbitrage condition is needed to prevent consumers in country 2 from buying the good in country 1.

$$p_2 \leq p_1 - s_1 + \tau_2$$

It is immediately apparent that the introduction of export subsidies alone (i.e. $\tau_1 = \tau_2 = 0$) is not feasible with integrated markets. In this case, with both subsidies non-negative and at least one strictly positive, it is not possible for both inequalities above to hold. An arbitrageur could repeatedly export a good from the country giving the subsidy and reimport the good, each time receiving the export subsidy but paying no import tariff, so export subsidies used alone clearly allow profitable arbitrage.

Now, to see under what conditions it might be possible to use export subsidies, consider the case where country 2 is passive (i.e. $\tau_2 = s_2 = 0$) and only country 1 uses trade policy. Using the two arbitrage conditions above, it can be seen that a necessary condition for country 1's trade policy to be compatible with integrated markets is $\tau_1 \geq s_1$. In other words, country 1 must set an import tariff which is at least as high as the export subsidy it sets. To see why this is necessary, consider what would happen if a good produced in country 1 were exported to country 2 and then reimported by an

arbitrageur. The arbitrageur would collect an export subsidy of s_1 on exporting the good and pay an import tariff of τ_1 . Thus if $s_1 > \tau_1$, the arbitrageur could repeatedly export and reimport the good, making a profit of $s_1 - \tau_1$ each time. Hence it can be seen that each government, to be sure of preventing this type of profitable arbitrage, can only use an export subsidy if it is accompanied by an equal or greater import tariff.⁴³

In this chapter and Chapter 5 the trade policy instrument used is an export subsidy and an import tariff set at an equal rate. This is sufficient to allow for the analysis of export subsidies under integrated markets, as explained above, while also ensuring markets remain truly integrated, avoiding the anti-competitive effect associated with import tariffs.⁴⁴ To see how trade policy could be used to keep markets segmented, suppose a country set a tariff greater than its export subsidy, which is consistent with the analysis above. This effectively allows that country to artificially segment its market, as the tariff partially insulates producers in the country from foreign competition and raises the price they are able to charge for their product. Hence it is argued that the use of an import tariff higher than that country's export subsidy is a way of keeping markets segmented, and consequently not consistent with the analysis of integrated markets. The use of an export subsidy and an import tariff set at an equal rate allows the analysis of export subsidies under integrated markets

⁴³ A similar condition applies to import subsidies, namely that any import subsidy must be accompanied by an equal or greater export tax to ensure there are no opportunities for profitable arbitrage. In this case both τ_1 and s_1 are negative, so again $\tau_1 \geq s_1$.

⁴⁴ The anti-competitive effect of conventional tariffs when markets are integrated has been shown by Venables (1994) and Fisher and Wilson (1995) under Bertrand oligopoly, while Collie (1998) has shown how this combined trade policy instrument will avoid these anti-competitive effects.

while also ensuring that markets are not artificially segmented. An additional advantage of this trade policy instrument is that it greatly simplifies the analysis of trade policy under integrated markets, as it implies a single arbitrage condition which must hold with equality instead of two inequalities.

Integrated and segmented markets are both extreme assumptions, but despite the fact that the literature on trade under imperfect competition is mainly concentrated on the case of segmented markets, this assumption does not seem closer to reality than the alternative. Generally, as trade barriers are removed and global markets become more integrated, it seems reasonable to suggest that the world is moving away from a situation of segmented markets and closer to a single global market. Therefore a greater understanding of models of trade under integrated markets is important.

The literature on trade policy under segmented markets is extensive and the main results are well known. Brander (1995) provides a comprehensive survey of the literature on strategic trade policy, the vast majority of which assumes segmented markets. The literature using the alternative assumption of integrated markets is far smaller. Strategic trade policy under integrated markets was previously analysed by Markusen and Venables (1988), but they only consider small deviations from free trade, not optimal policy. In their textbook, Heffernan and Sinclair (1990) consider the effect of a tariff where firms have the same marginal costs. Trade policy under integrated markets with Bertrand competition is analysed by Collie (1998).

4.3. The basic model with complete information.

The world economy consists of two countries: country 1 and country 2; variables relating to country 1 will be labelled by a subscript 1 and those relating to country 2 by a subscript 2. The markets of the two countries are integrated; hence, in the absence of transport costs, perfect arbitrage ensures that any price difference between the two markets is due entirely to trade taxes and subsidies. A single firm is located in each country and these two firms compete as Cournot duopolists in the integrated world market. Demand in the two markets is assumed to be identical and given by the linear demand functions $y_i = \alpha - \beta p_i$ for $i = 1, 2$, where y_i is consumption and p_i is the price in the i th market. The firm in the i th country has constant marginal cost c_i and produces output x_i ; it is assumed that $c_i < \alpha/\beta$ since otherwise a firm will never produce any output. Net imports of the i th country are given by domestic consumption minus domestic production: $m_i = y_i - x_i$. With only two countries, market clearing will ensure that total consumption of the good is equal to total production of the good in the integrated world market so $y_1 + y_2 = x_1 + x_2$ which implies that $m_1 + m_2 = 0$. The governments of the two countries each set the trade policy instrument described below to maximise their national welfare.

Formally, trade policy setting is modelled as a two stage game where the two governments simultaneously set trade policies in the first stage, and then in the second stage the two firms compete as Cournot duopolists given the trade policies set by the

two governments. As usual, the game is solved for the subgame perfect equilibrium by backwards induction.

Demand in the integrated world market is the sum of demands in the two countries. Since the two markets are integrated, perfect arbitrage will ensure that prices in the two markets will differ only by the amount of any trade policies which implies that $p_1 - t_1 = p_2 - t_2$. Summing the demand functions in the two countries, then using the arbitrage and market clearing conditions, yields the inverse demand functions facing the two firms in the integrated world market as functions of their outputs:

$$p_i = \frac{\alpha}{\beta} - \frac{x_i + x_j}{2\beta} + \frac{t_i - t_j}{2} \quad i, j = 1, 2 \quad i \neq j \quad (4.1)$$

Hence, the slope of the inverse demand function facing the i th firm is $\partial p_i / \partial x_i = -1/2\beta$. The two firms compete as Cournot duopolists in the integrated world market, and the profits of the firm in the i th country are $\pi_i = (p_i - c_i)x_i$. Assuming an interior solution where both firms produce positive output, the first order conditions for the Cournot-Nash equilibrium are:

$$\frac{\partial \pi_i}{\partial x_i} = p_i - c_i + x_i \frac{\partial p_i}{\partial x_i} = 0 \quad i, j = 1, 2 \quad i \neq j \quad (4.2)$$

Substituting the inverse demand functions (4.1) into these first order conditions and then solving for the Cournot-Nash equilibrium outputs yields⁴⁵

$$x_i = \frac{2}{3}(\alpha - 2\beta c_i + \beta c_j) + \beta(t_i - t_j) \quad i, j = 1, 2 \quad i \neq j \quad (4.3)$$

The effect of an import tariff or export subsidy, t_i , is to increase the output of the domestic firm, $\partial x_i / \partial t_i = \beta$, and to reduce the output of the foreign firm by an equal amount, $\partial x_j / \partial t_i = -\beta$; therefore, total production in the integrated world market is unchanged. Using the Cournot-Nash equilibrium outputs (4.3) in the inverse demand functions (4.1) yields the prices in the two markets:

$$p_i = \frac{1}{3\beta}(\alpha + \beta c_1 + \beta c_2) + \frac{1}{2}(t_i - t_j) \quad i, j = 1, 2 \quad i \neq j \quad (4.4)$$

The effects of trade policy, t_i , on prices in the two markets are $\partial p_i / \partial t_i = 1/2$ and $\partial p_j / \partial t_i = -1/2$; hence, half of an import tariff is passed through to domestic consumers while half is absorbed by the foreign firm, and half of an export subsidy is passed through to foreign consumers while half is absorbed by the domestic firm. Substituting these prices (4.4) into the demand functions of the two countries gives consumption in the two markets:

⁴⁵ With linear demand, since profit functions are concave, the second-order conditions for profit-maximisation are satisfied and there exists a unique Cournot equilibrium.

$$y_i = \frac{1}{3}(2\alpha - \beta c_1 - \beta c_2) - \frac{\beta}{2}(t_i - t_j) \quad i, j = 1, 2 \quad i \neq j \quad (4.5)$$

Trade policy, t_i , reduces consumption in the domestic market, $\partial y_i / \partial t_i = -\beta/2$, and increases consumption in the foreign market by the same amount, $\partial y_j / \partial t_i = \beta/2$; therefore, total consumption in the integrated world market is unchanged. Net imports are the difference between domestic consumption and domestic production in a country so $m_i = y_i - x_i$ and market clearing implies that $m_i = -m_j$; hence, using (4.3) and (4.5), net imports of i th country are:

$$m_i = \beta(c_i - c_j) - \frac{3\beta}{2}(t_i - t_j) = -m_j \quad i, j = 1, 2 \quad i \neq j \quad (4.6)$$

Since trade policy, t_i , increases domestic production and reduces domestic consumption, it will reduce the i th country's net imports, $\partial m_i / \partial t_i = -3\beta/2$, and increase the other country's net imports by the same amount, $\partial m_j / \partial t_i = 3\beta/2$.

Equations (4.3) to (4.6) describe the equilibrium of the integrated world market as a function of the trade policies set by the two governments. Ignoring distributional questions and assuming that preferences are quasi-linear, the welfare of a country is given by the sum of consumer surplus, the profits of the domestic firm,

and government revenue from trade policy.⁴⁶ Thus, the welfare of each country is given by:

$$W_i = \frac{1}{\beta} \int_0^{y_i} (\alpha - \beta q) dq - p_i y_i + \pi_i + t_i m_i = \frac{1}{2\beta} y_i^2 + (p_i - c_i) x_i + t_i m_i \quad i = 1, 2 \quad (4.7)$$

Before looking at trade policy, the question of whether there are gains from trade under oligopoly with integrated markets will be briefly considered. Setting $t_1 = t_2 = 0$ in (4.3) to (4.6) gives output, prices, consumption and net imports under free trade, and substituting these into (4.7) yields the welfare of the i th country under free trade:

$$W_i^F = \frac{2}{9\beta} (2\alpha - \beta c_i - \beta c_j) (\alpha - 2\beta c_i + \beta c_j) + \frac{\beta}{2} (c_i - c_j)^2 \quad i, j = 1, 2 \quad (4.8)$$

In autarky, since the domestic firm faces no competition from the foreign firm, it can set the monopoly price in the domestic market and earn monopoly profits. It is straightforward to show that the welfare of the i th country under autarky is $W_i^A = 3(\alpha - \beta c_i)^2 / 8\beta$, and obviously there are gains from trade if $\Delta W_i = W_i^F - W_i^A > 0$. It can be shown that ΔW_i has a minimum at $c_i = (13\alpha + 28\beta c_j) / 41\beta$ where its value is $\Delta W_i = (\alpha - \beta c_j)^2 / 82\beta > 0$; hence, there

⁴⁶ For an import tariff, government revenue is positive since trade policy is positive and net imports are positive while, for an export subsidy, government revenue is negative since trade policy is positive and net imports are negative.

are always gains from trade whatever the relative costs of the two firms.⁴⁷ In other models of international trade with imperfect competition under integrated markets, such as Markusen (1981), it is generally shown that a sufficient condition for gains from trade is that the output of the domestic industry expands under free trade. Here, it has been shown that there are gains from trade even if the output of the domestic firm contracts under free trade. An important point to note is that there will be gains from trade in the symmetric case, when both firms have the same costs, even though net imports will be equal to zero. These gains arise from the possibility of trade that introduces competition between the two firms, leading to lower prices, and a consequent reduction in the deadweight loss from monopoly.

4.4. Trade policy with complete information

In this oligopolistic industry, a government can use trade policy to shift profits to its domestic firm and to improve the terms of trade by extracting rent from the foreign firm. This section firstly analyses the optimal trade policy of a country while taking the trade policy of the other country as given, and then analyses the Nash equilibrium in trade policies when both countries set them simultaneously. The optimal trade policy for the i th country is given by maximising its welfare (4.7) with respect to t_i , while taking t_j as given, which yields the first order condition:

⁴⁷ The assumption that demand in both markets is identical is important, since it is possible that a country could lose from trade if its market was much larger than the market in the other country, see Markusen (1981). Surprisingly, this suggests that cost differences should be a less important issue in trade liberalisation than differences in the size of the markets.

$$\frac{\partial W_i}{\partial t_i} = m_i \left(1 - \frac{\partial p_i}{\partial t_i} \right) + (p_i - c_i) \frac{\partial x_i}{\partial t_i} + t_i \frac{\partial m_i}{\partial t_i} = 0 \quad i = 1, 2 \quad (4.9)$$

Solving for the optimal trade policy yields:

$$t_i^* = \left(m_i \left(1 - \frac{\partial p_i}{\partial t_i} \right) + (p_i - c_i) \frac{\partial x_i}{\partial t_i} \right) / \left(- \frac{\partial m_i}{\partial t_i} \right) \quad i = 1, 2 \quad (4.10)$$

Since the denominator is clearly positive, the overall sign of the optimal trade policy depends upon the terms in the numerator. The first term in the numerator is the terms of trade effect which is positive (negative) if net imports are positive (negative) and the second term is the profit-shifting effect which is positive. Hence, if a country is a net importer then the optimal trade policy is an import tariff, but if it is a net exporter then the optimal policy seems to be ambiguous. However, noting that $p_i - c_i = x_i/2\beta$ from (4.1) and (4.2), that $\partial x_i/\partial t_i = \beta$ from (4.3), and that $\partial p_i/\partial t_i = 1/2$ from (4.4), the optimal trade policy can be shown to be $t_i^* = y_i/3\beta$ which is positive if domestic consumption is positive; this leads to the following proposition:

Proposition 4.1. *The optimal trade policy for a country is an import tariff if it is a net importer and an export subsidy if it is a net exporter.*

When the country is a net importer, both the terms of trade effect and the profit-shifting effect are positive, hence the optimal policy is a positive import tariff which is similar to the result in Brander and Spencer (1984) for segmented markets. When the country is a net exporter, the positive profit-shifting effect outweighs the negative terms of trade effect, hence the optimal policy is an export subsidy which is similar to the result in Brander and Spencer (1985) for segmented markets. The optimal policies under integrated markets are generally smaller than those under segmented markets as the greater degree of competition in the former case results in smaller price-cost margins and thus reduces the effect of strategic trade policies. The analysis can be extended to the case of many firms in each country without much difficulty. If the country is a net importer then the optimal policy is always an import tariff, but if the country is a net exporter then the optimal policy may be an export tax if the number of domestic firms is large relative to the number of foreign firms as in Dixit (1984) for segmented markets. The analysis can also be extended to the case when the country uses a production subsidy as well as trade policy. In this case, the optimal policy is a production subsidy to ensure that price is equal to the marginal cost of the domestic firm and an import tariff or export tax to improve the terms of trade.

