Pasi Holm

ESSAYS ON INTERNATIONAL TRADE AND TAX POLICY IN VERTICALLY RELATED MARKETS

VALTION TALOUDELLINEN TUTKIMUSKESKUS
Government Institute for Economic Research
Helsinki 1994
ISBN 951-561-087-7
ISSN 0788-5008

Valtion taloudellinen tutkimuskeskus
Government Institute for Economic Research
Hämeentie 3, 00530 Helsinki, Finland

J-Paino Ky
Helsinki

ABSTRACT: This collection of essays considers international trade in the presence of vertically related key intermediate product and final goods markets. The traditional assumption of perfectly competitive key intermediate and final product markets is replaced either by an imperfectly competitive final goods market or by a strong protected intermediate product market. There are two common issues in this collection of essays. The first is profit-shifting inside vertical structure of firms or economic agents and the second is profit-shifting between countries. Profit-shifting inside vertical structure results i) from differences of profit taxation in different industries or countries or ii) from the dependence of one sector taxes on the other sector's actions. A standard duopoly model with two-sided market power and with both firms having Cournot conduct introduces the possibility of strategic trade policy. A government in one country can use its trade policies for the purpose of profit shifting between countries. In every chapter these two profit-shifting mechanisms have been integrated into the same model.

KEY WORDS: vertically related markets, transfer pricing, strategic trade and tax policy.
Contents

Acknowledgements

Chapter 1: Introduction 1

Chapter 2: Vertically integrated oligopoly and international trade policy 27

Chapter 3: A multinational firm with vertically related markets and international trade policy 50

Chapter 4: A multinational firm with vertically related markets and international tax policy 97

Chapter 5: Effects of the GATT proposal for agricultural support on welfare and optimal policy in the presence of imperfect competition 125

Chapter 6: Agricultural policy harmonization and trade liberalization in the Nordic countries 161
ACKNOWLEDGEMENTS

I am indebted to my examiners Erkki Koskela and Matti Tuomala, whose important comments and helpful criticism greatly benefited the progression of my work. I also wish to thank the staff of the Department of Economics at the University of Helsinki for providing a stimulating atmosphere.

Rederick McConhie not only checked the language but made a notable contribution by clarifying many of my original arguments.

The financial support of the Yrjö Jahnsson Foundation, the Finish Cultural Foundation and Foundation for Research of the OKO-bank Group is gratefully acknowledged. I would also like to thank the Government Institute for Economic Research for publishing the study.

I am grateful to my wife Tiina for her encouragement and support. During the little spare time that I had, I enjoyed to play and relax with my daughters, Sanni and Jenni.


Pasi Holm
Chapter 1

INTRODUCTION

1. IMPERFECTLY COMPETITIVE FINAL GOODS MARKETS AND STRONGLY PROTECTED KEY INTERMEDIATE PRODUCT MARKETS

This collection of essays considers international trade in the presence of vertically related key intermediate product and final goods markets. The traditional assumption of perfectly competitive key intermediate and final product markets is replaced either by an imperfectly competitive final goods market or by a strong protected intermediate product market.

The relevance of imperfect competition can be motivated by recognition that a large part of international trade cannot be credibly explained by differences in national patterns of comparative advantage. Many countries both import and export products in the same narrow industrial classification, counter to the prediction of classical trade theory that nations will specialize in industries where they have a comparative advantage. In the case of the United Kingdom and Belgium, for example, the share of intra-industry trade exceeded 80% in 1985 (Globerman and Dean 1990). The average proportion of intra-industry trade of the total trade flows in Finnish manufacturing industry amounted to 56% in 1985.

In the major papers in the literature on international trade in the presence of imperfect competition a basic unit of analysis is a single industry. This collection of essays captures situations in two particular
industries, namely a high-tech industry and the food industry. Although the high-tech industries and the food industry function very differently, in general, one common factor is strong protection of domestic producers in every industrialized country. The current situation in many countries favours direct support for research and development investments which, being tax deductible, are essential components of technology policy. The Single European Act (Sec. IV), for example, explicitly allowed the Community to subsidize industries in a number of cases, and The European Union Treaty (art. 130n.) has added a new dimension to this by emphasizing the community’s role in supporting new technological developments. Agricultural policy, in turn, consists of trade restrictions and direct price support. Despite significant progress made toward trade liberalization in manufactured commodities through the GATT multilateral trade negotiations, agricultural protectionism has persisted and even strengthened in recent decades. For OECD countries as a whole, agricultural protection expressed in terms of the Producer Subsidy Equivalents soared from 28 per cent in 1980 to 47 per cent in 1986 (Rayner et al 1993). Protection was particularly high in Japan, the EFTA countries and the EU and rose sharply in the USA. Public support for high-tech industries to promote research and development investments is a topic excluded from the GATT negotiations.

Another common factor in many high-tech industries and the food industry is that there are a few rival firms operating in the industry. Firms are usually multinational enterprises which produce both final goods and key intermediate products. A notable current example of this extreme form of vertically-related input and output markets involves the computer industry where many large firms produce semiconductors themselves and export them to
their rival firms (Spencer and Jones 1991). In the food industry, especially in the Nordic and many EU countries, many firms are cooperative, i.e. farmers or farmers’ trade unions owning output producing firms. In Finland, the percentage shares of cooperative firms over the marketed quantities of agricultural products in 1991 were: milk, 93%; meat, 69%; eggs, 70%; and grain, 53%. In addition, the corresponding share of the sales of agricultural production inputs was as high as 45% (Aaltonen 1993).

In addition to empirical fact, the relevance of vertically-integrated structure can be motivated by observations how government policy or arguments for policy have been targeted. One purpose of this collection of essays is to show that the vertical structure clearly matters; policy instruments affecting intermediate product markets de jure affect final good markets de facto and vice versa.

It is worth studying how governments’ policy instruments affect the function of specific industries and what is the optimal policy of a single country as well as a group of countries. This can be motivated as follows. First, many high-tech industries and the food industry are strongly protected and supported. Second, firms in those industries are often vertically integrated and are not always price-takers. Third, the European integration and the formation of the North American Free Trade Association makes studies on the behaviour of economic and customs unions relevant.
2. PROFIT-SHIFTING INSIDE VERTICAL STRUCTURE AND BETWEEN COUNTRIES

There are two common issues in this collection of essays. The first is profit-shifting inside vertical structure of firms or economic agents and the second is profit-shifting between countries. Profit-shifting inside vertical structure results i) from differences of profit taxation in different industries or countries or ii) from the dependence of one sector taxes on the other sector’s actions. For example, it has been suggested that saving on tax payments may be one of the causes of the existence of the multinational firms, or for them to undertake any internal transactions (Kant 1990). The multinational firms have unique ways to avoid taxes that purely domestic firms do not have. One such mechanism is transfer pricing under which tax rate differentials and tariffs induce the multinational firm to charge a transfer price deviating from the marginal production cost.

In every essay except chapter 6 I have analyzed a standard duopoly model with two-sided market power and with both firms having Cournot conduct. Introducing market power on both sides also introduces the possibility of strategic trade policy. A government in one country can use its trade policies for the purpose of 'profit shifting' between countries. In a duopoly situation, firms earn excess profits that form a part of total national welfare. When government policy can be used to increase the share of industry profits accruing to a domestic firm, there can be a national welfare gain.

I have integrated these two profit-shifting mechanisms, one resulting either from differences in profit taxes or dependence of one sector’s taxes
on the other sector’s strategic variable and the other from imperfect
competition in a final goods market, into the same model. This has been
done by extending the basic structure of the duopoly model by integrating
imperfectly competitive or strongly protected intermediate product markets.
First, by specifying a vertically-integrated production structure such that
profit tax rates in the input and output producing sector differ, one can
introduce the transfer price problem into the strategic trade theory given
the condition that the input price charged inside a vertical structure
cannot be ‘pure transfer price’ (sections 5.1 and 5.2). Second, when taxes
levied on input producers depend on an output producer’s strategic
variable, a cooperative firm does not behave in the same way as a
non-cooperative firm (sections 5.3 and 5.4).

If a government in one country can use its trade policies for the purpose
of ‘profit shifting’ between countries, another country can try to do the
same. Therefore, in chapter 4 we will consider a trade policy game between
governments.

3. BERTRAND OR COURNOT COMPETITION

One of the most controversial ideas of the new industrial organization and
trade literature has been the suggestion that government intervention can
raise national welfare by shifting oligopoly rents from foreign to domestic
firms. The starting point of this debate was several papers by Brander and
Spencer (1983, 1985), who showed that government policies can serve the
strategic purpose of altering the subsequent incentives of firms, acting as
a deterrent to foreign competitors. The Brander-Spencer analysis, as is
normally case in this collection of essays, is based on the duopoly model with two-sided market power and with both firms having Cournot conduct, i.e. each firm taking its rival’s sales as given, shows that positive export subsidy increases domestic welfare.

Eaton and Grossman (1986) have shown that above trade policy recommendation depends on the nature of competition between firms; if firms produce differentiated products and have Bertrand conduct, i.e. each firm taking its rival price as given, positive export tax increases domestic welfare. If conjectures are rational or consistent (see Eaton and Grossman 1986), then there is neither export subsidy nor tax at optimum.