When both governments set trade policy non-cooperatively the result will be a trade policy war which is best analysed as the Nash equilibrium of this single-shot game. In the Nash equilibrium in trade policies, each government simultaneously and independently sets trade policy to maximise its national welfare. The first step in analysing the Nash equilibrium is to derive the best-reply functions that give the

optimal trade policy of the i th country as a function of the trade policy of the j th country. Using equations (4.3) to (4.6), equation (4.10) can be solved to give an explicit expression for the best-reply functions:

$$t_i^*(t_j) = \frac{2}{21\beta}(2\alpha - \beta c_1 - \beta c_2) + \frac{1}{7}t_j > 0 \quad i, j = 1, 2 \quad i \neq j \quad (4.11)$$

These best-reply functions show that the optimal response of the i th country to an increase in the trade policy of the j th country is to increase its trade policy, $\partial t_i^* / \partial t_j = 1/7$. As the best-reply functions of the two countries are upward sloping, the trade policies of the two countries are strategic complements in the terminology of Bulow et al. (1985). Thus, in response to a foreign export subsidy, a country should impose a countervailing duty equal to one-seventh of the foreign export subsidy. This countervailing duty fraction is smaller than the fraction of one-third obtained by Dixit (1988) for segmented markets. Surprisingly, in response to a foreign import tariff, a country should increase its export subsidy by one-seventh of the amount of the tariff. This is in sharp contrast to the results under segmented markets where the optimal response to a foreign tariff is to reduce the export subsidy by half the amount of the tariff.⁴⁸

The two best-reply functions are shown in Figure 4.1 together with the iso-welfare loci of country one for the symmetric case when both firms have the same

⁴⁸ Collie (1994) derives the trade policy best-reply functions and the Nash equilibrium in trade policies under segmented markets when the domestic country uses an import tariff and the foreign country uses an export subsidy.

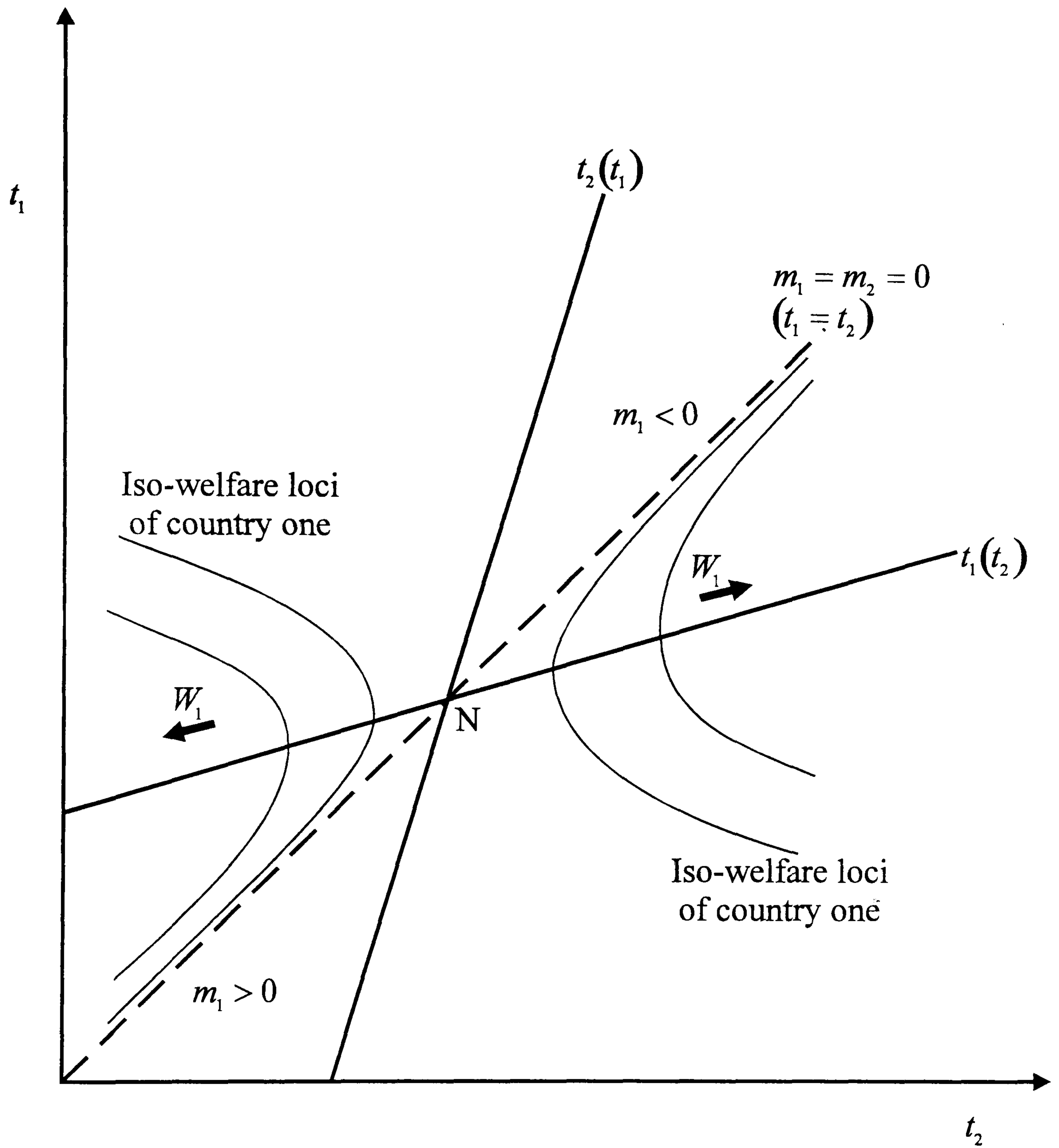


Figure 4.1: Trade policy best-reply functions in the symmetric case

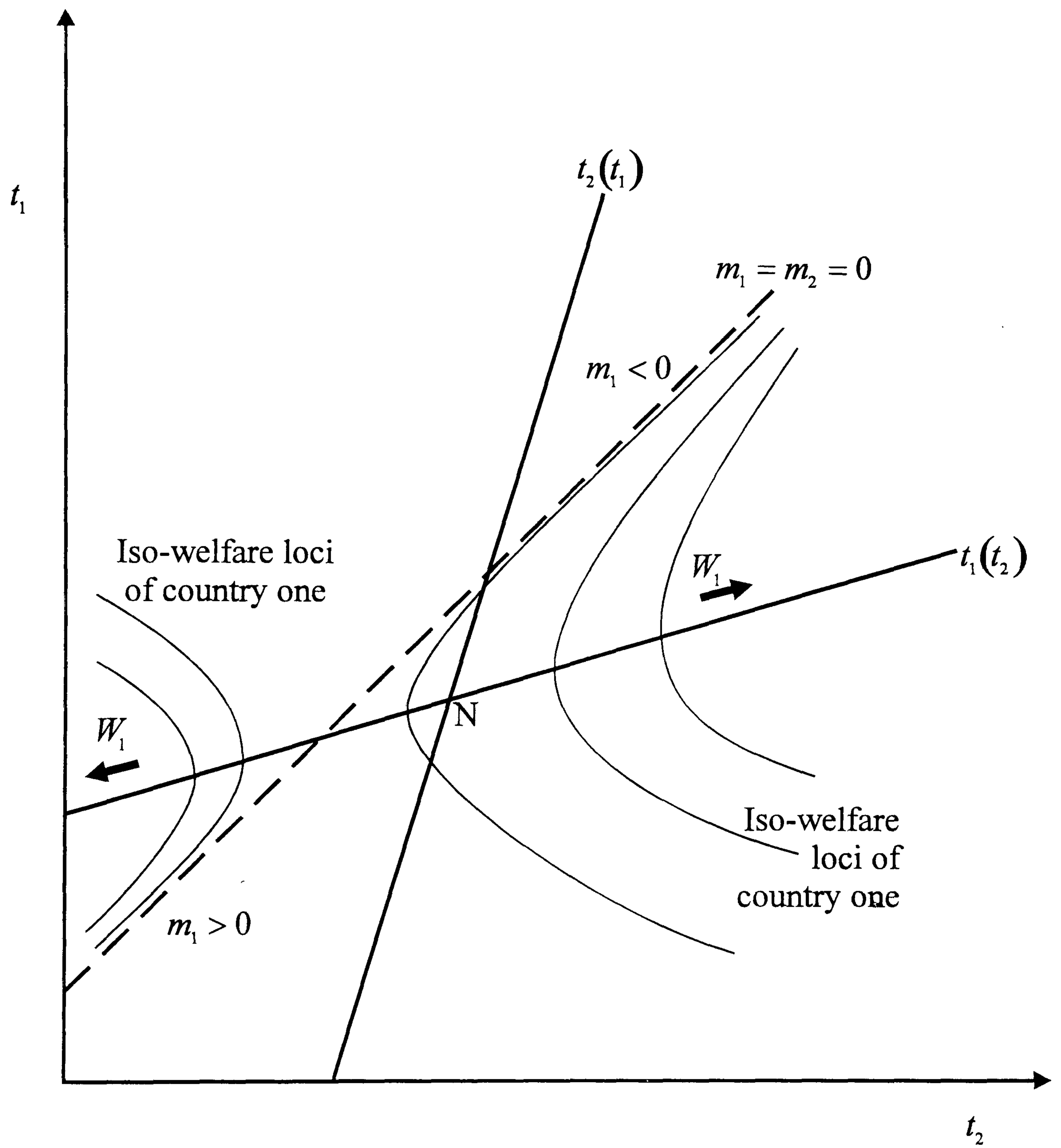


Figure 4.2: Trade policy best-reply functions for the asymmetric case

marginal cost ($c_1 = c_2$). Along the diagonal, where $t_1 = t_2$, it can be seen from equations (4.3) to (4.6) that prices, output and consumption in both countries are the same as under free trade while net imports are equal to zero, $m_1 = m_2 = 0$. Hence, the welfare of country 1 is constant along the diagonal, and this helps to explain the unorthodox shape of the iso-welfare loci. When country 1 is a net importer its welfare is increasing in country 2's trade policy (export subsidy), and when country 1 is a net exporter its welfare is decreasing in country 2's trade policy (import tariff). The asymmetric case, when the firm in country 1 has a cost disadvantage, $c_1 > c_2$, is shown in Figure 4.2.⁴⁹

The Nash equilibrium in trade policies is given by the intersection of the two best-reply functions as shown in Figures 4.1 and 4.2. Using (4.11) to solve for the intersection of the two best-reply functions yields the Nash equilibrium trade policies:

$$t_1^N = t_2^N = (2\alpha - \beta c_1 - \beta c_2)/9\beta > 0 \quad (4.12)$$

In the Nash equilibrium, both countries set their trade policy at exactly the same level.⁵⁰ Noting that the country with the low (high) cost firm will be a net exporter

⁴⁹ In the asymmetric case, when the two firms do not have the same costs, the line where net imports are equal to zero is below (above) the diagonal if country one's firm has lower (higher) costs than country two's firm. As above, welfare in each country is constant along the line where net imports are zero and the welfare of country one is increasing (decreasing) in country two's trade policy if country one is a net exporter (importer).

⁵⁰ Although not directly comparable, this result can be contrasted with that in de Meza (1986) which shows that the country with the low (high) cost firm will give the largest (smallest) Nash equilibrium export subsidy in the Brander and Spencer (1985) model under segmented markets. Here, although costs do affect the Nash equilibrium trade policies, cost differences do not lead to differences in the Nash equilibrium trade policies of the two countries.

(importer) in the Nash equilibrium in trade policies since $m_1 = \beta(c_1 - c_2) = -m_2$, leads to the following proposition:

Proposition 4.2. *In the Nash equilibrium in trade policies, the country with the low cost firm gives an export subsidy which is fully countervailed by the import tariff set by the other country.*

Comparing the Nash equilibrium in trade policies with free trade, it is obvious that the country with the low cost firm is made worse off while the other country is made better off since the net effect of the import tariff and the export subsidy is to transfer revenue from the exporting country to the importing country. World welfare in the Nash equilibrium is the same as under free trade. This analysis suggests that a country like Japan, which is a net exporter of oligopolistic products such as cars, will lose in a trade war with a net importer like the United States.

4.5. Incomplete information about costs.

In this section, incomplete information about costs is added to the basic model presented in Section 4.3. Each firm is assumed to have incomplete information about its competitor's marginal cost while each government knows the marginal cost of its domestic firm but not that of the foreign firm.⁵¹ In this situation, the trade policy set

⁵¹ The governments may directly observe the marginal cost of the domestic firm or each may design a mechanism to ensure that the firm truthfully reveals its costs as in Brainard and Martimort (1996).

by a government may provide a signal to the foreign firm about the costs of the domestic firm, and the governments will take this signalling effect into account when setting trade policy. This game of incomplete information has two stages. At the first stage, the two governments each observe the marginal cost of their domestic firm and set their trade policy to maximise their national welfare. Then, at the second stage, the two firms, having observed the trade policies set by the two governments, which they use to infer the marginal cost of their foreign competitor, independently and simultaneously choose their outputs to maximise their profits.

The marginal cost of the firm in the i th country, c_i , is assumed to be drawn from a continuous probability distribution with support on $[c_i^L, c_i^H]$ and with unconditional mean \bar{c}_i . The two probability distributions are assumed to be independently distributed, and to be common knowledge to both firms and both governments. The expected profits of the firm in the i th country are $\pi_i = E_i[(p_i - c_i)x_i | t_j]$ where E_i is the expectation operator given the firm's beliefs about the marginal cost of the foreign firm. Assuming an interior solution, the first-order conditions for the Bayesian-Nash equilibrium are:

$$\begin{aligned} \frac{\partial \pi_i}{\partial x_i} &= E_i \left[\left(p_i - c_i + x_i \frac{\partial p_i}{\partial x_i} \right) \middle| t_j \right] \\ &= \frac{1}{2\beta} \left(2\alpha - E_i(x_j | t_j) - 2x_i + \beta t_i - \beta t_j - \beta c_i \right) = 0 \quad i, j = 1, 2 \quad i \neq j \quad (4.13) \end{aligned}$$

In order to solve for Bayesian-Nash equilibrium quantities, it is first necessary to determine each firm's expectation of its competitor's output, $E_i(x_j|t_j)$. Taking expectations of the two firms' first-order conditions, using the common knowledge assumption, then solving the two simultaneous equations for the expected outputs yields:

$$E_i(x_j|t_j) = \frac{2}{3}(\alpha - 2\beta\hat{c}_j + \beta\hat{c}_i) + \beta(t_j - t_i) \quad i, j = 1, 2 \quad i \neq j \quad (4.14)$$

where $\hat{c}_i = \hat{c}_i(t_i) = E_j(c_i|t_i)$ is the j th firm's expectation of its competitor's marginal cost conditioned on the trade policy set by the government of the i th country. Substituting (4.14) into (4.13), then solving for the Bayesian-Nash equilibrium outputs of the two firms yields:

$$x_i = \frac{1}{3}(2\alpha - 3\beta c_i - \beta\hat{c}_i + 2\beta\hat{c}_j) + \beta(t_i - t_j) \quad i, j = 1, 2 \quad i \neq j \quad (4.15)$$

Using these outputs in the inverse demand functions (4.1) gives the prices in the two countries:

$$p_i = \frac{1}{6\beta}(2\alpha + 3\beta c_i - \beta\hat{c}_i + 3\beta c_j - \beta\hat{c}_j) + \frac{1}{2}(t_i - t_j) \quad i, j = 1, 2 \quad i \neq j \quad (4.16)$$

Consumption in each country can be found by using these prices in the demand functions of the individual countries:

$$y_i = \frac{1}{6}(4\alpha - 3\beta c_i + \beta \hat{c}_i - 3\beta c_j + \beta \hat{c}_j) + \frac{\beta}{2}(t_i - t_j) \quad i, j = 1, 2 \quad i \neq j \quad (4.17)$$

Net imports in each country are given by the difference between domestic consumption and domestic production in each country, hence:

$$m_i = \frac{\beta}{2}(c_i + \hat{c}_i - c_j - \hat{c}_j) - \frac{3\beta}{2}(t_i - t_j) = -m_j \quad i, j = 1, 2 \quad i \neq j \quad (4.18)$$

As in Section 4.3, the welfare of the i th country is given by the sum of consumer surplus, the profits of the domestic firm, and government revenue. Using equations (4.15) to (4.18) to evaluate the expected welfare of the i th country, $W_i(t_i, c_i, \hat{c}_i; t_j, c_j, \hat{c}_j)$, yields:

$$\begin{aligned} W_i = \frac{1}{72} E_i \left[32\alpha^2 / \beta - 72\alpha c_i - 8\alpha \hat{c}_i + 16\alpha \hat{c}_j + 24\alpha t_i - 24\alpha t_j + 45\beta c_i^2 \right. \\ + 18\beta c_i \hat{c}_i - 18\beta c_i c_j - 18\beta c_i \hat{c}_j - 18\beta c_i t_i + 54\beta c_i t_j + 5\beta \hat{c}_i^2 - 18\beta \hat{c}_i c_j \\ - 2\beta \hat{c}_i \hat{c}_j + 6\beta \hat{c}_i t_i + 30\beta \hat{c}_i t_j + 9\beta c_j^2 + 18\beta c_j \hat{c}_j + 18\beta c_j t_i - 54\beta c_j t_j \\ \left. - 7\beta \hat{c}_j^2 - 30\beta \hat{c}_j t_i - 6\beta \hat{c}_j t_j - 63\beta t_i^2 + 18\beta t_i t_j + 45\beta t_j^2 \right] \quad (4.19) \end{aligned}$$

where $i, j = 1, 2$ and $i \neq j$. Having derived the welfare of the i th country as a function of the trade policies set by the two governments, the marginal costs of the two firms, and the two firms' beliefs about their competitor's marginal cost, it is now possible to analyse the first stage of the game where the two governments set their trade policy.

4.6. Trade policy as a signal of costs.

With complete information, the trade policy set by a government affects national welfare through its direct strategic effect on the outputs of the two firms, but with incomplete information there is an additional signalling effect. The trade policy set by a government can be used by the foreign firm to infer the marginal cost of the domestic firm, and the foreign firm's beliefs about the marginal cost of the domestic firm will affect its output decision. The two governments will take this signalling effect into account when they set their trade policies. This section derives the separating equilibria of this signalling game when only one country signals the costs of its firm while taking the expected trade policy of the other country as given.⁵²

To solve for the separating equilibria of this game, assume that trade policy of the i th country in the separating equilibrium is given by $t_i = \phi_i(c_i; \bar{t}_j)$, where ϕ_i is a differentiable monotonic function of the domestic firm's marginal cost, c_i , and \bar{t}_j is

⁵² This game of incomplete information will also have a number of pooling equilibria and these are discussed in the appendix.

the expected trade policy of the j th country which is taken as given. In a separating equilibrium, $t_i = \phi_i(c_i; \bar{t}_j)$ must satisfy the incentive compatibility constraint that the government in the i th country maximises its welfare given the beliefs of the foreign firm, and that the beliefs of the foreign firm about the domestic firm's marginal cost are consistent with the separating equilibrium strategy. Beliefs are consistent with the separating equilibrium strategy if they are formed by inverting the separating equilibrium trade policy to obtain $\hat{c}_i(t_i) = \phi_i^{-1}(t_i; \bar{t}_j)$; hence, the foreign firm can correctly infer the domestic firm's marginal cost from the trade policy set by the government of the i th country in the separating equilibrium. Thus, the government of the i th country will choose $t_i = \phi_i(c_i; \bar{t}_j)$ to maximise $W_i(t_i, c_i, \hat{c}_i(t_i))$ where $\hat{c}_i(t_i) = \phi_i^{-1}(t_i; \bar{t}_j)$; which yields the following first-order condition for welfare maximisation:

$$\frac{dW_i}{dt_i} = \frac{\partial W_i}{\partial t_i} + \frac{\partial W_i}{\partial \hat{c}_i} \frac{d\hat{c}_i}{dt_i} = 0 \quad i, j = 1, 2 \quad i \neq j \quad (4.20)$$

In a separating equilibrium, the firms correctly infer the marginal costs of their foreign competitors from the trade policy set by the domestic government, so $\hat{c}_i(t_i) = c_i$. Using this, and noting that $d\hat{c}_i/dt_i = (d\phi_i/dc_i)^{-1}$, the differential equation (4.20) can be rewritten as:

$$\frac{d\phi_i}{dc_i} = \frac{-\partial W_i/\partial \hat{c}_i}{\partial W_i/\partial t_i} = \frac{4\alpha - 14\beta c_i + 10\beta \bar{c}_j - 3\beta t_i - 15\beta \bar{t}_j}{3(4\alpha - 2\beta c_i - 2\beta \bar{c}_j - 21\beta t_i + 3\beta \bar{t}_j)} \quad i, j = 1, 2 \quad i \neq j \quad (4.21)$$

The separating equilibrium trade policy function is a particular solution of the differential equation (4.21) that satisfies the relevant initial value condition. In general, finding an analytical solution to the differential equation would be very messy, but is unnecessary since a qualitative analysis of the differential equation will yield sufficient information about the separating equilibrium. The first step in the qualitative analysis of the differential equation is to plot in (c_i, t_i) space the locus where the numerator is zero ($N = 0$) and the locus where the denominator is zero ($D = 0$) in Figure 4.3. From equation (4.11), it can be seen that the $D = 0$ locus gives the optimal tariff under complete information as a function of the marginal cost of the domestic firm, $t_i^*(c_i)$. These loci are both linear, and intersect where the marginal cost of the domestic firm is $c_i^0 \equiv (2\alpha + 6\beta \bar{c}_j - 9\beta \bar{t}_j)/8\beta$ and the trade policy of the i th country is $t_i^0 \equiv (2\alpha - 2\beta \bar{c}_j + 3\beta \bar{t}_j)/12\beta$. Noting that the numerator is negative (positive) above (below) the $N = 0$ locus and the denominator is negative (positive) above (below) the $D = 0$ locus, it is possible to sign the derivative in (4.21) and hence plot a qualitative solution to the differential equation starting from any point in Figure 4.3. There are two linear solutions of the differential equation for which explicit solutions can be obtained by positing a solution of the form: $\phi_i(c_i) - \phi_i(c_i^0) = k(c_i - c_i^0)$. Substituting this solution into the differential equation and noting that $d\phi_i/dc_i = k$, yields the quadratic $63k^2 + 3k - 14 = 0$ which has a

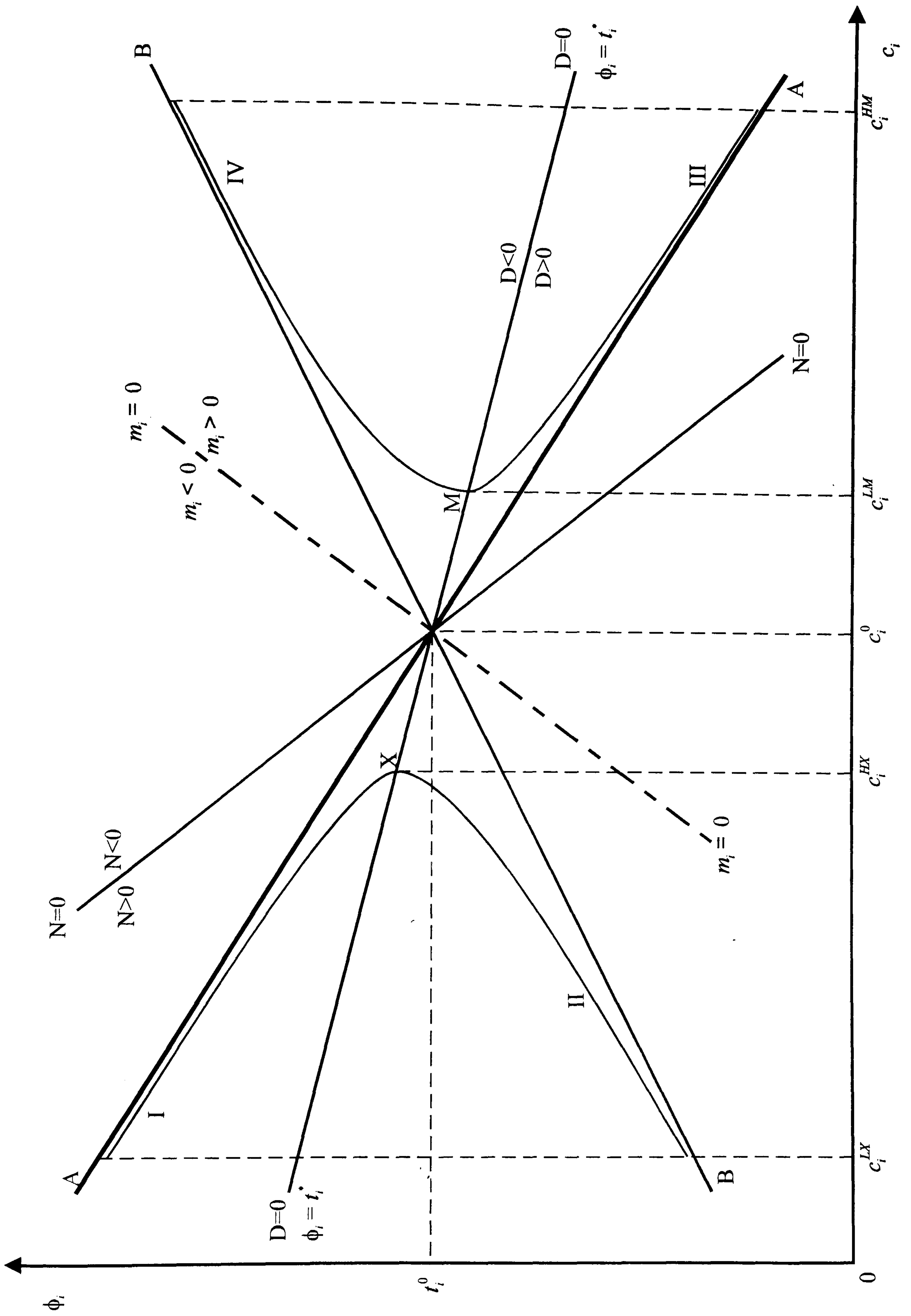


Figure 4.3: Separating equilibria

negative solution $k = (-1 - \sqrt{393})/42$ labelled as A in Figure 4.3 and a positive solution $k = (-1 + \sqrt{393})/42$ labelled as B. Also shown is the locus where net imports of the i th country are zero ($m_i = 0$), obtained from equation (18) with $\hat{c}_i = c_i$, and it is easily shown that the country is a net exporter (importer) in the region above (below) this locus.

The next step in the qualitative analysis of the differential equation is to determine the initial value condition that selects the particular solution. It turns out that there are three distinct cases to be considered depending upon the cost parameters, but two of these cases have already been analysed by Collie and Hviid (1993, 1999) under segmented markets and will be considered only briefly in this thesis.