To clarify the dependence of trade policy recommendations on the nature of competition between firms let us follow Krugman (1989) and consider the simple model where there are only two firms, each in one country. Neither country has any demand for the firms’ products, but instead both export to a third country. Distortions other than the presence of imperfect competition in this industry are also ruled out. The result is that for each country national welfare can be identified with the profits earned by its firm.

Assume first that two firms compete Cournot fashion, i.e. both firms take the sales of the other firm as given. Each firm’s reaction function will slope down, because of reasonable restrictions on cost and demand, and the home firm’s reaction function will be steeper than its foreign competitor’s. The intersection of the reaction functions is the Nash equilibrium (see figure 1). One of the home firm’s iso-profit curves is drawn through point N. Given that the reaction function is constructed by
maximizing home's profits at each level of foreign output, the iso-profit curve is flat at point N.

Now it is apparent that the home firm could do better than at point N if it could only somehow commit itself to produce more than its Cournot output. Indeed, if the home firm could commit itself to any level of output, while knowing that the foreign firm would revise its own plans optimally, the outcome could be driven to the Stackelberg point S. The problem is that there is no good reason to assign the leadership role to either firm. If no way to establish a commitment exists, the Nash outcome is what will emerge.

What Spencer and Brander pointed out was that a government policy could serve the purpose of making a commitment credible. Suppose that the home government establishes an export subsidy. This subsidy will shift the home firm's reaction function to the right, and thus the outcome will shift downwards along the foreign firm's reaction curve. The optimal export subsidy is one that shifts the reaction function to achieve the Stackelberg point S.

Assume second that the two firms produce differentiated products and compete Bertrand fashion, with firms taking each others' prices as given. Then the reaction function diagram must be drawn in the price space (see figure 2). Each firm's best responses describe an upward sloping reaction function. With reasonable stability restrictions, the home firm's curve is steeper that the foreign firm's. The Nash equilibrium is at N, and the home iso-profit curve passing through N is flat at that point.

The crucial point is that now the home firm can increase its profits only
by moving upwards along the foreign firm's reaction function. That is, it
must commit itself to charging a higher price than at the Nash equilibrium.
To do this, it must commit itself to a higher price that will be optimal ex
post. To achieve this, the government must impose an export tax.

Krugman (1989) considers three other important lines of research suggested
by a critique of Brander-Spencer strategic trade policy, which challenges
the robustness of their results. First there is the general equilibrium
issue raised by the fact that industries must compete for resources within
a country. Second is question of entry. Third there is the question of who
is behaving strategically with respect to whom. It should be noted that the
first two things do not change the qualitative result of the
Brander-Spencer analyses.

4. ARGUMENTS FOR MY CHOICE OF FRAMEWORK

In theory, the models of Cournot and Bertrand conducts make different
predictions as to what will happen in the duopoly situation. As Kreps
(1990) points out, in the end the answer to the question of which of these
predictions will be borne out by data, must be empirical. Thus, I have no
fundamental reasons to choose firms having Cournot conduct rather than
Bertrand conduct. The argument for my choice that firms have Cournot
conduct rather than Bertrand conduct is mainly practical; the Cournot model
is easier to analyse, since one can assume homogeneous products, and
therefore it is more commonly used in literature than the Bertrand model.

Spencer and Jones have considered both conducts in their paper (1991)
(which I generalize in chapters 3 and 4) which considers the incentives for a foreign vertically-integrated firm and a foreign country to supply a key intermediate product, the domestic firm being dependent on that supply, when firms compete in the market for the final product. They conclude the comparison of Cournot and Bertrand conduct by saying that optimal policy by the foreign exporting country is fundamentally affected by whether the final products produced by each firm are strategic substitutes or complements (Bulow, Geanakoplos and Klemperer 1985). Optimal policies tend to have opposite signs if the final products are strategic complements (as in Bertrand case) rather than strategic substitutes (as in Cournot case). They add nevertheless, that whether there is Bertrand or Cournot competition in the output markets, the conditions in the domestic importing country which determine the profitability of vertical input supply are basically unaffected.

5. DESCRIPTION AND CONTENTS OF THE CHAPTERS

In this section I describe the theoretical structure, the trade flows and the price structure of the models and connect chapters with each other. Although the applications of the chapters differ a lot, this section tries to show that the theoretical structure of chapters forms an integrated whole. Analysis presented in first three chapters can be applied both to a high-tech industry, Spencer and Jones (1991; 1992) giving an example from the computer industry, and to industries manufacturing important raw materials. Chapters 5 and 6 analyse two versions of the model which I have developed to describe trade flows of agricultural products in industrialized countries.
In every essay we consider public interest of countries, i.e. optimal policy of countries are studied. Governments maximize social surplus in the first-best world, where governments’ budget constraints are not binding. The welfare functions consist of three parts: first consumers’ utility and other sectors of economy, second, firms net profits and third, governmet incomes.

5.1. Chapter 2

Recent work in the theory of international trade considers the optimal policy or effects of policy instruments on welfare within an environment of imperfect competition in the final production (output) market. Several papers have extended this basic structure by integrating imperfectly competitive intermediate product or input markets into it. Brander and Spencer (1988) examine the consequences of labour unionization increasing the wage level in one firm for international duopoly. Spencer and Jones (1991; 1992) analyse an international duopoly in which a vertically integrated firm producing both input and output competes with another firm in output markets. In several cases corporate tax rates in input and output production sectors may differ, causing transfer pricing in which, depending on tax rate differentials, a vertically-integrated firm overinvoices or underinvoices the input price. The transfer price problem without strategic behaviour in output markets has been studied by Kant (1990), for example.

In chapter 2 we combine the transfer price model by Kant (1990) and the strategic trade policy model by Brander and Spencer (1983). We consider an international duopoly in an output market where the sales of homogeneous
final products are assumed to be determined by Cournot competition, and then analyse the effects of vertical integration on international trade policy. Another firm in the model is a vertically integrated multinational firm whose parent company produces output in one and its affiliate input in the other country. By allowing for the possibility that profit tax rates in the input-producing country may differ from that in the output-producing country, we can incorporate the profit-shifting motive of the MNF into the strategic trade policy model, since the input price is assumed to be the only instrument by which the MNF can shifts its profits from the higher profit tax country to the lower profit tax country.

The most extreme form of dependence on a vertically-integrated firm has been considered by assuming that the MNF controls the production of the final goods and the transfer pricing. One problem with a very basic model that includes transfer pricing is that an MNF charges either the highest or the lowest possible transfer price without any government control. To introduce an interior solution we follow Kant (1990) and assume that the MNF follows the guideline that the transfer price charged be equal to the marginal production cost. It is assumed that if the transfer price differs from the marginal production cost there is some penalty of known size that can be imposed on the MNF with some probability that depends positively on the absolute difference between the transfer price and the marginal production cost.

In the model (see figure 3) there are three countries. A final good is produced and consumed in countries 1 and 2, whereas a key intermediate product is produced in countries 0 and 2. A multinational firm's (MNF) parent company produces the final good in country 1 and its affiliate
Figure 3: Trade flows and prices

- Consumers in country 1: consumer price in both countries: \( p \)
- Consumers in country 2
- Firm 1 in country 1: output producer, input export: \( Y^1 \), input price: \( r \)
- Firm 0 in country 0: input producer
- Firm 2 in country 2: output producer, input: \( X^2 \), input price: \( r \)
- Input producing firms in country 2

Output: \( Z^1 \) from firm 1 to consumers
Output export: \( Y^1 - Z^1 \)
Output: \( Y^2 \) from firm 2 to consumers
Input export: \( Y^2 - X^2 \)
Input producing firms in country 2
produces the key intermediate product in country 0 (dashed circle in figure 3 means vertically-integrated structure). The multinational firm has a Cournot competitor in the final good market in country 2, which either produces its own inputs or buys them from a competitive input market in country 2. Trade flows in chapter 2 are the same as presented in figure 3 except that no input trade between countries 0 and 2 is allowed, (i.e. we analyse the case of vertical foreclosure, as it will be called in chapters 3 and 4). Note finally, that the input price paid by firm 2 may differ from the transfer price of an MNF in this chapter in contrast to what is presented in Figure 3.

The model contains three types of policy instruments: trade policy instruments, profit taxes, and governments’ attitudes to transfer pricing. We have related our discussion here to strategic trade theory, and therefore first examine how different instruments affect the decision variables of the MNF (output production and transfer price) and its rival (output production). Then we solve for the optimal policy of the MNF’s parent company’s home country.