In the first case, illustrated in Figure 4.3, the distribution of marginal cost is such that $c_i^H = c_i^{HX} < c_i^0$ so that the i th country is always a net exporter as in Collie and Hviid (1993). Below the $N = 0$ locus, the numerator in (4.21) is positive so the i th country's welfare is decreasing in the beliefs of the foreign firm about the domestic firm's marginal cost, $\partial W_i / \partial \hat{c}_i < 0$; hence, the domestic government would like the foreign firm to believe that the domestic firm has low costs and the worst beliefs for the government are when $\hat{c}_i = c_i^{HX}$. When $c_i = c_i^{HX}$, since the true marginal cost of the domestic firm will be revealed in the separating equilibrium, there is no incentive for the government to set any export subsidy other than the optimal export subsidy under complete information; hence, the initial value condition is that $\phi_i(c_i^{HX}) = t_i^*(c_i^{HX})$.

Starting from the initial value condition at X there are two possible solutions, I and II, shown in Figure 4.3, but the second order condition for welfare maximisation can be used to eliminate II.⁵³ Therefore, the unique separating equilibrium of this game is given by the solution with a negative slope and labelled as I in Figure 4.3. Inspection of Figure 4.3 shows that the export subsidy in the separating equilibrium is larger than the optimal export subsidy under complete information, represented by the $D = 0$ locus. As in Collie and Hviid (1993), the government signals the competitiveness of the domestic firm by using an export subsidy that is larger than the optimum under complete information.

In the second case, illustrated in Figure 4.3, the distribution of marginal cost is such that $c_i^L = c_i^{LM} > c_i^0$ so that the country is always a net importer as in Collie and Hviid (1999). Above the $N = 0$ locus, the numerator in (21) is negative so the i th country's welfare is increasing in the beliefs of the foreign firm about the domestic firm's marginal cost, $\partial W_i / \partial \hat{c}_i > 0$; hence, the government would like the foreign firm to believe that the domestic firm has high costs and the worst beliefs for the government are when $\hat{c}_i = c_i^{LM}$. When $c_i = c_i^{LM}$, since the true marginal cost of the domestic firm will be revealed in the separating equilibrium, there is no incentive for the government to set any tariff other than the optimal tariff under complete information; hence, the initial value condition is that $\phi_i(c_i^{LM}) = t_i^*(c_i^{LM})$. Starting from the initial value condition at M in Figure 4.3 there are two possible solutions

⁵³ The second-order condition for welfare maximisation is derived in Collie and Hviid (1993) following Mailath (1987).

labelled as III and IV but, as above, the second order condition for welfare maximisation can be used to eliminate IV. Therefore, the unique separating equilibrium of this game is given by the solution III in Figure 4.3. Inspection of Figure 4.3 shows that the tariff in the separating equilibrium is smaller than the optimal tariff under complete information, represented by the $D = 0$ locus. As in Collie and Hviid (1999), the government signals the uncompetitiveness of the domestic firm by using a tariff that is smaller than the optimum under complete information.

In the third case, illustrated in Figure 4.3, the distribution of marginal cost is such that $c_i^0 \in [c_i^L, c_i^H]$ so the country can be either a net exporter or a net importer depending upon the costs of the domestic firm. The previous two cases both satisfied the conditions required for the existence and uniqueness of a separating equilibrium in Mailath (1987), but belief monotonicity is not satisfied in this case since $\partial W_i / \partial \hat{c}_i < 0$ below the $N = 0$ locus and $\partial W_i / \partial \hat{c}_i > 0$ above the $N = 0$ locus.⁵⁴ In this case, the worst beliefs for the government are when $\hat{c}_i = c_i^0$ where there is actually no incentive to signal since $\partial W_i / \partial \hat{c}_i = 0$; hence, the domestic government will set the optimal trade policy under complete information and the initial value condition is that $\phi_i(c_i^0) = t_i^*(c_i^0) = t_i^0$. The two solutions that satisfy the initial value condition are the linear solutions labelled as A and B in Figure 4.3. In this case it is not possible to use the second order condition for welfare maximisation to eliminate one of the possible

⁵⁴ In Mailath (1987), the conditions required for the existence and uniqueness of a separating equilibrium in games with a continuum of types are belief monotonicity, type monotonicity, and single-crossing.

solutions as it is satisfied by both solutions. However, it can be shown that A, $\phi_i^A(c_i)$, Pareto dominates B, $\phi_i^B(c_i)$, since it yields higher welfare for all values of marginal cost except $c_i = c_i^0$; the difference in welfare between the two solutions can be shown to be:

$$W_i(c_i, c_i, \phi_i^A(c_i)) - W_i(c_i, c_i, \phi_i^B(c_i)) = \frac{\sqrt{393}}{168} (c_i - c_i^0)^2 \geq 0 \quad (4.22)$$

Since B can be ruled out by Pareto-dominance, the unique separating equilibrium is given by A in Figure 4.3. This seems to be intuitively reasonable as the separating equilibria in the other two cases both converge towards A. Inspection of Figure 4.3 shows that the government uses a larger (smaller) export subsidy (import tariff) than the optimum under complete information, represented by the $D = 0$ locus. Thus, the results in all three cases can be summarised by the following proposition:

Proposition 4.3. *The export subsidy (import tariff) in the separating equilibrium is larger (smaller) than the optimal export subsidy (import tariff) under complete information.*

The intuition for these results requires an understanding of the marginal costs of signalling. In this model, the marginal cost of signalling for the country is the marginal welfare loss from setting a trade policy that deviates from the optimum under complete information, $|\partial W_i / \partial t_i|$. Figure 4.4 shows the marginal welfare effect

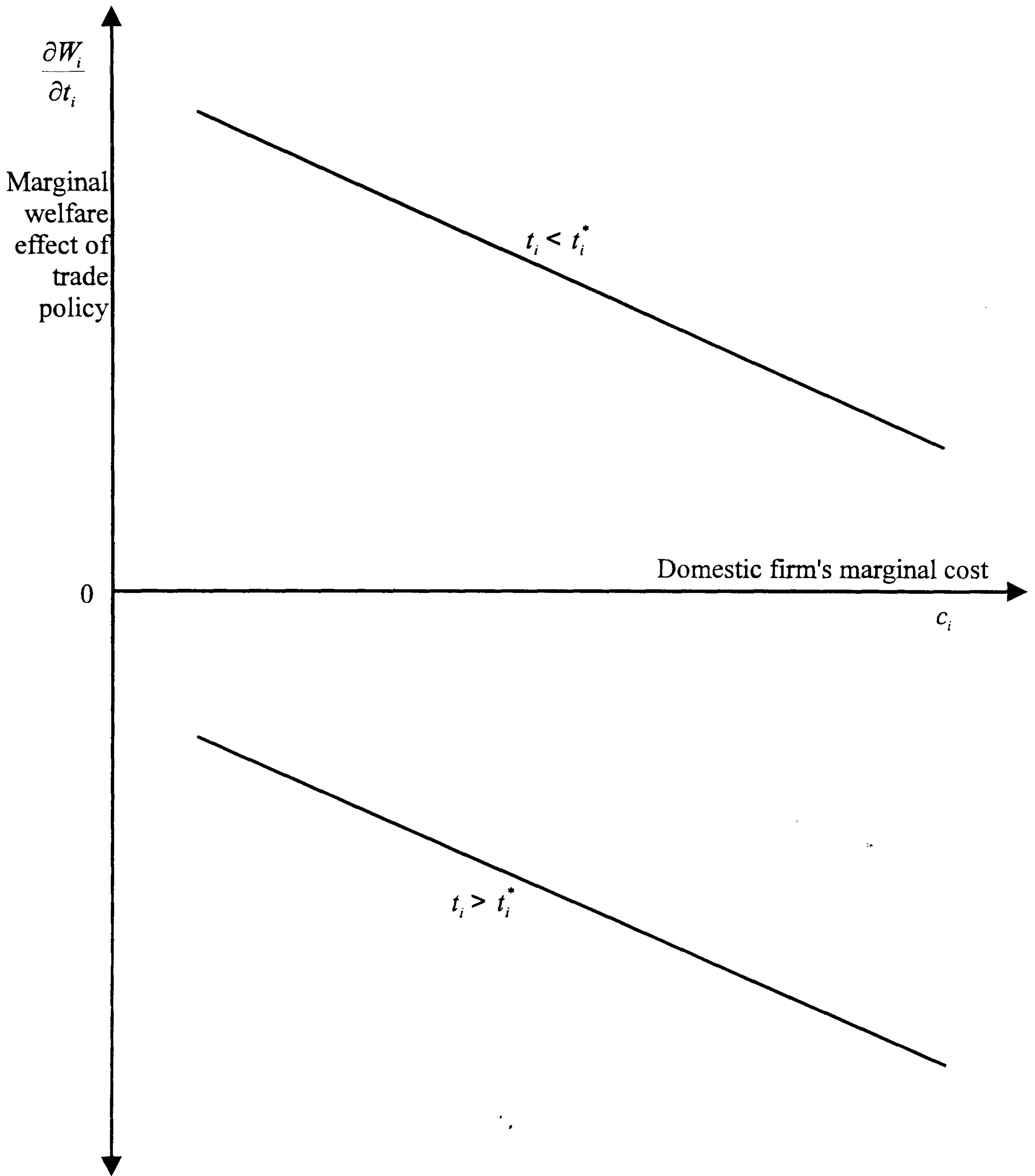


Figure 4.4: The marginal cost of signalling

of trade policy as a function of the domestic firm's cost when trade policy is larger than the optimum, $t_i > t_i^*$ so $\partial W_i / \partial t_i < 0$, and when it is smaller than the optimum, $t_i < t_i^*$ so $\partial W_i / \partial t_i > 0$. As the domestic firm's cost increases, the main effect is to reduce the profit-margin of the domestic firm thus weakening the profit-shifting effect, and thereby reducing the marginal welfare gain from using trade policy, $\partial^2 W_i / \partial c_i \partial t_i < 0$. Thus, the marginal cost of signalling with a trade policy below (above) the optimum is decreasing (increasing) in the domestic firm's cost, and is lowest when the domestic firm has the highest (lowest) possible costs.

When the country is a net exporter, the government would like the foreign firm to believe that the domestic firm has low costs as this will lead the foreign firm to reduce its output. This increases the welfare of the country since profits are shifted to the domestic firm and there is an improvement in the terms of trade. The government signals the competitiveness of the domestic firm by setting an export subsidy larger than the optimum under complete information because, in this case, the marginal cost of signalling is increasing in the domestic firm's cost. When the country is a net importer, the government would like the foreign firm to believe that the domestic firm has high costs as this will lead the foreign firm to increase its output thereby reducing the price of imports. This increases the welfare of the domestic country since the terms of trade and tariff revenue gains exceed the profit-shifting loss of the domestic firm. The government signals the uncompetitiveness of the domestic firm by setting a tariff smaller than the optimum under complete information because, in this case, the marginal cost of signalling is decreasing in the domestic firm's cost.

4.7. Simultaneous signalling game

Having derived the separating equilibrium of this signalling game with the expected trade policy of the other country taken as given, it is now possible to solve the separating equilibrium of the simultaneous signalling game when both governments use trade policy as a signal of their firms' costs. As both countries simultaneously set their trade policy at the first stage of the game, they will only observe the other country's trade policy after they have set their own trade policy. Therefore, the two governments must set their trade policy knowing only the expected costs of the foreign firm and the expected trade policy of the other country. The expected trade policy of the other country is obtained by taking expectations of the separating equilibrium trade policy given the distribution of the foreign firm's marginal costs. In the separating equilibrium of the simultaneous signalling game, each government sets its separating equilibrium trade policy $\phi_i(c_i; \bar{t}_j)$ where its expectation of the other country's trade policy is rational; thus, the following conditions must be satisfied:

$$t_i = \phi_i(c_i; \bar{t}_j) \quad \text{and} \quad \bar{t}_j = E_i[\phi_j(c_j; \bar{t}_i)] \quad i, j = 1, 2 \quad i \neq j \quad (4.23)$$

Since the separating equilibrium trade policies may be non-linear, it is generally not possible to solve explicitly for the separating equilibrium of this simultaneous signalling game. However, in the case when the separating equilibrium trade policy is linear, $t_i = t_i^0 + k(c_i - c_i^0)$, where $c_i^0 \equiv (2\alpha + 6\beta\bar{c}_j - 9\beta\bar{t}_j)/8\beta$,

$t_i^0 \equiv (2\alpha - 2\beta\bar{c}_j + 3\beta\bar{t}_j)/12\beta$, and $k = (-1 - \sqrt{393})/42$, an explicit solution can easily be obtained. Taking expectations of the linear separating equilibrium trade policy yields the best-reply functions of the two countries in terms of their expected trade policies:

$$\bar{t}_i = \frac{1}{6\beta}(\alpha - \beta\bar{c}_j) - \frac{k}{4\beta}(\alpha - 4\beta\bar{c}_i + 3\beta\bar{c}_j) + \frac{2+9k}{8}\bar{t}_j \quad i, j = 1, 2 \quad i \neq j \quad (4.24)$$

These best-reply functions are shown in Figure 4.5. Since the best-reply functions are downward sloping, $d\bar{t}_i/d\bar{t}_j = (2+9k)/8 \approx -0.31$, the expected trade policies of the two countries are strategic substitutes whereas trade policies were strategic complements under complete information. The expected trade policies of the two countries in the separating equilibrium of the simultaneous signalling game are given by the intersection of the two best-reply functions, and can be obtained by solving the simultaneous equations (4.24):

$$\bar{t}_i^s = \frac{1}{9\beta(10+9k)} \left[4(5\alpha - \beta\bar{c}_i - 4\beta\bar{c}_j) + 18k(\alpha + 3\beta\bar{c}_i - 4\beta\bar{c}_j) \right] \quad i, j = 1, 2 \quad i \neq j \quad (4.25)$$

Having obtained the expected trade policies of the two countries, these can be substituted back into (4.23) to obtain a complete description of the separating equilibrium of the simultaneous signalling game. In the symmetric case, where $\bar{c}_1 = \bar{c}_2 = \bar{c}$, the expected trade policy of the two countries is