We can show that i) the optimal policy involves the effective role of each instrument considered if a government controls transfer pricing by imposing a penalty schema, ii) without the transfer price penalty schema, a government can use either the export subsidy or the tax rate to affect outcome of game between Cournot competitors.
5.2. Chapters 3 and 4

Chapters 3 and 4 analyse the same model, being an extended version of the model both presented in chapter 2 and analysed by Spencer and Jones (1991; 1992). Extension into chapter 2 results from the possibility that an MNF, having a cost advantage in the production of a key intermediate product over its rival, can sell a key intermediate product to it, lowering its rival’s cost. In chapters 3 and 4 then, firm 2 buys its inputs either from the perfect competitive input market prevailing in country 2 or from an MNF or from both. This model generalizes the model by Spencer and Jones by allowing a vertically-integrated firm to be a multinational firm producing an input in a third country. When corporate tax rates in countries 1 and 0 differ, the ‘profit-shifting motive’ of the multinational firm has an effect on prices. Thus we have integrated a transfer price problem, as in chapter 2, into the strategic behaviour of the vertically-integrated firm.

The trade flows of the model are presented in Figure 3. Note now that the MNF can sell input to its rival. The crucial point in the model is the structure of input prices. First, if the multinational firm supplies inputs to its rival, the price charged should be same as prevailing in country 2 given that the firm 2 buys a part of its inputs from its domestic market. If these prices differ, firm 2 will buy all its inputs at the lower price. Second, the transfer price charged by the MNF in its internal trade is assumed to be the same as the input price paid by firm 2 for its inputs, i.e. the input price prevailing in country 2 or charged by the MNF from its rival for input import. The argument in favour of the transfer price being equal to the price paid by firm 2 is that governments in countries 1 and 0 know the price level prevailing in country 2 and/or the price charged in
input trade between countries 0 and 2 and use this price as the effective transfer price in their profit taxation. If this assumption is thought to be too restrictive, it can be relaxed by introducing the penalty schema presented in chapter 2. If one wanted to do this, one should assume, for example, that the input price paid by firm 2 affects governments' estimates of the affiliate's marginal input production cost, remembering that the probability to the transfer price penalty depends positively on the absolute difference between the transfer price reported by the MNF and the governments' estimates of the marginal production cost. This would give an additional degree of freedom to the MNF in transfer pricing, but at the same time it would make the analyses too complicated. So in chapters 3 and 4 we have only one input price as presented in Figure 3.

The first question arising in chapters 3 and 4 is whether the multinational firm supplies inputs to its rival, lowering the rival's cost, or not. The second question to be analysed is what the optimal trade and tax policy of different countries is. The section answering these questions is divided into two sub-sections: first, the case of vertical foreclosure, i.e. where the multinational firm does not supply any inputs to its rival, is analysed and second, the case of vertical supply is considered.

Although chapters 3 and 4 consider the same model, they differ in the sense that the former considers the effects of trade policy instruments, e.g. import tariffs and export subsidies, and the latter the effects of tax policy instruments, i.e. corporate profit tax rates. The reasons for this are mainly practical. First, tax policy instruments on the one hand and trade policy instruments on the the other hand form a natural whole often considered separately in economic literature. Second, if these instruments
were analysed together, this chapter would be very awkward to handle. Third, to anticipate the results in chapter 2, a government in country 1 can use either the export subsidy or the profit tax rate to affect the outcome of the game between Cournot competitors, without the transfer price penalty schema. In the case of vertical supply, the effects of these two types of instruments differ.

In addition to analyses of the optimal policy of a single country or a group of countries chapter 4 considers the Nash equilibrium of the tax policy game between countries.

Spencer and Jones (1991) have shown that when every trade policy instrument are zero and when it is prohibitively expensive to produce the input in country 2 any small tariff on output will induce the MNF to supply its rival with the input. In our model, if the tax rate in the affiliate’s home country is higher than that in the parent’s home country the MNF will vertically supply even in absence of tariffs. When, in contrast, the tax rate is the parent’s home country is higher than that in the affiliate’s home country any small tariff on output will not induce the MNF to supply its rival with input: the higher the difference between tax rates, the higher the tariff should be.

The optimal trade and tax policy of three countries are considered, as well as the optimal policy of customs unions. We find that, firstly, independent of whether a MNF vertically forecloses or vertically supplies inputs to its rival the global government optimally should tax both firms such that their true output price-marginal cost margins are positive and of equal size when consumer surpluses and welfare distribution between countries do not
matter. This implies that the marginal production cost of firms should be of equal size at optimum. Secondly, the customs union consisting of both the parent company’s and the affiliate’s home country should subsidize the output export less (more) than the Spencer and Jones (1991) result suggests when the tax rate levied on the parent’s profit is higher (lower) than the tax rate levied on the affiliate’s profit. Thirdly, chapter 4 shows that the profit tax rates can be used as strategic policy instruments and that perfect harmonization of tax rates are optimal only in some special cases. In general, the global government optimally should levy different tax rates on the parent’s and the affiliate’s profits and the Nash equilibrium of the tax policy game between the parent’s and the affiliate’s home country produces the differentiated tax rates.

5.3. Chapter 5

Agricultural policy in advanced countries has been characterized by strong protection of domestic producers by means of trade restrictions and direct price support. Despite significant progress made toward trade liberalization in manufactured commodities through the GATT multilateral trade negotiations, agricultural protectionism has persisted and even strengthened in recent decades. In the Uruguay Round negotiations in the GATT a high priority was given to reforming domestic farm policies which distort agricultural trade. Countries have shared a common purpose in seeking reforms that, firstly, would improve market access, secondly, would reduce domestic price support, and thirdly, would reduce export subsidies (see Rayner et al, 1993).

This chapter studies a very simplified model which tries to capture some
main characteristics of the agricultural sector, trade in agricultural products and agricultural policy harmonization and trade liberalization (see Figure 4). Firstly, the agricultural sector is divided into farming and an imperfectly competitive food industry. Family farmers produce intermediate products (e.g. meat, milk, grain) for the food industry which produces consumer goods (e.g. processed meat, dairy products, grain products).

Instead of having a vertical structure of one input and one output producing firm, as in chapters from 2 to 4, we assume now that there are many input producers forming the union/coalition which owns and controls another output producing firm. This gives us a new opportunity to model the behaviour of the input producers and output production. The novelty is that each input producer makes its own input production decision independently assuming that its own actions have no effects on the actions of the other input producers or output production. But when the input producers as a group decide on output production they maximize the sum of output producing firm's profit and aggregate profits of input producers, taking into account the behaviour of independent input producers. The driving force in this chapter is that taxes paid by input producers depend on the behaviour of the output producer.

Secondly, we have assumed that input and output production take place in countries 1 and 2. In contrast to chapter 3 and 4 there is no intermediate products trade between countries 1 and 2, since both countries restrict intermediate product imports by tariffs or non-tariff barriers and since they support domestic production, implying agricultural intermediate products surpluses. Both countries 1 and 2 attempt to dump processed
Figure 4: Trade flows and prices

Country 1

consumers

output: $Z^1$

firm 1

input: $Y^1$

Input price: $q^1$

farmers

Effective input price: $r^1$

Country 2

consumers

output: $Y^2$

firm 2

input: $Y^2$

Input price: $q^2$

farmers

Effective input price: $r^2$

input overproduction in both countries

Input export: $X^1 - Y^1$

Input export: $X^2 - Y^2$

Rest of the world

world market input price: $\bar{q}$
surpluses (e.g. butter, milk powder, frozen meat, flour) onto the rest of the world at low world market prices relative to price levels in countries 1 and 2. Consumer goods are traded between countries 1 and 2 and not exported to the rest of the world. Output-producing firms in both countries are Cournot competitors as in the preceding chapters.

Since there is no input trade between countries 1 and 2 and since governments in both countries regulate the input market, the input price level may differ in those countries in contrast to the situation in chapters 3 and 4. The world market input price is assumed to be independent of the amount of overproduction in those countries. Since output trade is allowed between countries the consumer price is assumed to be same in both countries as before.

The main purpose of this chapter is to study the effects of the GATT proposal in reducing price and export support for agriculture on welfare and optimal policy in developed countries. We consider whether an imperfectly competitive food industry changes the common view that the most efficient transfers are those that do not distort production or consumption decisions. Such 'decoupled' agricultural policies have long been advocated by economists as a form of welfare (Winters, 1993), but rejected by farmers, with silent acceptance of agro-industries.

One of the main reference in the agricultural application is the paper by Munk (1990). He considers, however, only the case in which the consumption of agricultural product is final and perfect competition in production prevails, analysing the optimality of the following trade policy instruments: lump-sum transfers, subsidies to primary factors, deficiency
payments and price support. Chapter 5 extend his instrument set by including a marketing levy paid by farmers in the case of overproduction of agricultural products. The methodological difference between Munk’s paper and this chapter is that Munk has analysed the second-best problem, i.e. government’s budget constraint is binding, whereas the first-best problem is analysed here.

The results show that a reduction in the amber support, implying restriction on the sum of the total value of internal price support and export support for agricultural intermediate product, increases consumer surplus and decreases farmer surplus. The effects on output producer surplus are ambiguous. In the presence of the GATT proposal, a marketing levy charged to farmers to finance export costs of agricultural product and a food industry export subsidy are perfect substitutes for welfare maximization.

5.4. Chapter 6

Finland, Norway and Sweden applied for membership in the EU in the early nineties. From the very beginning it was clear that agriculture would be one of the most difficult matters to resolve. The Nordic countries’ agreement with the EU will probably cause agricultural policy harmonization and trade liberalization. Agricultural policy harmonization implies that price support to farmers will be determined by the rules of the EU’s Common Agricultural Policy; trade liberalization means that the Nordic countries will have to relax import restrictions on final goods.

This chapter uses a partial equilibrium analysis to evaluate the welfare
impacts of the Nordic countries’ EU membership on the agricultural sector. According to the Finnish negotiation targets agricultural policy harmonization, i.e. reduction of price support, and trade liberalization, i.e. an increase in import quotas, is partial (see Kettunen, 1993). The movement toward the Common Agricultural Policy and free trade is step-by-step. In this chapter we are particularly interested therefore in the effects on welfare during the transition period.

The agricultural sector is divided into farming and the food industry (as in chapter 5). Farmers produce intermediate products for the food industry, which in turn produces consumer goods. A special feature in the Nordic countries is that cooperative firms owned by agricultural producers have a dominant role with substantial market power in the food industry.

In Nordic countries and in the EU an agricultural intermediate product price level, controlled by governments, is so high that input overproduction prevails. But the prices, at least in Finland and Norway, are higher than the price in the EU. Due to overproduction in the Nordic countries intermediate product import from the EU is totally restricted. In the EU, final good production is characterized by perfect competition and it is imported in free trade. Following Eldor and Levin (1990) we first analyse an increase in import quota on the final good set either by the EU or the Nordic governments (it is considered as a voluntary export restraint (VER) if it is set by the EU). Second we study reduction of the input price level in the Nordic countries towards the price level in the EU.

When an intermediate good surplus prevails, causing export costs paid largely by taxpayers, and when restriction on a final good import is
carried out by a quota, it is shown that agricultural policy harmonization, a reduction in price support, unambiguously increases domestic welfare; trade liberalization, an increases in final good import quota, ambiguously affects welfare.

6. CONNECTIONS WITH ECONOMIC THEORY AND INSTITUTIONS

All models in this collection of essays belong to the new literature on industrial organization and trade theory. These essays theoretically contribute to the literature in the following two ways: first, richer and wider vertically-integrated structures for different economic agents have been analysed. Second, the profit-shifting motive (due to tax differences) and strategic behaviour (due to oligopolistic competition) of a vertically-integrated structure have been integrated together.

These essays pay attention to two aspects new to the literature. First, a vertically-integrated firm in Spencer and Jones’s model is specified as a multinational firm which produces a key intermediate product in a low-cost developing country and produces a final good in a well-educated industrialized country. Second, the important institutional factors in the agricultural sector are taken into account when analysing the effects of the politically sensitive GATT proposal and the effects of the politically sensitive EU membership of the Nordic countries.

The analysis of this collection of essays is limited in the sense that optimality is defined from an efficiency point of view. Government distributional objectives and so-called ‘non-economic’ objectives of
agricultural support are not considered here. Clearly, there remains some scope for improvement in these respects. As usual in the new IO/trade literature this collection of essays considers industry-specific applications. However, we have tried to concentrate on those aspects with economic importance and relevance, multinational firms, and the politically topical agricultural sector.

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Chapter 2

VERTICALLY INTEGRATED OLIGOPOLY AND INTERNATIONAL TRADE POLICY

ABSTRACT. Vertical structure of firms can have important effects on imperfectly competitive rivalries between firms. This chapter examines the consequences of vertical integration with transfer pricing for the rivalry between duopoly firms in an international environment, using the (non-cooperative) Nash equilibrium to determine the output equilibrium. The chapter analyzes the trade policy incentives resulting from vertical integration in an output exporting country, focusing on export subsidy, profit tax rate, and attitudes towards transfer pricing in that country. It is shown that if a government does not control transfer pricing by imposing a penalty schema, a government can use either the export subsidy or the tax rate to affect outcome of game between Cournot competitors. With the transfer price penalty schema, introducing the interior solution to the transfer price, the optimal policy involves the effective role of both instruments.

JEL classification: 612, 1222.

1. INTRODUCTION

Recent work in the theory of international trade considers the optimal policy or effects of policy instruments on welfare within an environment of imperfect competition in the final product (output) market. Several papers have extended this basic structure by integrating into it imperfectly competitive intermediate products or input markets. Brander and Spencer (1988) examine the consequences of labour unionization increasing the wage level in one firm for international duopoly. Spencer and Jones (1991; 1992) analyze an international duopoly in which a vertically integrated firm
producing both input and output competes with another firm in output markets. In several cases corporate tax rates in input and output production sectors may differ, causing transfer pricing under which, depending on tax rate differentials, a vertically integrated firm overinvoices or underinvoices the input price. The transfer price problem without strategic behavior in output markets has been studied, for example, by Kant (1990).

In this chapter we combine the transfer pricing model by Kant (1990) and the strategic trade policy model by Brander and Spencer (1983). We consider an international duopoly in an output market where the sales of homogeneous final products are assumed to be determined by Cournot competition, and then analyze the effects of vertical integration on international trade policy. In the model, another type of firm is the vertically integrated multinational firm (MNF) whose parent company produces output in one country and affiliate input in another country. By allowing for the possibility that profit tax rate in the input producing country may differ from that in the output producing country, we can incorporate the profit-shifting motive of the MNF into the strategic trade policy model, since the input price is assumed to be the only instrument by which the MNF can shift its profits from the higher profit tax country to the lower profit tax country.

The most extreme form of dependence on a vertically integrated firm has been considered by assuming that the MNF controls the production of the final goods and the transfer pricing. One problem with a very basic model that includes transfer pricing is that a MNF charges either the highest or the lowest possible transfer price without any government control. To
introduce an interior solution we follow Kant (1990) and assume that the
MNF follows a guideline that the transfer price charged be equal to the
marginal production cost. If the transfer price differs from the marginal
production cost there is some penalty of known size that can be imposed on
the MNF with some probability that positively depends on the absolute
difference between the transfer price and the marginal production cost.

The model contains three types of policy instruments: trade policy
instruments, profit taxes, and governments’ attitudes about transfer
pricing. We first examine how different instruments affect the decision
variables of the MNF (output production and transfer price) and that of its
rival (output production). Then we solve for the optimal policy of the
MNF’s parent company’s home country.

The anticipated results are that, first, the export subsidy, the tax rate,
and the effort to control transfer pricing are not perfect substitutes for
welfare maximization, i.e. each instrument has an effective role if a
government controls transfer pricing by imposing a penalty schema. Without
the transfer price penalty schema, a government can use either the export
subsidy or the tax rate to affect outcome of game between Cournot
competitors. Second, in the overinvoicing case the output exporting country
should tax exports, if the profit shifting due to transfer pricing is
higher than the profit shifting due to Cournot competition. In the opposite
case the optimal subsidy can be positive or negative. Third, in the
underinvoicing case, both the strategic behavior of Cournot competitors and
the MNF’s profit shifting behavior call for export subsidy.

The chapter is organized as follows; section 2 presents the basic models of
vertically integrated international oligopoly, section 3 examines the trade policy consequences of vertical integration, and section 4 contains concluding remarks.

2. THE MODEL WITH TRANSFER PRICING PENALTY

The MNF's output producing parent company is located in country 1 and its input producing affiliate in country 0. The output producing firm (firm 1) exports a final product to country 2 in competition with a rival (firm 2), located in country 2. We present the analysis as if firm 2 is vertically integrated. This is not, however, necessary; the input could be produced by a perfectly competitive industry in country 2 as well.

Technological relationships are simplified by assuming that one unit of input is required to produce one unit of output with linear cost function and that there are no other factors of production. The MNF produces the input (and the final good) at a constant marginal cost, $d$, whereas firm 2 can produce its own supplies of input only at a higher and increasing marginal cost. We rule out the possibility that the MNF sells input to its rival, thus we consider the vertical foreclosure case (see Spencer and Jones, 1991; 1992).

We assume that the MNF decides simultaneously on its output produced and the transfer price (i.e., the price, $q$, charged for in its internal trade) taking its rival's output produced as given. While deciding on its output produced firm 2 takes the MNF's transfer price and output produced as given. Thus outputs of final product are determined by Cournot competition.
The novelty in this analysis is that the MNF can avoid its profit taxes by transfer pricing. If the transfer price is higher (lower) than the marginal production cost, the MNF's tax avoidance is harmful to country 1 (country 0), since the parent company's (the affiliate's) reported profits are lower than "true profits". Therefore, if the transfer price is higher (lower) than the marginal production cost, it is country 1 (country 0), who wants to control transfer pricing by imposing a penalty. So country 1 (country 0) is assumed to commit to the transfer price policy in the overinvoicing (underinvoicing) case. In addition, country 1 is assumed in its policies to commit to a specific subsidy, s, for final product exports and to a profit tax rate, τ, prior to firms' choosing of their policies. Country 0 may commit to a profit tax rate, μ, at the same stage. It is assumed that profit taxation in country 1 is based on the source principle, i.e., the MNF's parent company's profit is taxed at the rate of τ and the affiliate's profit at the rate of μ.