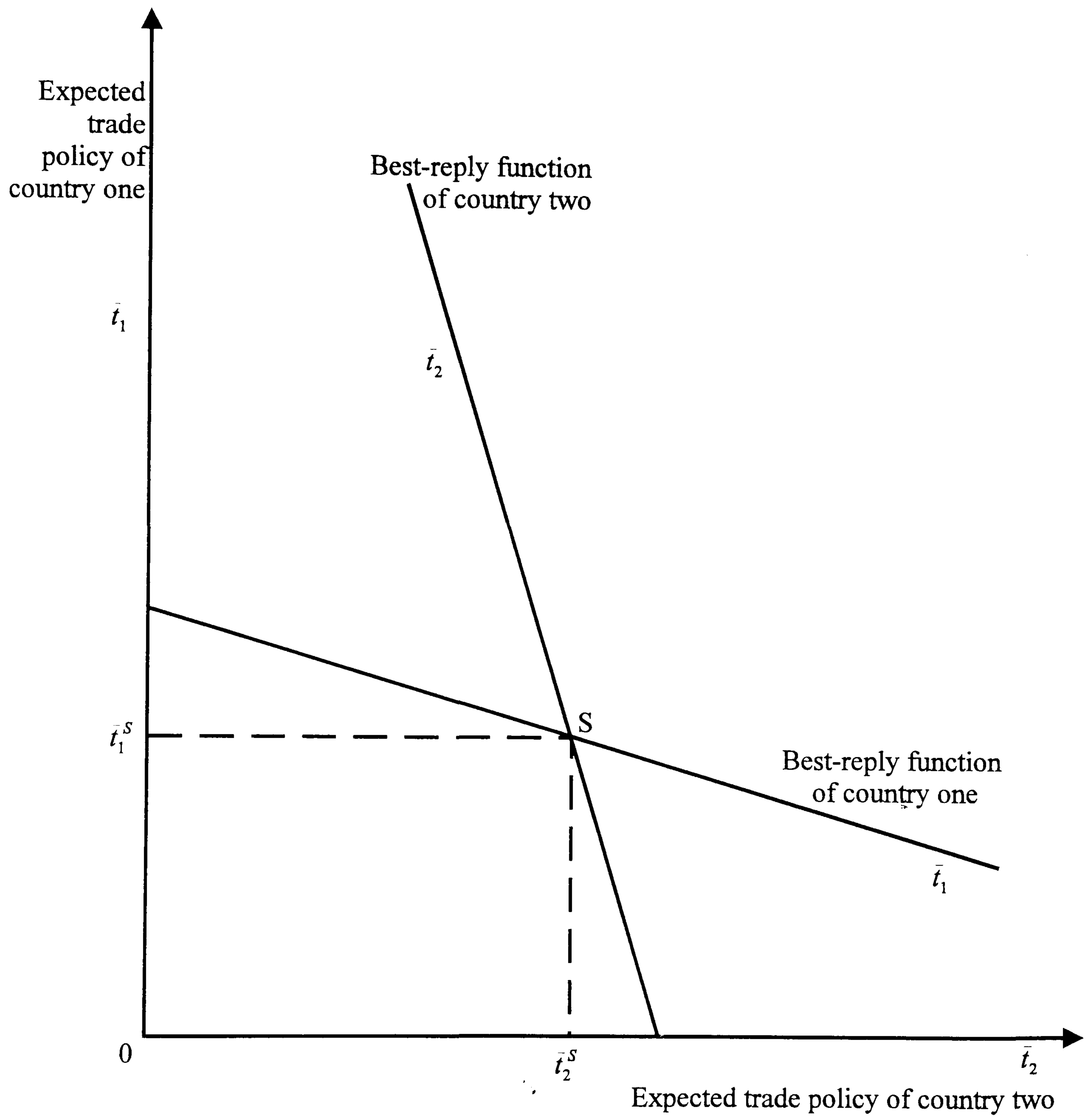


Figure 4.5: Simultaneous signalling equilibrium

$\bar{t} = \bar{t}_1^S = \bar{t}_2^S = 2(\alpha - \beta\bar{c})/9\beta > 0$ which is equal to the Nash equilibrium under complete information when $c_1 = c_2 = \bar{c}$. To compare expected trade policies in the asymmetric case, subtract the expected trade policy of the j th country from the expected trade policy of the i th country, to obtain:

$$\bar{t}_i^S - \bar{t}_j^S = \frac{2(2 + 21k)}{30 + 27k}(\bar{c}_i - \bar{c}_j) = \frac{14(\sqrt{393} - 3)}{3(137 - \sqrt{393})}(\bar{c}_j - \bar{c}_i) \quad (4.26)$$

Observing that the coefficient on the righthand side is positive leads to the following proposition:

Proposition 4.4. *In the separating equilibrium of the simultaneous signalling game, the country that has the firm with the lower (higher) expected cost has the higher (lower) expected trade policy and will be an expected net exporter (importer).*

This contrasts with the result under complete information in Proposition 4.2 where both countries set their Nash equilibrium trade policies at exactly the same level.⁵⁵

An interesting question about the separating equilibrium of the simultaneous signalling game is whether intervention by both governments makes the two countries worse off than under free trade. To answer this question, the assumption of symmetry

⁵⁵ This result is similar to that in de Meza (1986) under segmented markets and with complete information.

will be exploited to allow expected welfare under free trade to be compared with expected welfare in the separating equilibrium. The assumption of symmetry implies that the probability distributions of the two firms' costs are identical with the same mean, \bar{c} , and the same variance, σ^2 . This implies that expected net imports under free trade will be zero for both countries; a country will be a net importer if the domestic firm's costs turn out to be higher than those of the foreign firm. In the separating equilibrium of the simultaneous signalling game, both firms will employ the same linear separating strategy, $t_i^S = t_i^0 + k(c_i - c_i^0)$, which implies that expected net imports will be zero for both countries so $c_i^0 = \bar{c}$ and the expected value of trade policy is $\bar{t} = t_i^0 = 2(\alpha - \beta\bar{c})/9\beta > 0$. Since the domestic firm's costs can be inferred from a country's trade policy, the beliefs of the foreign firm are $\hat{c}_i = c_i$ in the separating equilibrium. Substituting these values into (4.19) and taking expectations yields expected welfare in the separating equilibrium:

$$W^S = EW_i(t_i^S, c_i, c_i; t_j^S, c_j, c_j) = \frac{4}{9\beta}(\alpha - \beta\bar{c})^2 + \frac{44 - 36k - 9k^2}{36}\beta\sigma^2 \quad (4.27)$$

Under free trade, both countries set their trade policy equal to zero, $t_1 = t_2 = 0$, so obviously neither firm can infer the costs of its foreign competitor and, hence, the beliefs of both firms are that costs are equal to their expected value, $\hat{c}_1 = \hat{c}_2 = \bar{c}$. Substituting these values into (4.19) and taking expectations, yields the expected value of welfare under free trade:

$$W^F = EW_i(0, c_i, \bar{c}; 0, c_j, \bar{c}) = \frac{4}{9\beta}(\alpha - \beta\bar{c})^2 + \frac{3}{4}\beta\sigma^2 \quad (4.28)$$

As a benchmark, it is straightforward to show that expected welfare of a country under autarky is:

$$W^A = \frac{3}{8\beta}(\alpha - \beta\bar{c})^2 + \frac{3}{8}\beta\sigma^2 \quad (4.29)$$

Comparing (4.28) and (4.29), it is clear that expected welfare is higher under free trade than under autarky so there are gains from trade for both countries with incomplete information.⁵⁶ To compare expected welfare under free trade with expected welfare in the simultaneous separating equilibrium, subtract (4.28) from (4.27) and recall that $k = (-1 - \sqrt{393})/42$:

$$W^S - W^F = \frac{17 - 36k - 9k^2}{36}\beta\sigma^2 = \frac{1553 + 83\sqrt{393}}{3528}\beta\sigma^2 > 0 \quad (4.30)$$

This is unambiguously positive which leads to the following surprising and counterintuitive proposition:

Proposition 4.5. *In the symmetric case, both countries gain from trade and the*

⁵⁶ Note that the mean and variance terms are both larger under free trade than under autarky. The difference in the means is due to the pro-competitive gain from trade whereas the difference in the variances represents the gain from specialisation when costs differ.

expected welfare of both countries is higher in the separating equilibrium than under free trade.

There are two reasons for this at first surprising result. Firstly, under free trade neither firm gains any information about the costs of its foreign competitor whereas in the separating equilibrium the true costs of both firms are revealed. In the separating equilibrium, when a firm learns that its competitor has higher (lower) than average costs it will expand (contract) its own output. Secondly, in the separating equilibrium, the firm with the lower cost will receive a large export subsidy while the firm with the higher cost will be protected by a small tariff. Both of these effects will increase worldwide efficiency compared to free trade since they lead the firm with the lower cost to expand its output and lead the firm with the higher cost to contract its output. Thus, intervention by both governments leads to greater specialisation according to comparative advantage and an increase in the expected welfare of both countries. That both countries gain is somewhat paradoxical since each government is motivated by the profit-shifting and rent-extracting arguments for intervention, both of which are usually beggar-my-neighbour policies.

In the symmetric case, the efficiency gains from increased specialisation in the separating equilibrium are divided equally between the two countries but, with cost asymmetries, the gains will not be equally divided. In the Nash equilibrium with complete information, the country with the low cost firm was worse off than under free trade while the other country was better off. Similarly, although there will be a worldwide efficiency gain in a separating equilibrium with cost asymmetries, the

country with the low expected cost firm may be worse off than under free trade while the other country will undoubtedly be better off.⁵⁷

4.8. Conclusions

A model of strategic trade policy under integrated markets has been presented and optimal trade policies have been derived under assumptions of both complete and incomplete information. With complete information, it has been shown that the optimal policy is an import tariff (export subsidy) when a country is a net importer (exporter). In the Nash equilibrium in trade policies, the country that has the firm with the lowest cost gives an export subsidy which is fully countervailed by the import tariff of the other country. The introduction of incomplete information about the costs of the two firms adds an incentive for both governments to use their trade policy as a signal of their domestic firm's cost. As a result of this signalling effect, the export subsidy (import tariff) in the separating equilibrium is larger (smaller) than the optimum under complete information. In the simultaneous signalling game, the country that has the firm with the lower (higher) expected cost will have the higher (lower) expected trade policy in the separating equilibrium. When both firms have the same expected cost, expected welfare in the separating equilibrium is higher than under free trade and both governments gain from intervention in the simultaneous signalling game.

⁵⁷ Obviously, the possibility that country with the low expected cost firm will lose is most likely when the variance of costs is small.

The last result is the most significant result in this chapter since it provides a rare example where non-cooperative trade policy setting leads to higher welfare for both countries than under free trade. Intervention by both governments results in the true costs of the two firms being truthfully revealed with the more efficient firm receiving a large export subsidy and the less efficient being protected by a small tariff. Compared to free trade, this leads to an expansion (contraction) of the more (less) efficient firm and a welfare gain from increased specialisation according to comparative advantage. Intervention can increase welfare because imperfect competition and incomplete information do not allow the full gains from comparative advantage to be exploited.

Appendix 4: Pooling versus separating strategies

Obviously, the simultaneous signalling game analysed in this paper has a number of pooling equilibria in addition to the unique separating equilibrium. The obvious candidate for a pooling equilibrium is for each country to set its trade policy equal to the Nash equilibrium trade policy under complete information (4.12) with $c_i = \bar{c}$ so that $t_i = \bar{t} = 2(\alpha - \beta\bar{c})/9\beta$, which is the same as the expected trade policy in the separating equilibrium, where the equilibrium beliefs are that $\hat{c}_i = \bar{c}$. This pooling equilibrium can be sustained by the out of equilibrium beliefs that $\hat{c}_i = c_i^L$ if $t_i < \bar{t}$ and $\hat{c}_i = c_i^H$ if $t_i > \bar{t}$.

To compare pooling and separating strategies, suppose the two countries can each choose between these two strategies at the start of the game. Then, the expected welfare of the countries in the four possible outcomes can be shown to be:

$$\begin{aligned}
 W^{SS} &= EW_i(t_i^S, c_i, c_i; t_j^S, c_j, c_j) = \frac{4}{9\beta}(\alpha - \beta\bar{c})^2 + \frac{44 - 36k - 9k^2}{36} \beta\sigma^2 \\
 W^{PP} &= EW_i(\bar{t}, c_i, \bar{c}; \bar{t}, c_j, \bar{c}) = \frac{4}{9\beta}(\alpha - \beta\bar{c})^2 + \frac{3}{4} \beta\sigma^2 \\
 W^{SP} &= EW_i(t_i^S, c_i, c_i; \bar{t}, c_j, \bar{c}) = \frac{4}{9\beta}(\alpha - \beta\bar{c})^2 + \frac{77 - 12k - 63k^2}{72} \beta\sigma^2 \\
 W^{PS} &= EW_i(\bar{t}, c_i, \bar{c}; t_j^S, c_j, c_j) = \frac{4}{9\beta}(\alpha - \beta\bar{c})^2 + \frac{65 - 60k + 45k^2}{72} \beta\sigma^2
 \end{aligned} \tag{A4.1}$$

where the first superscript indicates the strategy of the country under consideration;

the second superscript indicates the strategy of the other country; P denotes pooling; and S denotes separating. Note that welfare in the pooling equilibrium is the same as welfare under free trade (4.28). Comparing the expected welfare of a country when it separates with that when it pools given the strategy of the other country yields:

$$\begin{aligned} W^{SS} - W^{PS} &= \frac{23 - 12k - 63k^2}{72} \beta \sigma^2 = \frac{43 + \sqrt{393}}{336} \beta \sigma^2 > 0 \\ W^{SP} - W^{PP} &= \frac{23 - 12k - 63k^2}{72} \beta \sigma^2 = \frac{43 + \sqrt{393}}{336} \beta \sigma^2 > 0 \end{aligned} \tag{A4.2}$$

Since these are both positive, separating dominates pooling whatever the strategy of the other country, therefore both countries will choose the separating strategy and the outcome will be the separating equilibrium; this leads to the following proposition:

Proposition A4.1. *In the symmetric case, for both governments, the separating strategy dominates the pooling strategy and the outcome will be the separating equilibrium.*

The pooling equilibrium can be ruled out as a reasonable outcome of this game for at least two reasons. Firstly, as Proposition A4.1 makes clear, for each country the pooling strategy is Pareto-dominated by the separating strategy. Secondly, the out of equilibrium beliefs supporting the pooling equilibrium are unreasonable since a country that sets a trade policy larger (smaller) than the pooling equilibrium tariff is

assumed to have high (low) costs even though such a country would have the least incentive to set this trade policy.