In considering the market for the final product in country 2, we omit the possibility that the final product is also sold in countries 1 and 0. If the three markets are segmented, this involves no loss of generality. The price, p, of the output in country 2 is given by the inverse demand curve \( p = p(Z) \) where \( p'(Z) < 0 \) and where \( Z = Y + X \) represents total consumption: Y is the MNF's output export and X is firm 2's output produced. Firms are assumed to produce homogeneous products.

There is no profit taxation in country 2. Thus firm 2's profits are

\[
\Pi^2 = pX - c(X),
\]  

(1)
where \( c(X) \) is the marginal production cost with \( c' > 0 \). The after-tax profits (without transfer price penalty) of the MNF's parent company from the export of \( Y \) are

\[
\Pi^1 = (1-\tau)\pi^1 = (1-\tau)((p+s)Y-qY),
\]

(2)

where \( \tau \) is the profit tax rate in country 1, \( s \) is the specific subsidy for the output exports set by country 1, and \( q \) is the transfer price applied in input trade inside the MNF. The affiliate's after-tax profits from export of input are

\[
\Pi^0 = (1-\mu)\pi^0 = (1-\mu)[qY-D(Y)],
\]

(3)

where \( \mu \) is the profit tax rate in country 0 and \( D(Y) \) is the input production cost with a positive but constant marginal cost, in other words \( d \equiv D'(Y) > 0 \).

Let us now turn to the transfer price penalty schema proposed by Kant (1990). Following Kant, it is assumed that the MNF faces a guideline that the transfer price charged be equal to the marginal production cost \( d \). If it differs from \( d \), there is some penalty of known size that can be imposed on it with some probability. The probability, \( \beta \), depends on the extent of divergence between the transfer price charged and the marginal cost. Let \( q^c \) be the transfer price which triggers the penalty with certainty. Then, as \( q \) gets closer to \( q^c \), the probability of promulgation of the penalty increases, and it is assumed that it increases at an increasing rate.
In symbols, when the MNF wishes to charge the highest possible transfer price (HTP), we have:

\[\text{for } d < q < q^C, \ 0 < \beta(L, q-d) < 1, \ \beta_q(L, q-d) > 0, \ \beta_{qq}(L, q-d) > 0,\]  

(4a)

\[\text{for } q \leq d, \ \beta(L, q-d) = 0, \ \text{and for } q \geq q^C, \ \beta(L, q-d) = 1,\]

where L is the shift parameter describing governments’ attitudes towards transfer pricing.

For the lowest possible transfer price (LTP):

\[\text{for } d > q > q_c, \ 0 < \beta(L, q-d) < 1, \ \beta_q(L, q-d) < 0, \ \beta_{qq}(L, q-d) > 0,\]  

(4b)

\[\text{for } q \geq d, \ \beta(L, q-d) = 0, \ \text{and for } q \geq q^C, \ \beta(L, q-d) = 1.\]

In the tax evasion literature (see e.g., Cowell, 1989), the penalty for evasion is usually a surcharge on the unpaid tax. Here we assume that governments have the opportunity to impose a fixed penalty, \(\xi > 0\), instead of a surcharge on evaded tax. Then the expected loss from the penalty is, both in the case of HTP and in the case of LTP:

\[\xi \beta(L, q-d) + 0(1 - \beta(L, q-d)) = \xi \beta(L, q-d) > 0.\]  

(5)

Thus the expected loss from the penalty depends on the governments’ instruments, L and \(\xi\), and on the transfer price. The governments’ attitude towards transfer pricing is modeled via the probability of imposition of the penalty. The more lenient the government is, the higher the value of L is. So in the overinvoicing case \((d < q < q^C), \ \beta_L < 0, \ \text{and } \beta_{qL} < 0, \ \text{and in}\)

the underinvoicing case \((q_c < q < d), \ \beta_L < 0, \ \text{and } \beta_{qL} > 0.\)
Now we turn to the MNF’s after-tax profit function with the transfer pricing penalty. We assume that the penalty is not tax-deductible and that the probability function and the penalty are independent of whether country 1 or country 0 impose the penalty. From (2), (3), and (5)

$$\Pi^M = (1-\tau)[(p+s-q)Y+\alpha(qY-D(Y))] - \xi \beta(L,q-d),$$  \hspace{1cm} (6)

where the relative tax factor is \( \alpha = (1-\mu)/(1-\tau) \), measuring how the MNF values a marginal increase in the affiliate’s profit relative to a marginal increase in the parent’s profit. So if \( \alpha \neq 1 \), the transfer price affects the behavior of the MNF.

At the Cournot equilibrium for the final goods, the MNF sets its output export and transfer price simultaneously to maximize (6), given the output of its rival and the prior committed values of government instruments. Similarly, firm 2 chooses its output to maximize its profit, given the MNF’s output export and the values of government instruments. The first order conditions are:\(^{1}\)

$$\Pi^M_q = (\tau-\mu)Y - \xi \beta_q = 0,$$  \hspace{1cm} (7)

$$\Pi^M_Y = (1-\tau)[p'Y+p+s-d+(\alpha-1)(q-d)] = 0,$$  \hspace{1cm} (8)

$$\Pi^2_X = p'X+p-c' = 0.$$  \hspace{1cm} (9)

\(^{1}\)If we followed the common practice in the tax evasion literature of imposing a surcharge on evaded tax with a constant surcharge and a constant probability of imposition of the penalty, there would be no interior solution for the transfer price. If, in addition, the probability depended on the transfer price, the model would become intractable.
This model includes the transfer price as a full member of the first-order conditions such that the transfer price has an interior solution. If \( \tau > \mu \), i.e., the profit tax rate is higher in the parent company’s home country than in the affiliate’s home country, then \( \beta_q > 0 \), implying from (4a) that \( q > d \), i.e., the MNF overinvoices. If \( \tau < \mu \), then \( \beta_q < 0 \), implying that \( q < d \), i.e., the MNF underinvoices. Equation (9) shows that the output price is higher than the marginal cost in imperfect competition due to the negative strategic term \( (p'X) \). Transfer pricing never reduces production of the MNF, since the last term in equation (8) is always positive if tax rates in countries 1 and 0 differ.

Solving (7), (8) and (9) simultaneously, the Cournot equilibrium levels of output and transfer price can be expressed as functions of \( s, \tau, \mu, \) and \( L \), i.e. \( y = y(s,\tau,\mu,L) \), \( x = x(s,\tau,\mu,L) \) and \( q = q(s,\tau,\mu,L) \). The comparative statics (derived in Appendix A) are presented in Table 1:

<table>
<thead>
<tr>
<th></th>
<th>Export subsidy</th>
<th>Taxes: ( \tau, (\mu) )</th>
<th>Less control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( q &gt; d )</td>
<td>( q &lt; d )</td>
<td>( q &gt; d )</td>
</tr>
<tr>
<td>Transfer price</td>
<td>+</td>
<td>-</td>
<td>+ (-)</td>
</tr>
<tr>
<td>MNF’s export</td>
<td>+</td>
<td>+</td>
<td>+ (-)</td>
</tr>
<tr>
<td>Firm 2’s output</td>
<td>-</td>
<td>-</td>
<td>- (+)</td>
</tr>
<tr>
<td>Total output</td>
<td>+</td>
<td>+</td>
<td>+ (-)</td>
</tr>
</tbody>
</table>

Note that the signs depend on several assumptions made: i) the outputs produced by each firm are strategic substitutes (see Bulow, Geanakoplos, and Klemperer, 1985); ii) the second-order conditions hold and the ‘extended Cournot equilibrium’ is unique.
In some cases, the effects on the decision variables depend on whether the MNF overinvoices or underinvoices. Firstly, the export subsidy affects directly only the MNF’s marginal revenue with respect to the output export and this effect is positive independent on the regime \( \Pi_{Ys}^{M} = 1 - \tau \). The output export affects, in turn, negatively the firm 2’s production independent on the regime \( \Pi_{XY}^{2} = p' + p''X < 0 \) whereas its effect on the transfer price depends on the regime \( \Pi_{Y}^{M} = \tau - \mu \). Therefore, the export subsidy increases the MNF’s output export and decreases firm 2’s production independent of the regime. But it increases (decreases) the transfer price in the overinvoicing case (in the underinvoicing case). Secondly, the less control affects directly only the MNF’s marginal revenue with respect to the transfer price and this is the regime-dependent \( \Pi_{qL}^{M} = -\xi_{q}B_{qL} \). But since the transfer price has the regime-dependent effect on the MNF’s export as well, the effect of the less control on the MNF’s export and the firm 2’s production is the regime-independent. A more lenient attitude towards the MNF’s transfer pricing (an increase in L) thus increases the MNF’s output export and decreases firm 2’s production independent of the regime, whereas it increases (decreases) the transfer price in the overinvoicing case (in the underinvoicing case).

The tax rate in country 1 (country 0) positively (negatively) affects the transfer price in both cases; thus, for example, an increase in the profit tax rate in the parent company’s home country increases the transfer price since in this way the MNF can reduce its tax burden. The tax rates have direct effects on the MNF’s both marginal revenue functions. Since e.g. the \( \Pi_{Yq}^{M} \) and \( \Pi_{Y\tau}^{M} \) are the regime-dependent but \( \Pi_{q\tau}^{M} \) is the regime-independent, the effect of the tax rate, \( \tau \), on the MNF’s output export (on firm 2’s production) is positive (negative) in the overinvoicing case; in the
under invoicing case the effects are the opposite. The effects of the tax rate in country 0, $\mu$, and that in country 1, $\tau$, are opposite, since only the difference between tax rates matters.

Proposition 1:

i) The effect of the export subsidy and the control effort on the transfer price depend on whether the MNF overinvoices or underinvoices, whereas the tax rate in the parent firm’s home country positively affects the transfer price in both regimes.

ii) The effect of the export subsidy and the control effort on the MNF’s output export and on firm 2’s production are same in both regimes, but the effect of the tax rates vary according to the regime.

3. OPTIMAL POLICY UNDER VERTICAL INTEGRATION

Recent work in the theory of international trade has shown that imperfect competition creates an additional motive, referred to as ‘profit-shifting’, for the use of trade policy instruments such as tariffs and subsidies. Spencer and Jones (1991; 1992) examine the implications of vertical integration without transfer pricing for the profit-shifting trade policy. Here we introduce transfer pricing, i.e., profit-shifting by the MNF, into the profit-shifting trade policy.

The welfare function of country 1 consists only of the MNF’s after-tax profits and government’s net income. Consumer surplus does not matter since output markets are assumed to be perfectly segmented. The government’s net income depends on the regime, i.e. whether the profit tax rate in country 1
is higher or lower than in country 0. When the MNF overinvoices (underinvoices) it is country 1 (country 0) that wants to control transfer pricing by imposing a penalty, since then the MNF's tax avoidance is harmful to country 1 (country 0).

So in the over invoicing case, the government's net income depends positively on profit tax revenue and on the transfer price penalty, and negatively on the export support and the direct public resource cost, \( \varphi(L) \), (with \( \varphi' < 0 \)) of administering the tax-enforcement system. In the under invoicing case, in turn, the government's net income depends only on the profit tax revenue and the export support, since country 0 has to pay the direct cost of administering the tax-enforcement system to get the penalty.

*The over invoicing case*

Let us first consider the optimal policy in the over invoicing case. In this partial equilibrium analysis the welfare function is

\[
W^1 = \pi^1 + (1-\mu)\pi^0 - sY - \varphi(L).
\]  

Country 1 sets an output exporting subsidy \( s \), a profit tax rate \( \tau \), and its attitude towards transfer pricing \( L \) to maximize welfare as in (10). After using equation (8) the optimal values of \( s \), \( \tau \), and \( L \) satisfy (11), (12), and (13), respectively,

\[
\frac{\partial W}{\partial s} = (p'Y)X_s[\tau\alpha(q-d)+s]Y_s-(\mu Y)q_s = 0,
\]  

(11)
\[ \frac{\partial W}{\partial \tau} = (p'Y)X_L - \tau \alpha(q-d) + s)Y_L - (\mu Y)q_L = 0, \]  
\[ \frac{\partial W}{\partial L} = (p'Y)X_L - \tau \alpha(q-d) + s)Y_L - (\mu Y)q_L - \varphi' = 0, \]

where the effects of instruments on output export and produced and transfer price can be seen from Table 1.

Consider first equation (11). The first two terms, when \( \tau = 0 \) or \( \alpha = 1 \), capture the Spencer and Brander result (1983) that an export subsidy increases welfare in the exporting country when there is Cournot competition between two firms in different countries. When the tax rates in countries 1 and 0 are positive and when they differ, two more terms appear in the optimal conditions. The second term, when \( s = 0 \), measures how the excess value of input trade changes due to changes in input import (or output export), i.e. \((q-d)dY\). The tax weight follows from that the change in the output export affects the parent company's gross profits at rate of \(-\alpha(q-d)\), when the MNF optimizes, and the affiliate's gross profits at rate of \((q-d)\). Since country 1 takes into account the parent's gross profits and the affiliate's net profits, the net welfare effect of the export subsidy via the excess value of input trade, when the transfer price is constant, is thus \(-\alpha\tau(q-d)Y_s\) where \(\tau = 1 - \mu - \alpha\). The third term comes from that the transfer price affects the parent's gross profits at rate of \(-Y\) and the affiliate's net profits at rate of \((1-\mu)Y\). The net welfare effect via the transfer price is thus \(-\mu Yq_s\).

We know from Table 1 that the first term, "the strategic effect", in equation (11) is positive, since an increase in the export subsidy decreases firm 2's production, increasing the output price and thus the
value of the MNF’s export, whereas the last term is negative since an increase in export subsidy increases the transfer price which lowers (increases) the MNF’s profits belonging to country 1 (country 0). If this latter profit-shifting effect, called profit-shifting due to transfer pricing, is larger than the profit-shifting effect due to Cournot competition, the optimal export subsidy is negative, i.e. country 1 should tax output export. The higher the domestic profit tax rate is the higher the export tax is at optimum. If profit-shifting due to Cournot competition dominates over profit-shifting due to transfer pricing, then the term $\alpha \tau (q-d)+s$ is positive at optimum, implying that the optimal export subsidy can be positive or negative. The lower the domestic tax rate is the more likely the domestic country should subsidize export.

The domestic tax rate affects welfare via the same mechanisms as the export subsidy. Since the domestic profit tax rate positively affects the MNF’s output export and the transfer price and negatively affects firm 2’s production, the first term in (12) is positive and the third term is negative. As in the case of optimal export subsidy the results depend on the relative size of two profit-shifting effects. Let us evaluate the optimal domestic profit tax rate at $s = 0$, i.e., the domestic country cannot use the export subsidy for some reason. Then an interior solution for the domestic tax rate is only possible when the profit-shifting due to Cournot competition is larger than the profit-shifting due to transfer pricing. In the opposite case, only the corner solution where the domestic tax rate is equal to the foreign tax rate is optimal.

Finally, a more lenient attitude towards transfer pricing affects the MNF’s export, the firm 2’s production and the transfer price qualitatively the
same way as the export subsidy does. Therefore, a more lenient attitude towards transfer pricing increases welfare via profit-shifting due to Cournot competition and via reducing administrative cost. But it decreases welfare via profit-shifting due to transfer pricing.

**Proposition 2:** Assume that the domestic tax rate is higher than the foreign tax rate.

i) If profit-shifting due to Cournot competition is smaller than profit-shifting due to transfer pricing, the domestic country should tax output export. In the opposite case the optimal export subsidy can be either positive or negative.

ii) Assume that the export subsidy is zero. Then an interior solution for the domestic tax rate is only possible when profit-shifting due to Cournot competition is larger than profit-shifting due to transfer pricing.

iii) The more lenient attitude towards transfer pricing affects welfare via the same mechanisms as the export subsidy and the tax rate.

The economic interpretation is clear. Consider, for example, the tax rates. The higher the difference between \( \tau \) and \( \mu \) the higher the domestic output export and the lower firm 2’s production. This shifts excess profits due to Cournot competition from country 2 to the domestic country. However, the high tax rate increases the MNF’s incentive to shift profits from the domestic country to country 0 using the transfer price. Thus there is trade-off between those two profit-shifting mechanisms.

Let us next consider the optimal policy mix. When the export subsidy is set at its optimal level, condition (11) can be substituted into (12) and (13). Due to the proportional property that \( X_s / Y_s = X_\tau / Y_\tau = X_L / Y_L = -\Pi_{XY}^2 / \Pi_{XX}^2 \).
i.e. the instruments affect the rival's production only indirectly via changing the MNF's marginal revenue function with respect to the output export, equations (12) and (13) reduce to

\[
\frac{q_{\tau}}{Y_{\tau}} = \frac{q_s}{Y_s},
\]

\[
\phi' = -(\mu Y)Y_L \left( \frac{q_L}{Y_L} - \frac{q_s}{Y_s} \right),
\]

respectively. Thus the domestic tax rate should be set such that the effect of \( \tau \) on the transfer price divided by its effect on the output export is equal to the effect of \( s \) on the transfer price divided by its effect on the output export. Since all these effects are positive in this regime, an interior solution is possible. How should the government decide its attitude towards transfer pricing? Since the direct public resource cost of administering the tax-enforcement system matters (\( \phi' < 0 \)) and since \( Y_L > 0 \), the government's attitude towards transfer pricing should be determined such that the effect of \( L \) on the transfer price divided by its effect on the output export is higher than the effect of \( s \) on the transfer price divided by its effect on the output export.

The general result is that the optimal policy mix includes an interior solution for each instrument considered, i.e. the export subsidy, the tax rate, and the control level are not perfect substitutes for welfare maximization. This follows from the penalty schema, implying that each instrument very differently affects the MNF's marginal revenue with respect to the transfer price; thus \( q_s/Y_s \neq q_{\tau}/Y_{\tau} \neq q_L/Y_L \). Without the transfer price penalty schema, given that the transfer price has a constant upper
limit instead of the interior solution, a government can affect the outcome of game between Cournot competitors by simply affecting the production decision of the vertically integrated oligopoly using profit taxation; it does not need to use trade policies to achieve this result. This follows i) from that the transfer price is constant and ii) from that the export subsidy and the tax rate affect only the MNF's marginal revenue.