Chapter 5.

Trade Bloc Formation under Integrated Markets

5.1. Introduction

This chapter combines the two central themes of this thesis, by introducing the assumption of integrated markets and the trade policy instrument introduced in the previous chapter into two models of trade bloc formation. These models are otherwise similar to the two models presented in Chapter 2. Countries are assumed to be symmetric, and in the first model, presented in Section 5.2, firms have common constant marginal costs. The second model, presented in Section 5.3, assumes that membership of a larger trade bloc results in a reduction in a firm's marginal cost. As explained earlier in Chapter 2, this could be as a result of cheaper inputs after the abolition of tariffs between partners in other industries, harmonisation of standards or the promotion of research joint ventures.

The change from segmented markets to integrated markets, and the associated change in trade policy from a simple tariff to a combined tariff and export subsidy, has a major impact on the outcome of the model. Both models presented in Chapter 2 had equilibrium structures in which two trade blocs formed, the first of which was larger and had higher levels of welfare for its members. In this chapter, the result from the model with common costs is that the structure of trade blocs has no effect on welfare. With declining costs, if two trade blocs form then a representative country belonging to the small bloc is actually better off than a member of the larger bloc. Hence the change from segmented to integrated markets is clearly highly significant.

The rest of this chapter is set out as follows. Section 5.2 considers a model of trade bloc formation under integrated markets in which each country contains a single

firm with common, constant marginal cost. It is shown that, under the assumptions of the model, tariffs and welfare are independent of the size of trade blocs. In Section 5.3 the model is adapted so that costs fall as membership of a trade bloc increases. It is shown that when the world is divided into two trade blocs, the trade blocs will set equal trade policies. Thus the large (relatively low cost) bloc will set an export subsidy which is fully countervailed by the import tariff set by the smaller bloc. It is also shown that the grand coalition, in which all firms belong to a single trade bloc in which all firms have the lowest attainable marginal cost, will not be an equilibrium for a large range of parameter values. There is in these cases an incentive for a group, containing less than half of the total countries in the world, not to join the grand coalition and to form a separate trade bloc. The result that a country would never want to be in the larger of two blocs is initially surprising and contrasts with results found under segmented markets, but can be explained by considering the effect of the trade policy instrument on government revenue. Government revenue is positive for an importing bloc, which sets a positive import tariff, but negative for an exporting bloc, which pays a subsidy on all exports. Thus the trade policy instrument used effectively penalises low cost, exporting blocs. It is further argued that where countries have an incentive to belong to a small trade bloc, the two bloc coalition structure is likely to prove unstable and a larger number of small blocs is likely to form. Finally, Section 5.4 contains conclusions and some suggestions for further research.

5.2. Model with constant costs

This section develops a model of trade bloc formation under integrated markets. The formation of trade blocs is modelled as a noncooperative sequential game, similar to Bloch's (1995) model of endogenous formation of associations in oligopolies, Yi's (1996) model of endogenous trade bloc formation with unanimous regionalism and the segmented markets model in Chapter 2 of this thesis. Countries are indexed $i = 1, 2, \dots, n$. One country, i , is selected as the initiator and proposes an association, $A(i)$, consisting of a subset of the countries in the world.⁵⁸ All prospective members of association $A(i)$ respond in turn, and the association is only formed if all these countries agree. In this case the country outside this association with the lowest index number is chosen as the new initiator. If a prospective member of $A(i)$ rejects the offer, it becomes the initiator in the new round. The game has an infinite horizon and countries do not discount payoffs. In the case of an infinite play of the game, all countries receive a payoff of zero. The process continues until an association structure emerges, which is a partition of all the countries in the world into disjoint associations.

This game allows for the formation of asymmetric associations, and it is possible that in equilibrium countries in one trade bloc would rather become members of a different bloc. This situation arises because it is possible for any member of a trade bloc to prevent the admission to the bloc of a country which it does not wish to have as a member.⁵⁹

⁵⁸ Given the symmetry between countries, it can be assumed without loss of generality that country 1 is the initiator.

⁵⁹ The reasons for using this solution concept, and possible alternatives, were discussed in Chapter 1.

Formally, the model can be described as follows. First, the multi-stage game of trade bloc formation described above is played. Subsequently, trade blocs set their trade policies to maximise members' welfare. The trade policy instrument used is an import tariff and an export subsidy set at equal rates, as discussed in the previous chapter of this thesis. Finally, firms compete in quantities in an integrated world market.

The world consists of n symmetric countries, $i = 1, \dots, n$, each of which contains one firm producing a homogeneous product. It is assumed that there are no transport costs. Using the same notation as in Chapter 2, the countries form customs unions (associations), with country i belonging to association $A(i)$. The associations are indexed $r = 1, \dots, R$, with the number of countries belonging to bloc r denoted a_r . Hence the association structure S is given by:

$$S = \{A_1, A_2, \dots, A_R\} \quad \sum_{r=1}^R a_r = n \quad (5.1)$$

Each trade bloc A_r sets a common external tariff and export subsidy t_r .⁶⁰ Trade between partner countries is not subject to tariffs or subsidies.

As usual, in analysing this game the final stage is considered first.⁶¹ Firms are assumed to set quantities and each firm has a common constant marginal cost c .

⁶⁰ Given the assumption of common marginal costs and symmetry between countries the same trade policy would be set regardless of whether customs unions or free trade areas were being considered.

⁶¹ The model presented here is a multi-country extension of the full information model considered in the previous chapter.

Demand in country i is given by the linear demand function $y_i = \alpha - \beta p_i$, where y_i and p_i are total demand and price in country i . Under the assumption of integrated markets, perfect arbitrage ensures that prices only differ between markets by an amount dependent on the trade policies in the markets. Thus $p_j - t_j = p_k - t_k = p^*$ for all j and k . Hence demand can be written as

$$y_i = \alpha - \beta (p^* + t_i) \quad (5.2)$$

Summing across countries gives an expression for world demand:

$$\begin{aligned} \sum_{j=1}^n y_j &= \sum_{j=1}^n [\alpha - \beta(p^* + t_j)] \\ &= n\alpha - n\beta p^* - \beta \sum_{j=1}^n t_j \end{aligned} \quad (5.3)$$

Using the fact that world supply, X_w , must equal world demand, an expression can be derived for p^* :

$$p^* = \frac{\alpha}{\beta} - \frac{X_w}{n\beta} - \bar{t} \quad (5.4)$$

where $\bar{t} = \frac{1}{n} \sum_{i=1}^n t_i$ is the mean trade policy across all countries. Thus the price in country i is

$$p_i = \frac{\alpha}{\beta} - \frac{X_w}{n\beta} + (t_i - \bar{t}) \quad (5.5)$$

The profits earned by the firm in country i are given by

$$\pi_i = (p_i - c)x_i \quad (5.6)$$

where x_i denotes total sales of the country i firm. The first order condition for profit maximisation for the firm in country i is

$$\begin{aligned} \frac{\partial \pi_i}{\partial x_i} &= p_i - c + x_i \frac{\partial p_i}{\partial x_i} \\ &= p_i - c - \frac{x_i}{n\beta} = 0 \end{aligned} \quad (5.7)$$

Substituting the expression for price in equation (5.5) into the first order condition gives the output of the firm in country i :

$$x_i = n\alpha - X_w - n\beta c + n\beta(t_i - \bar{t}) \quad (5.8)$$

Summing across countries yields an expression for total world output:

$$X_w = \frac{n^2}{n+1}(\alpha - \beta c) \quad (5.9)$$

Substituting (5.9) into (5.8) gives the following expression for output in country i :

$$x_i = \frac{n}{n+1}(\alpha - \beta c) + n\beta(t_i - \bar{t}) \quad (5.10)$$

The price in country i can be found by substituting (5.9) into (5.5):

$$p_i = \frac{\alpha}{(n+1)\beta} + \frac{n}{(n+1)}c + (t_i - \bar{t}) \quad (5.11)$$

Substituting this price into the demand equation gives

$$y_i = \frac{n}{n+1}(\alpha - \beta c) - \beta(t_i - \bar{t}) \quad (5.12)$$

Net imports in country i are the difference between demand and output in that country, $m_i = y_i - x_i$. Thus subtracting (5.10) from (5.12) gives

$$m_i = -(n+1)\beta(t_i - \bar{t}) \quad (5.13)$$

It should be noted that for any country i in customs union $A(i)$, all its imports (exports) will come from (go to) countries outside $A(i)$. This is because the symmetry, both *ex ante* and in terms of trade policy, between bloc members ensures that they will behave identically - that is, all will either be net importers or net exporters. Thus all imports (exports) to (from) country i will be subject to the trade policy set by bloc $A(i)$.

Welfare W_i in country i is again taken to be the sum of consumer surplus, profits of the home firm and net government revenue:

$$\begin{aligned} W_i &= \frac{1}{\beta} \int_0^{y_i} (\alpha - \beta q) dq - p_i y_i + \pi_i + t_i m_i \\ &= \frac{1}{2\beta} y_i^2 + (p_i - c)x_i + t_i m_i \end{aligned} \quad (5.14)$$

In the second stage of the game, governments set their trade policies to maximise welfare given the trade policy of other governments.⁶² The optimal trade policy for country i is found by solving the following first order condition:

$$\frac{\partial W_i}{\partial t_i} = \frac{1}{\beta} y_i \frac{\partial y_i}{\partial t_i} + (p_i - c) \frac{\partial x_i}{\partial t_i} + x_i \frac{\partial p_i}{\partial t_i} + m_i + t_i \frac{\partial m_i}{\partial t_i} = 0 \quad (5.15)$$

Using equations (5.10) to (5.13), the following expression can be obtained for country i 's optimal trade policy:

$$t_i = \frac{n}{(n+1)^2} \frac{(\alpha - \beta c)}{\beta} + \frac{n}{n+1} (t_i - \bar{t}) \quad (5.16)$$

A number of cases are considered below. First, the optimal trade policy is derived when only a single trade bloc is active in setting trade policy. Then the Nash equilibrium trade policies are derived for the case where the world is divided into two

⁶² In the case of free trade areas, each government sets trade policy independently. With customs unions, the member governments collectively set a common trade policy. As has already been explained, the resulting trade policies are the same in either case.

blocs of any sizes. Finally, the optimal trade policy is derived for any country or bloc in any trade bloc structure.

To analyse the first two cases, it is assumed that bloc A_1 , with a_1 members, sets trade policy t_1 while all countries outside A_1 set trade policy t_2 (with $t_2 = 0$ when only one bloc pursues an active trade policy). Thus the mean trade policy \bar{t} is a weighted average of t_1 and t_2 , and the difference between bloc A_1 's tariff and the mean tariff is

$$t_1 - \bar{t} = \frac{(n - a_1)(t_1 - t_2)}{n} \quad (5.17)$$

Using this expression for the difference between bloc A_1 's tariff and the mean tariff in (5.16), the following expression for the optimal tariff can be derived:

$$t_1 = \frac{n}{(n+1)(a_1+1)} \frac{\alpha - \beta c}{\beta} - \frac{n - a_1}{a_1 + 1} t_2 \quad (5.18)$$

The first result we can obtain using (5.18) is the optimal trade policy for bloc A_1 when no governments outside the bloc are active in setting trade policy. Setting $t_2 = 0$ gives

$$t_1^* = \frac{n}{(n+1)(a_1+1)} \frac{(\alpha - \beta c)}{\beta} \quad (5.19)$$

This expression is clearly positive, so the trade policy is an export subsidy combined

with an import tariff.⁶³ It can be seen from equation (5.19) that the optimal trade policy falls, for given n , as a_1 , the number of countries in the trade bloc, rises. This is due to the fact that as a_1 rises, the number of firms outside the bloc falls. With a lower number of firms to shift profits from there is less incentive to impose a profit-shifting trade policy, so the level of this policy falls.

Using (5.18) and a similar expression for t_2 as a function of t_1 , the Nash equilibrium trade policies set by the two trade blocs when both are active are found to be:

$$t_1^N = t_2^N = \frac{n}{(n+1)^2} \frac{(\alpha - \beta c)}{\beta} \quad (5.20)$$

Again, the trade policy is clearly positive, implying an export subsidy and import tariff. As a_1 does not enter into the expression, surprisingly the Nash equilibrium trade policy is the same regardless of the sizes of the two blocs. In fact, as is shown in the proof of Proposition 5.1 below, this result holds for any number of blocs of any size.

The result that trade policies are independent of bloc size has important implications. From (5.10), (5.11) and (5.12) it can be seen that all firms set the same output and that price and demand are equal in every country. More importantly, from (5.13) it can be seen that net imports in each country are zero, so there is no trade. Hence with equal trade policies, welfare is the same as under free trade.

⁶³ This result is equivalent to that given in Proposition 4.2 for the two-country case.

Consequently, the possibility to jointly set trade policy provides no incentive for the formation of trade blocs, and bloc formation has no effects. Proposition 5.1 summarises these results.

Proposition 5.1. *Under integrated markets and with common, constant marginal costs, trade bloc formation has no effect on trade policy or welfare. Regardless of the bloc structure, no net trade occurs.*

Proof. Equation (5.16) above gives country i 's optimal trade policy as a function of the mean trade policy set across all countries, \bar{t} . This mean trade policy can be found by taking the sum of t_i across all i and dividing by n , giving:

$$\bar{t} = \frac{\sum_{i=1}^n t_i}{n} = \frac{n}{(n+1)^2} \frac{\alpha - \beta c}{\beta} \quad (5.21)$$

Substituting this value back into (5.16) yields the same solution for t_i as is given in (5.20). Hence this is the Nash equilibrium trade policy set by any country, regardless of the structure of trade blocs. It can then immediately be seen from equations (5.10) to (5.14) that welfare is equal in all countries and net imports are zero everywhere. ■

This result contrasts with the results found under segmented markets, both in Chapter 2 and in the previous work on trade blocs mentioned in earlier chapters. In Chapter 2 it was shown that there is always an incentive either for global free trade (when there are no more than four countries) or for the formation of a trade bloc

containing most of the countries in the world (when there are five or more countries). Tariffs and welfare are always affected by membership of a trade bloc. Krugman (1991) suggests that the enlargement of customs unions would raise tariffs and reduce welfare up to the point where there are three symmetric blocs, while in the model of Sinclair and Vines (1994) the enlargement of free trade areas causes tariffs to fall. Collie (1997) finds that the enlargement of trade blocs will lower export subsidies and raise welfare. In none of the previous work does the change in the size of trade blocs have no effect.