Proposition 3:
i) The export subsidy, the tax rate, and control efforts are not perfect substitutes for welfare maximization; each of these instrument has to be utilized in order for the government to achieve the optimum.

ii) Without the transfer price penalty schema, a government can use either the export tax or the tax rate to affect outcome of game between Cournot competitors.

The under invoicing case

In this case the welfare function is

\[ W^1 = \pi^1 + (1-\mu)\pi^0 - sY - \beta(L,q-d)\zeta, \] (16)

since the MNF has to pay a potential penalty to country 0. Country 1 sets an output exporting subsidy (s) and a profit tax rate (\(\tau\)) to maximize welfare as in (16). After using equations (7) and (8), the optimal values of s and \(\tau\) satisfy (17) and (18), respectively,

\[ \partial W/\partial s = (p'Y)X_s - [\tau\alpha(q-d) + s]Y_s - (\tau Y)q_s = 0, \] (17)
\[ \frac{\partial W}{\partial \tau} = (p'Y)X_{-\tau}[\tau\alpha(q-d)+s]Y_{-\tau}(\tau Y)q_\tau = 0, \] (18)

where the effects of instruments on output export and produced and transfer price can be seen from Table 1. In addition to the mechanisms described in the overinvoicing case, the export subsidy and the domestic tax rate affect the welfare by changing the probability of imposition of the transfer price penalty. Since the MNF optimizes with respect to the transfer price, then 
\[ \mu Y + \xi \beta_q = \tau Y, \] i.e. the sum of the effect of transfer price on the profit taxes charged by country 0 and the effect of transfer price on the MNF’s expected loss due to the penalty reduces to the effect of transfer price on the profit taxes charged by country 1.

We know from Table 1 that the first term, "the strategic effect", in equation (17) as well as the last term, the profit-shifting due to transfer pricing, is positive. The latter follows from that an increase in the export subsidy decreases the transfer price, decreasing country 0’s tax revenue and increasing the parent’s profits. Thus both profit-shifting mechanisms call for export subsidy, since \( \alpha \tau(q-d) \) is non-positive. In equation (18) both profit-shifting mechanisms call for a positive term \([\alpha \tau(q-d)+s]\), since \( X_{-\tau} > 0, Y_{-\tau} < 0, \) and \( q_{-\tau} > 0 \). Assume that \( s = 0 \). Then there is only a corner solution for the domestic tax rate (e.g., \( \tau = 0 \)), since by lowering the tax rate country 1 can decrease firm 2’s output production and the transfer price, and increase the MNF’s output export and thus shifts profit due to both Cournot competition and transfer pricing to itself. As in the overinvoicing case, both instruments are relevant at optimum in this regime.
Proposition 4:

i) Both the strategic behavior of Cournot competitors and the MNF's profit shifting motive call for the export subsidy.

ii) Assume that $s = 0$. Then the domestic tax rate should be set to zero.

4. CONCLUSION

In this chapter we have considered an international duopoly model, which integrates a transfer pricing and a strategic trade policy model. The model includes two profit shifting motives: one follows from Cournot competition and the other from vertical integration. The chapter shows that the vertical integration of one firm has a substantial impact on an international duopoly when profit tax rates applied in a multinational firm's parent company's home country and in its affiliate's home country differ, implying, in turn, changes in strategic trade policy.

The following policy instruments of an output exporting country where vertical integration occurs have been studied: an export subsidy, a profit tax rate, and a government's attitude towards transfer pricing. The main results are: 1) The optimal policy includes the effective role for each instrument considered if the government controls transfer pricing by imposing a penalty. Without the transfer price penalty schema, a government can use either the export subsidy or the tax rate to affect outcome of game between Cournot competitors. 2) In the over invoicing case, the output exporting country should tax export, if the profit-shifting due to transfer pricing is higher than the profit-shifting due to Cournot competition. 3) In the under invoicing case, both the strategic behavior of Cournot
competitors and the MNF’s profit-shifting behavior call for an export subsidy.

The chapter leaves room, of course, for further work. First, it will be interesting to examine the private incentives for an MNF to export an intermediate product to a higher cost rival, lowering its rival’s cost (see Spencer and Jones 1991; 1992). Second, it is a familiar result from the analysis of duopoly behavior for a single product that a Cournot firm sets output too low, and a Bertrand firm too high, relative to the optimal behavior of a welfare maximizer. But what effect assumptions about firms’ conduct have on this model is still a question?
REFERENCES


APPENDIX A: Effects of instruments on output production and transfer price.

The comparative statics can be calculated from the following matrix equation:

\[
\begin{bmatrix}
    dq \\
    dY \\
    dX
\end{bmatrix}
= \frac{1}{|A|} \begin{bmatrix}
    \Delta & -\Pi^M_{qY} & \Pi^2_{XX} & -\Pi^M_{qY}\Pi^M_{XX} \\
    -\Pi^M_{qY}\Pi^2_{XX} & \Pi^M_{qY} & \Pi^2_{XX} & -\Pi^M_{qY}\Pi^M_{XX} \\
    \Pi^M_{XY} & -\Pi^M_{qY}\Pi^2_{XY} & \Pi^2_{XY} & -\Pi^M_{qY}\Pi^M_{XY} \\
    \Pi^M_{Yq} & -\Pi^M_{qY}\Pi^2_{XY} & \Pi^2_{XY} & -\Pi^M_{qY}\Pi^M_{XY} \\
\end{bmatrix}
\begin{bmatrix}
    ds \\
    d\tau \\
    d\mu \\
    dL
\end{bmatrix}
\]

where \(|A| = \Pi^M_{qY}\Delta - \Pi^M_{qY}\Pi^M_{YY}\Pi^2_{XX} (< 0), \Delta = \Pi^M_{YY}\Pi^2_{XX} - \Pi^M_{YY}\Pi^2_{XY} (> 0)\) and

\[
\begin{align*}
    \Pi^M_{qY} &= -\xi^q_{qq'}, \\
    \Pi^M_{qY} &= \tau - \mu, \\
    \Pi^M_{qY} &= 0, \\
    \Pi^M_{qY} &= Y, \\
    \Pi^M_{qY} &= -\xi^q_{qL}, \\
    \Pi^M_{qY} &= \tau - \mu, \\
    \Pi^M_{YY} &= (1 - \tau)(2p' + p''Y), \\
    \Pi^M_{YY} &= \alpha(q - d), \\
    \Pi^M_{YY} &= 0, \\
    \Pi^M_{YY} &= 0, \\
    \Pi^2_{XY} &= p' + p''X, \\
    \Pi^2_{XY} &= 0, \\
    \Pi^2_{XY} &= 0, \\
    \Pi^2_{XY} &= 0.
\end{align*}
\]
In considering comparative statics the following three assumptions are made. First, \( \Pi_{XY}^M \) and \( \Pi_{XY}^2 \) are negative, implying that given the transfer price, reaction functions in output space have negative slopes, or equivalently, that the outputs produced by each firm are strategic substitutes.\(^2\) Second, given the transfer price, the second-order conditions for profit maximization hold (as assumed in standard Cournot competition models): i.e. \( \Pi_{YY}^M < 0, \Pi_{XX}^2 < 0, \) and \( \Delta > 0. \) Third, the second-order conditions hold and the 'extended Cournot equilibrium' is unique: \( |A| < 0. \)

Note that the sufficient condition for \( |A| < 0 \) is \( \tau = \mu. \) Using (A1) and (7) one obtains

\[
q_s = (1-\tau)(\tau-\mu)(2p'+p''X-c'')/|A|, \tag{A2}
q_\tau = -[Y\Delta-\alpha(\tau-\mu)(q-d)(2p'+p''X-c'')]/|A| > 0,
q_\mu = [Y\Delta-(\tau-\mu)(q-d)(2p'+p''X-c'')]/|A| < 0,
q_L = \xi\beta_{qL}|A|,
\]

\[
Y_s = (1-\tau)\xi\beta_{qq}(2p'+p''X-c'')/|A| > 0,
Y_\tau = \xi[\beta_{q\mu}+\alpha(q-d)\beta_{qq}](2p'+p''X-c'')/|A|,
Y_\mu = -\xi[\beta_{q\mu}+(q-d)\beta_{qq}](2p'+p''X-c'')/|A|,
Y_L = -(\tau-\mu)\xi\beta_{qL}(2p'+p''X-c'')/|A|,
\]

\[
X_s = -(1-\tau)\xi\beta_{qq}(p'+p''X)/|A| < 0,
X_\tau = -\xi[\beta_{p\mu}+\alpha(q-d)\beta_{pqq}](p'+p''X)/|A|,
X_\mu = \xi[\beta_{p\mu}+(q-d)\beta_{pqq}](p'+p''X)/|A|,
X_L = (\tau-\mu)\xi\beta_{pL}(p'+p''X)/|A|.
\]

\(^2\)It is possible for the homogeneous outputs to be strategic complements (see Bulow, Geanakoplos, and Klemperer 1985). In the analysis of a Cournot oligopoly, this assumption is used in order to ensure stability (Hahn, 1962).
Chapter 3

A MULTINATIONAL FIRM WITH VERTICALLY RELATED MARKETS
AND AN INTERNATIONAL TRADE POLICY

ABSTRACT. One way to extend the standard oligopoly model in international trade is to assume that international differences in the cost of production of a key intermediate product can mean that a firm in one country is dependent on supplies from a vertically integrated firm (VIF) in other country. Here the VIF is a multinational firm (MNF) whose affiliate in a third country produces the input. This chapter integrates the profit-shifting motive and strategic behavior of the foreign MNF and considers the incentives for the MNF to supply the input to its domestic rival when the firms compete in a Cournot market for the final product. The vertical supply decision is significantly affected by i) domestic supply conditions for the input, ii) domestic tariffs on imports, and iii) profit tax rates in foreign and third country. The main focus is, however, the optimal trade policy of three countries, as well as the optimal policy of customs unions. Independent of whether a MNF vertically forecloses or vertically supplies inputs to its rival the global government optimally should tax both firms such that their true output price-marginal cost margins are positive and of equal size when consumer surpluses and welfare distribution between countries do not matter. JEL classification: 612, 820.