The above results depend crucially on two assumptions in the model: common marginal costs and integrated markets. The assumption of common marginal costs means that when tariffs are equal, prices are the same in each country. The assumption of integrated markets, as opposed to segmented markets, means that when goods are homogeneous no net intra-industry trade occurs, and each country can only be either an importer or an exporter of any one good. Therefore with common costs and equal trade policies no trade will occur, as was shown for the two country case in Chapter 4. A change to either of these key assumptions would be expected to alter the results.

Despite the fact that no trade actually occurs in this model, there are still gains from potential trade. If each country was an autarky, the firm producing in each country would be able to choose its monopoly output and price. However in this model the possibility of trade forces every firm to produce a larger output at a lower price than under autarky.

5.3. Model with decreasing costs

This section adapts the model presented in Section 5.2 by changing the assumption made about firms' cost functions. Specifically, it is now assumed that the marginal cost of the firm in country i is decreasing in the number of countries which are members of $A(i)$, the trade bloc to which country i belongs. This assumption is the same as that used in the model with decreasing costs in Chapter 2, and the justifications are the same: that is, costs might fall due to the falling cost of inputs, harmonisation of standards or the encouragement of research joint ventures.⁶⁴

The specific functional form chosen for the marginal cost of firm i belonging to association $A(i)$ of size a_i is, as in Chapter 2:

$$c_i = \lambda + \frac{\mu}{a_i} \tag{5.22}$$

Thus it can be seen that c_i is decreasing in a_i , but the additional effect of each subsequent member joining a trade bloc is declining. This functional form is preferred to that used by Bloch (1995), $c_i = \lambda - \mu a_i$, because of the diminishing effect that additional bloc members have on the cost reduction, as discussed in Section 2.3.

It is now assumed that only two trade blocs may form; that is, if bloc A_1 forms with a_1 members, all the other $(n - a_1)$ countries in the world are members of bloc

⁶⁴ These arguments were discussed in detail in Section 2.3.

A_2 .⁶⁵ Other than the change in the firms' costs, this is the only alteration to the model presented in Section 5.2. Hence equations (5.2) to (5.5) give each country's demand, world demand and prices as before.⁶⁶ Profits for the firm in country i are given by:

$$\begin{aligned}\pi_i &= (p_i - c_i)x_i \\ &= \left(\frac{\alpha}{\beta} - \frac{X_w}{n\beta} + \frac{n - a_i}{n}(t_i - t_j) - \lambda - \frac{\mu}{a_i} \right) x_i\end{aligned}\quad (5.23)$$

for $i, j = 1, 2$. Differentiating equation (5.23) with respect to country i 's output, x_i , gives the first order conditions for profit maximisation:

$$\frac{\partial \pi_i}{\partial x_i} = \frac{\alpha}{\beta} - \frac{X_w}{n\beta} + \frac{n - a_i}{n}(t_i - t_j) - \lambda - \frac{\mu}{a_i} - \frac{x_i}{n\beta} = 0\quad (5.24)$$

The first order condition for the firm in country i can be used to obtain the following expression for its output:

$$x_i = n\alpha - X_w + (n - a_i)\beta(t_i - t_j) - n\beta\lambda - \frac{n\beta\mu}{a_i}\quad (5.25)$$

Summing across countries yields the following expression for world output:

⁶⁵ From the results obtained later in this section, it seems unlikely that such a two-bloc world would ever be an equilibrium. However, allowing for a larger number of blocs would greatly complicate the analysis as a separate arbitrage condition would be needed between each pair of blocs. The assumption used here greatly simplifies the analysis, while giving a clear insight into what would happen if more blocs were allowed for.

⁶⁶ Note that in the case with two blocs, $\bar{t} = \frac{a_1 t_1 + (n - a_1) t_2}{n}$. This fact will be used in subsequent equations.

$$X_w = \frac{n^2(\alpha - \beta\lambda) - 2n\beta\mu}{n+1} \quad (5.26)$$

Substituting (5.24) into (5.23) gives an expression for output in country i :

$$x_i = \frac{n}{n+1}(\alpha - \beta\lambda) - \left(\frac{n}{a_i} - \frac{2n}{n+1}\right)\beta\mu + (n - a_i)\beta(t_i - t_j) \quad (5.27)$$

The price in country i can be found by substituting (5.26) into (5.5):

$$p_i = \frac{\alpha}{(n+1)\beta} + \frac{n}{n+1}\lambda + \frac{2\mu}{n+1} + \frac{n - a_i}{n}(t_i - t_j) \quad (5.28)$$

Substituting the price in country i into that country's demand equation gives

$$y_i = \frac{n}{n+1}(\alpha - \beta\lambda) - \frac{2\beta\mu}{n+1} - \frac{n - a_i}{n}\beta(t_i - t_j) \quad (5.29)$$

Net imports in country i are the difference between demand and output in that country, $m_i = y_i - x_i$. Thus subtracting (5.27) from (5.29) gives

$$m_i = \left(\frac{n}{a_i} - 2\right)\beta\mu - \frac{(n+1)(n - a_i)}{n}\beta(t_i - t_j) \quad (5.30)$$

As before, welfare in country i , W_i , is defined as the sum of consumer surplus, profits earned by the home firm and net government revenue, and given by equation (5.14). Differentiating W_i with respect to the trade policy t_i in each bloc allows us to derive a pair of simultaneous equations for the trade policies set by representative members of each bloc:

$$t_1 = \frac{n^2(n-a_1)(\alpha-\beta\lambda)}{\beta(n+1)(n^2+2a_1n^2-a_1^2-2a_1^2n)} - \frac{(2a_1^2-2a_1n+4a_1^2n+n^2-4a_1^3n^2+n^3)n\mu}{a_1(n+1)(n^2+2a_1n^2-a_1^2-2a_1^2n)} + \frac{(-a_1^2-2a_1^2n+a_1n+3a_1n^2-n^3)}{n^2+2a_1n^2-a_1^2-2a_1^2n}t_2 \quad (5.31)$$

$$t_2 = \frac{n^2(\alpha-\beta\lambda)}{\beta(n+1)(2n^2+2n-2a_1n-a_1)} - \frac{(2a_1^2-2a_1n+4a_1^2n+n^2-4a_1^3n^2+n^3)n\mu}{a_1(n+1)(n-a_1)(2n^2+2n-2a_1n-a_1)} + \frac{(n^2+n^3+a_1^2+2a_1^2n-2a_1n-3a_1n^2)}{(n-a_1)(2n^2+2n-2a_1n-a_1)}t_1 \quad (5.32)$$

Solving this pair of equations yields the following solution:⁶⁷

$$t_1 = t_2 = \frac{n}{(n+1)^2} \frac{\alpha-\beta\lambda}{\beta} + \left[\frac{2}{(n+1)^2} - \frac{4a_1n}{(n-a_1)(n+1)^2} + \frac{(4a_1^3-n-1)n^2}{a_1(n-a_1)(n+1)^2} \right] \mu \quad (5.33)$$

The most striking aspect of this result is that the trade policies set by the two trade blocs are equal, regardless of the size of each bloc. While this might seem surprising at first, it is less so when considered in the context of the two country,

⁶⁷ Note that setting $\mu = 0$ and substituting c for λ , equation (5.33) simplifies to equation (5.20), the Nash equilibrium tariff with constant marginal costs.

complete information model presented in Chapter 4. There it was shown that where two firms with different costs from different countries compete in an integrated world market, the country with the low cost firm gives an export subsidy which is fully countervailed by the import tariff set by the other country. Here there are two trade blocs, the larger of which has lower costs than the smaller. Noting from equation (5.30) that in the model presented in this section each country in the larger bloc (A_r , where $a_r > n/2$) will be a net exporter, equation (5.33) leads to the following proposition :

Proposition 5.2. *When costs are declining in the number of countries belonging to a bloc, if the world is divided into two blocs, countries in the larger bloc will be exporters. The larger bloc will set an export subsidy which is fully countervailed by the import tariff set by the smaller bloc.*

In effect, Proposition 5.2 implies that the result of the two blocs setting their optimal trade policies, compared to the case where the same two blocs are formed but governments are passive, is simply a transfer of government revenue. The larger, more efficient bloc sets an export subsidy, the entire amount of revenue raised by which is transferred to the governments in the other bloc via its import tariff. Thus countries in the efficient bloc are effectively penalised for their lower costs. This effect is crucial in the results on optimal bloc size which follow.

Using the fact that the two blocs set offsetting trade policies, the following simplified expressions can be obtained for output, prices, demand and net imports in a representative country in each of the two blocs:

$$x_i = \frac{n}{n+1}(\alpha - \beta\lambda) - \left(\frac{n}{a_i} - \frac{2n}{n+1}\right)\beta\mu \quad (5.34)$$

$$p_i = \frac{\alpha}{(n+1)\beta} + \frac{n}{n+1}\lambda + \frac{2\mu}{n+1} \quad (5.35)$$

$$y_i = \frac{n}{n+1}(\alpha - \beta\lambda) - \frac{2\beta\mu}{n+1} \quad (5.36)$$

$$m_i = \left(\frac{n}{a_i} - 2\right)\beta\mu \quad (5.37)$$

An interesting point to note in the above equations is that price and demand in each country are unaffected by the size of the trade bloc to which that country belongs. This is a direct consequence of the arbitrage condition for integrated markets: prices can only differ between countries due to differences in trade policies, but as each bloc sets its trade policy at the same level in equilibrium, price, and therefore demand, in each country is the same. Meanwhile, as expected, output is increasing in the number of countries belonging to a trade bloc. This is because of the cost reducing effect of each additional bloc member. Consequently net imports decline as bloc membership rises; the smaller bloc will always import from the larger bloc, or if the two blocs are of equal size there will be no trade.

Now that optimal trade policies have been found for any bloc size, the final stage of the analysis is to solve for the optimal value of a_1 , the size of the first bloc to

form, given that all other countries will join together in a second bloc. Welfare in a representative country belonging to bloc A_1 is given by:

$$\begin{aligned}
 W_1 = & \frac{[n(\alpha - \beta\lambda) - 2\beta\mu]^2}{2(n+1)^2\beta} + \frac{n[(\alpha - \beta\lambda) + (2a_1 - n - 1)\beta\mu]^2}{a_1^2(n+1)^2\beta} \\
 & + \frac{(n - 2a_1)\mu\{n^2(4a_1^3 - n - 1)\beta\mu + a_1(n - a_1)[n(\alpha - \beta\lambda) + 2\beta\mu] - 4a_1^2n\beta\mu\}}{a_1^2(n - a_1)(n+1)^2} \quad (5.38)
 \end{aligned}$$

Before attempting to find the optimal value of a_1 , it is useful to consider the effect on country i of an increase in a_i on each of the three terms which make up welfare: consumer surplus, profits earned by the domestic firm and net government revenue. From equation (5.36) it can clearly be seen that consumer surplus, which is equal to $y_i^2/2\beta$, is independent of a_i . Hence only profits and government revenue need be considered when looking at the effect of an expansion of a trade bloc on welfare. The profits of the firm in country i clearly increase with a_i as marginal cost falls, output rises and the price received by the firm remains unchanged. However net government revenue falls as bloc size increases, at least over some range of a_i . The reason for this can be seen from equation (5.37), which shows that net imports fall as the bloc grows, becoming negative as a_i exceeds $n/2$. Thus, considering bloc A_1 , as a_1 rises from a small proportion of n , at first bloc A_1 's imports decline, meaning tariffs are raised on less goods, and then the bloc becomes an exporter, so net government revenue becomes negative as these exports are subsidised.

From the above it can be seen that the effect on welfare of increasing the size of a trade bloc could be positive or negative, depending upon whether the positive

profit effect is offset by the possibly negative government revenue effect of bloc expansion. Thus, in a two bloc world, it is not immediately clear whether a country would wish to be in a small bloc or a large bloc. The next stage in finding the optimal size of the first bloc to form is to find the derivative of W_1 , the welfare of a representative member of the first bloc to form, with respect to a_1 , the number of members of that bloc, thus giving the following first order condition for welfare maximisation:

$$\begin{aligned}
 dW_1/da_1 = & \left\{ a_1 \mu n (2a_1^2 - 4a_1 n + a_1^2 n + 2n^2 - 2a_1 n^2 + n^3) (\alpha - \beta \lambda) \right. \\
 & + \beta \mu (-2a_1^2 + 2a_1^3 + 4a_1 n - 4a_1^2 n + 8a_1^3 n + 8a_1^5 n - 2n^2 + 5a_1 n^2 - 6a_1^2 n^2 \\
 & \left. - 16a_1^4 n^2 - 2n^3 + 3a_1 n^3 + 4a_1^3 n^3) \right\} / \left\{ a_1^3 (n+1)^2 (n-a_1)^2 \right\} = 0 \quad (5.39)
 \end{aligned}$$

It is immediately apparent that this function is not defined for $a_1 = 0$ or $a_1 = n$. The first of these possibilities can be ignored, as the welfare of a member of a trade bloc with no members is meaningless, but the case where $a_1 = n$ is the important case of the grand coalition, implying global free trade and the lowest possible marginal cost for every country. Therefore to find the bloc size which maximises a country's welfare it is necessary to first find the optimal size in the range $1 \leq a_1 \leq n - 1$ (only integer solutions need to be considered in this model) and then to compare the welfare a country achieves with this value of a_1 to its welfare under free trade, which is given by:

$$W_{ft} = \frac{[n(\alpha - \beta\lambda) - 2\beta\mu]^2}{2(n+1)^2\beta} + \frac{[n(\alpha - \beta\lambda) + (n-1)\beta\mu]^2}{n(n+1)^2\beta} \quad (5.40)$$

One result which can be stated immediately is given in the following lemma:

Lemma 5.1. *The size of the first trade bloc to form will never be in the range $n/2 \leq a_1 < n$. If the optimal value of a_1 in the range $1 \leq a_1 \leq n - 1$ is above $n/2$, then all countries would prefer to be in the grand coalition with $a_1 = n$.*

Proof. As has already been noted, consumer surplus is independent of a_1 and profits are strictly increasing in a_1 . Hence to prove the lemma it is only necessary to show that government revenue is at no point in the range $n/2 \leq a_1 < n$ greater than at $a_1 = n$. When all countries are in a single bloc, net imports and government revenue must be equal to zero as there are no countries outside the bloc to import from or export to. From equation (5.37) it is clear that each country in a bloc with $n/2$ members will also have zero net imports, while in the range $n/2 < a_1 < n$ net imports, and therefore government revenue, are negative. ■

This leaves two possible outcomes from the model: either all countries form a single trade bloc, or the first of two blocs contains less than half the countries in the world. Unfortunately it is not possible to find a general algebraic solution to equation (5.39), the first order condition for welfare maximisation. However, a range of numerical simulations, details of which for the case with $n = 100$ are given in Table 5.1 below, show that the optimal value for a_1 in the range $1 \leq a_1 \leq n - 1$ may lie below or above $n/2$, depending on the values given to the model parameters. Furthermore,

when $a_1 < n/2$, welfare for country i can be either higher or lower when it belongs to a bloc of this optimal size than under free trade. In many of the numerical examples considered, it is found that in a world consisting of not more than two trade blocs a country's welfare is maximised by being in a bloc containing less than half the countries in the world.⁶⁸

The first row of Table 5.1 provides a benchmark case, with $\alpha = 10$, $\lambda = 1$ and $\mu = 1$. Each of the other rows changes one of these parameter values.⁶⁹ For many of

α	λ	μ	a_1	W_1	W_{ft}
10	1	1	29	106.842	40.5041
50	1	1	30	1243.76	1200.38
100	1	1	30	4870.47	4900.01
1000	1	1	33	489233	498951
100000	1	1	65	4.99941×10^9	4.99941×10^9
10	0.001	1	29	116.139	49.9929
10	5	1	29	79.4188	12.5076
10	1	5	29	1719.34	40.7323
10	1	0.1	30	40.3677	40.496
10	1	0.0001	64	39.7022	40.496

Table 5.1: Some numerical examples

⁶⁸ In Table 5.1, different values of α , λ and μ are considered, with β normalised to 1. The values of a_1 given in the table are the integer values which maximise the welfare of the first bloc to form. The value of W_1 in each row is the value of a representative country in the first bloc to form, while W_{FT} gives the welfare of a representative country under global free trade.

⁶⁹ Note that some restrictions on parameter values are implied by the model. For instance, to ensure positive output for all values of a_1 it is necessary (but not sufficient) that $\alpha > \lambda + \mu$.

the examples in the table, it can be seen that $a_1 < n/2$ and $W_1 < W_{ft}$. However, for high values of α and for low values of μ this is not true. For the case with $\alpha = 100000$ and the case with $\mu = 0.001$, the optimal value of a_1 is greater than $n/2$. It then follows directly from Lemma 1 that the grand coalition is sustainable. For the cases where $\alpha = 100$ or 1000 , and where $\mu = 0.1$, a_1 is less than $n/2$ but W_{ft} can be seen to be larger than W_1 , so again the grand coalition is sustainable.

At first the result that countries might prefer to belong to the smaller bloc seems counter-intuitive, as it implies that there is an advantage in a country belonging to the smaller of two blocs which must, due to our assumption about costs, implies higher costs for its firm than if the country belonged to the larger bloc. This result contrasts with the results of Yi (1996) and Section 2.2 of this thesis with segmented markets and common, constant marginal costs, and also the results in Section 2.3 which used the same cost function as has been used in this section. With countries setting optimal tariffs but not export subsidies, countries wish to belong to a customs union which contains the majority of the countries in the world. However there are two assumptions in the model presented in this section which might help to explain the different result obtained. The first assumption, which is certainly crucial, is that of integrated markets, and the necessary assumption this entails about the nature of the trade policy instrument. As explained in Chapter 4, to prevent profitable opportunities for arbitrage and to keep markets integrated, the trade policy instrument used by each country is a combination of an import tariff and an export subsidy. This means that net government revenue will always be positive in the smaller, importing bloc and negative in the larger, exporting bloc. In effect, the form of trade policy used in the model imposes a penalty on countries with relatively efficient, exporting firms while

helping those countries with imports on which to raise tariffs. The second assumption which might help explain the result is the form of the cost function used in this model, which implies that most of the cost reduction from forming a trade bloc comes from the first few partners. An alternative where costs are linearly decreasing in the number of bloc members would be likely to increase the incentive for adding more members to a bloc, and thus make belonging to a small bloc less likely to be desirable. However, as was explained in Section 2.3, the cost function used here is thought to be more realistic.

Given the result that, in a two bloc world, countries wish to belong to the smaller bloc, it seems sensible to question whether the assumed behaviour of the other countries is reasonable. The model only allows for two blocs, so the $(n - a_1)$ countries which are not members of the first bloc to form must all combine in a second bloc. However, as the first bloc to form gains from its small size, it seems likely that other countries would also rather be part of a small bloc rather than remaining in the large, exporting bloc. Hence it is unlikely that the coalition structure with one small bloc and one large bloc would be sustainable. Instead it seems likely that the equilibrium coalition structure would consist of either a number of small trade blocs or a world in which no blocs are formed. The results found in this section are summarised in Proposition 5.3:

Proposition 5.3. *In the model with decreasing costs, the grand coalition might or might not maximise each country's welfare. For a wide range of parameter values, a group of less than $n/2$ countries have an incentive not to join the grand coalition and*

to form their own trade bloc. The resulting coalition structure is unlikely to be sustainable and the emergence of further small trade blocs is likely.

Inspection of the results in Table 5.1 shows that the cases where the grand coalition is formed are those where the demand parameter α is high relative to μ , which measures the degree by which firms gain from being in a larger trade bloc. Although in such cases the benefit in terms of falling costs from joining a trade bloc is small, crucially the gain in tariff revenue from being an importer is also small. This again highlights the importance to the results of the assumption of integrated markets and the trade policy instrument used.

5.4. Conclusions

This chapter has considered two models of trade bloc formation under integrated markets. In the first model, where firms have common, constant marginal costs, customs union formation has no effect on countries' trade policies or welfare. No trade occurs, regardless of the structure of trade blocs. In the second model, a firm's costs are decreasing in the number of countries which are members of the trade bloc that firm is located in. When two trade blocs form, the larger bloc is a net exporter and sets an export subsidy which is fully countervailed by the import tariff set by the smaller bloc. In this model the grand coalition, in which all countries are members of a single bloc, is not sustainable for a wide range of parameter values as some group of countries, consisting of less than half the total number of countries in the world, can gain by not joining the grand coalition but instead forming their own

trade bloc. This is likely to lead to further changes in the coalition structure as more countries leave the larger bloc.

As has already been noted elsewhere in this thesis, there has been little research conducted on trade policy under integrated markets in general. This is even more true when looking at trade blocs under integrated markets, and clearly further research would be useful. A first area for future research would be to consider alternative cost functions, to see whether the result that countries would like to be part of a small trade bloc is robust. The cost function used in Section 5.3 is of a form which means most of the cost reduction from joining a trade bloc is derived from the first few partner countries, and an alternative that could provide different results would be to consider costs which decrease linearly in the size of a trade bloc. Another useful area of research would be to formally analyse the case in which more than two trade blocs could form. A useful starting point for this analysis would be to present a three country model of trade under integrated markets, where the relatively small number of countries would mean that the need for a separate arbitrage condition between each pair of countries should not be unmanageable. The general case, with any number of countries and blocs allowed, would be unlikely to be solvable.

Chapter 6.

General Conclusions

This concluding chapter highlights the main results found in this thesis, offers some general conclusions and suggests some areas for future research.

Chapters 2 and 3 provide a number of new results concerning trade bloc formation under segmented markets. Using the basic model in Chapter 2, with symmetric countries and common constant marginal costs, it is shown that global free trade is preferred by all countries when the world consists of no more than four countries. With five or more countries, the world will split into two trade blocs, the first of which contains most of the countries in the world and has higher welfare than the smaller bloc. The model is extended later in Chapter 2 to include a cost reducing effect of trade bloc membership, which is a novel feature in this thesis. With segmented markets, this cost assumption does not change the structure of trade blocs. Chapter 3 considers the formation of trade blocs between countries with different market sizes where firms have common constant marginal costs. The main result in this chapter is that the formation of a two-country free trade area or customs union will always raise the smaller country's welfare, whereas the larger country's welfare will generally fall when it joins a free trade area and might fall when it joins a customs union. The results in this chapter provide a possible explanation for the concessions by small countries on non-trade issues which have accompanied many recent trade agreements.

Chapters 4 and 5 contain a number of results concerning trade policy and trade bloc formation under integrated markets. As well as adding to the limited literature on integrated markets, these chapters also make it possible to make comparisons between

segmented and integrated markets. Chapter 4 presents a two-country model, under complete and incomplete information. The main results are: in the Nash equilibrium with complete information, the low cost country gives an export subsidy which is fully countervailed by the high cost country's import tariff; with incomplete information about costs, the signalling effect increases the export subsidy and reduces the tariff; and in the simultaneous signalling game, with symmetry, expected welfare in the separating equilibrium is higher than under free trade for both countries. The model of trade bloc formation under integrated markets with common constant marginal costs in Chapter 5 suggests that there is no incentive for trade bloc formation, as tariffs and welfare are independent of bloc size. However, when costs fall as the size of a trade bloc rises, there is an incentive for trade bloc formation. Surprisingly, when global free trade is not optimal, if the world were to divide into two blocs, countries belonging to the smaller bloc would be better off than those in the larger bloc.

Although in the two-country model presented in Chapter 4 the analysis of strategic trade policy under integrated markets shows few qualitative differences to the case of segmented markets, this is not true when the formation of trade blocs is considered. Comparing the results in Chapters 2 and 5 suggests that the incentives for trade bloc membership are very different under the alternative assumptions. When firms' marginal costs are unaffected by trade bloc membership, there is a clear incentive to belong to a large bloc under segmented markets, but no gain from trade bloc membership under integrated markets. The two alternative assumptions also lead to contrasting conclusions about the importance of the cost reducing effect which

might be associated with trade bloc formation. Under segmented markets, there is no effect on the equilibrium structure of trade blocs, although all countries achieve higher welfare, whereas under integrated markets the cost reducing effect provides an incentive either to move to global free trade or to belong to a (small) trade bloc when there would otherwise be no such incentive.

Although any policy conclusions based on such specific models are at best tenuous, it is interesting to consider what the models in this thesis suggest in relation to the real world. More specifically, the results in this thesis allow some conjectures to be made about what might happen with regard to trade blocs as world markets continue to become more integrated. The main conclusion would appear to be that there is less incentive to belong to a trade bloc when markets are integrated than when they are segmented, and in particular there is less incentive to belong to a large trade bloc. When trade blocs have no effect on the costs of firms located in member countries, the results in Chapters 2 and 5 suggest that a move from segmented to integrated markets removes the incentive to belong to a trade bloc. However there is no loss related to belonging to a trade bloc, and consequently no incentive for any country to leave a bloc to which it already belongs. This is not true, however, if trade bloc membership reduces firms' costs. Comparing the results in Chapters 2 and 5 shows that in this case, countries move from wanting to belong to a large bloc under segmented markets to preferring either global free trade or membership of a small bloc under integrated markets. It must be remembered that the difference in the trade policy instruments used in the two chapters could be important in reaching this result.

One obvious area for future research is to consider further the case of asymmetric countries. The model in Chapter 3 made a first step in this direction, but made no attempt to derive any results about equilibrium trade bloc structures. Given the complexity in finding results where countries are symmetric, it seems unlikely that consideration of a general n -country case would be fruitful. However, with specific, small numbers of countries it is likely that some interesting results could be generated. Chapter 3 takes a first step in this direction by considering a three-country model, but finds no incentive for trade bloc formation in the absence of transfers. An interesting area for future investigation would be to see how many countries are needed before there is an incentive for two or more of them to form a customs union or free trade area.

Another area for future research would be to consider other types of asymmetry between countries. The only way in which countries differ in Chapter 3 is through a demand parameter, which implies differences in market size. Other asymmetries could be introduced on the production side, either by having different numbers of firms in different countries or by allowing firms' marginal costs to differ between countries. An obvious starting point would be to assume that those countries with larger markets also contain more firms. In this case, it is likely that the gains to small countries and losses to large countries which arise when they gain access to each other's markets would be reduced, and possibly even reversed, with significant effects on the overall incentives for trade bloc formation.

Throughout the thesis, as well as assuming that every country contains one firm, it has also been assumed that the number of firms in the market is unaffected by trade bloc formation. However, allowing for free entry and exit would make it likely that changes in the structure of trade blocs would also result in changes in the number of firms in an industry. For example, in the case of segmented markets, if a country was a member of a large trade bloc, with a relatively large 'home' market, the profitability of firms located in that country would be increased at the expense of firms based outside the bloc. Hence there might be incentives for firms to enter the industry in countries belonging to the large bloc or leave the industry in countries belonging to the small bloc.

Finally, it should be noted that global integration is effectively considered as a demand side phenomenon in this thesis. The comparison between segmented and integrated markets could arise due to a change in firms' perceptions, as they perceive the world to have changed from being divided into geographically distinct markets to being a single market, but in reality a move to integrated markets is more likely to be due to the actions of consumers and arbitrageurs in eliminating price differentials between markets. However, globalisation is occurring in production as well as consumption, and multinational companies play an increasingly important role in the world economy. The effect of trade bloc formation on production, at firm level rather than at a more aggregated level, is an area where little research has been done and there are likely to be important effects on the location of production resulting from entry into a preferential trade agreement.

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