1. INTRODUCTION

One way to extend the standard oligopoly model in international trade is to assume that international differences in the cost of production of a key intermediate product can mean that a firm in one country is dependent on supplies from a vertically integrated firm in other country. Spencer and
Jones (1991 and 1992) analyze an international duopoly in which a vertically integrated foreign firm producing both input and output competes with a domestic firm in Cournot (or Bertrand) market for a final product. The foreign vertically integrated firm produces a key intermediate product at lower cost than the domestic vertically integrated firm (or delivers of the domestic firm) implying that the domestic firm may be dependent on supplies from the foreign firm. Spencer and Jones do not postulate corporate taxation in their model. However, in several cases corporate tax rates in input and output production sectors may differ causing transfer pricing under which, depending on tax rate differentials, a vertically integrated firm over or underinvoices the input price. The transfer price problem without strategic behaviour in output markets has been discussed by e.g. Kant (1990).

This chapter generalizes the model by Spencer and Jones by taking into account the transfer price problem. For this reason, the foreign vertically integrated firm is assumed to be the multinational firm (MNF) whose affiliate in a third country produces a key intermediate product. This generalization is quite realistic; many large companies produce their inputs, raw materials or intermediate products in developing countries where profit tax rates are very low compared to taxes in industrial countries.

When profit tax rates in the foreign and the third country differ, the profit-shifting motive affects the strategic behavior of the MNF, since the input price is the only instrument by which the MNF can shift its profits from the higher profit tax country to the lower profit tax country and since the model contains only one effective input price. In Spencer and
Jones's model, there is only one input price, since if a vertically integrated foreign firm supplies inputs to its rival, the price charged should be same as prevailing in domestic country given that the rival buys part of its input from its domestic market. Here we assume, in addition, that the transfer price in the MNF's internal trade should be same as the input price paid by the MNF's rival.

The argument in favour of one input price is that governments in the MNF's parent company's home country and its affiliate's home country know the input price paid by a rival firm and use this price as the effective input price in their profit taxation. If this assumption is thought to be too restrictive, it can be relaxed by introducing the penalty schema proposed by Kant (1990), who assumes that the probability of the transfer price penalty which governments may impose on the MNF depends positively on the absolute difference between the transfer price reported by the MNF and the government estimate of the marginal input production cost. If one wanted to introduce the transfer price penalty schema, one should assume that the input price paid by the rival firm affects the government estimate of the affiliate's marginal input production cost. This would give an additional degree of freedom to the MNF in transfer pricing, but at the same time it would make the analyses too complicated.

Following Spencer and Jones we first examine briefly the private incentives for the MNF to export an intermediate product to its higher cost rival, lowering the rival's cost. We then consider the public interest of the countries. Note that changes in the model structure affect the instrument set of the countries analyzed by Spencer and Jones. Since this model contains three countries it is possible to allow the countries to form
customs unions. The optimal policy of the three different customs unions are considered in addition to the policy of single countries. European integration and the formation of the North American Free Trade Association ensure the relevance of studies of the behavior of these customs unions.

The most extreme form of dependence on a vertically integrated supplier has been considered by assuming that the MNF controls the exports of both the input and the final product. Differences in production costs are assumed to arise as a consequence of international differences in endowments and technologies. If the rival firm has access to the input, either through its own production (for simplicity the rival firm is assumed to be vertically integrated) or through imports, then the sales of the homogeneous final product are assumed to be determined by Cournot competition. If the rival firm in the importing country has no independent source of supply, vertical foreclosure gives the exporting firm a monopoly of the final product market. The MNF is assumed to be able to act first, by committing itself to an export strategy for the input prior to the decision of the high cost firm as to its own level of production of the input and to the resolution of the Cournot game for the final input. The credibility of a commitment to the quantity exported supplies is supported by the idea that it takes time to export the input and that these supplies must be available to the rival at the same time of production of the final good. In choosing its export strategy, the exporting firm takes into account i) its rival’s reaction, including the possibility that the rival will alter its own level of production of the input and ii) that the input price paid by its rival affects its own profit taxation. This has the advantage that the vertical supply (or foreclosure) decision is made with a full understanding of its consequences.
In the model there are two types of instrument: trade policy instruments (tariffs, export taxes and subsidies, and subsidies on home production) and profit tax rates. The effects of the trade policy instruments are discussed in this chapter, whereas the effects of profit tax rates are analyzed in the next chapter. Since we have divided the analysis of the model into two parts, mainly for practical reasons, they are of course interrelated, implying that we must refer to the results to be derived in chapter 4 in this chapter.

The structure of this chapter follows that in the Spencer and Jones papers. The basic model is described in section 2. Section 3 is concerned with the Cournot equilibrium for the final product and Section 4 with the conditions under which the exporting foreign MNF will supply its rival with the input. Section 5 considers the optimal policy of the output exporting country in the case where the welfare function consists of consumer and producer surplus and the government's tax and tariff revenue. In section 6 we compare the optimal trade policy of different countries and customs unions in the simplified case where output markets are perfectly segmented and objective functions depend only on producer surplus and government tax revenue. Section 7 contains a summary and concluding remarks.

2. A MODEL

MNF in country 1 exports a final product to country 2 in competition with a higher-cost rival, firm 2, located in country 2. MNF has an affiliate in country 0, which produces an intermediate product for a parent firm and
also (potentially) exports its lower-cost intermediate product to country 2, reducing its rival's cost. Firm 2 has the opportunity of producing the input itself at higher cost than the MNF. The structure of the model is presented in figure 3 in chapter 1.

Technological relationships are simplified by assuming that one unit of the intermediate product is required to produce one unit of the final product with linear cost function and that there are no other factors of production. The affiliate produces the input at a constant marginal cost $a^0$, whereas firm 2 can produce its own supplies of the input only at an increasing marginal cost $s^2_x$.

The subgame-perfect equilibrium incorporates two stages of decision. In stage 1, the MNF commits itself to the price $r$ to be charged to its rival for the input. Equivalently, the MNF could commit itself to quantity $x$ of its export of the input to its rival at this stage. Note, that the MNF knows its profit taxation being based on the input price level in country 2.\(^1\) So, at the same time, it commits itself to the price $r$ to be used as the effective input price in its internal trade. The quantity of exports of the input inside the MNF is $y^1$ so that the quantity of exports of the input

\(^1\) Although we have specified the firm 2 to be vertically integrated, this is not necessary. The input could be produced by a perfectly competitive industry in country 2 as well. So input price in country 2 can be interpreted as market price. If the MNF supply inputs to its rival then international customs statistics reveal the price charged. Thus although the affiliate's marginal cost is private knowledge the rival's marginal cost is public one. Therefore, the MNF can under or overinvoice with respect to the affiliate's marginal cost but cannot w.r.t. the rivals' marginal cost.
to firm 2 is \( x = x^0 - y^1 \), where \( x^0 \) is total production of the input of the affiliate. The quantity of exports \( x \) and the price charged for these exports are related by the requirement that the demand for \( x \) by firm 2 equals the supply at \( r \). In the stage 2 outputs of the final product are determined by Cournot competition. Firm 2 produces the final product using the cost-minimizing combination of imported supplies and its own production \( x^2 \) of the input in stage 2.

The MNF exports the quantity \( y^1 - z^1 \) to country 2, where \( y^1 \) is the MNF's total production of the output and \( z^1 \) is total consumption of the output in country 1. Firm 2's production of the output is \( y^2 \). At equilibrium, \( y^1 + y^2 = z^1 + z^2 \), where \( z^2 \) is total consumption of the output in country 2. The final product is not consumed in country 0. Perfectly unsegmented output markets imply that the output price has to be same in both countries.

Country 1 is assumed to commit itself to the policy of a specific subsidy \( s^1 \) on final product exports and a specific tariff \( u^1 \) on input imports at stage 0. Country 2 is assumed to commit itself to a specific tariff \( t^2 \) and \( u^2 \) on imports of the final product and the input respectively, and a specific subsidy \( w^2 \) on firm 2's own production of the input at stage 0. Country 0 may adopt specific taxes \( v^1 \) and \( v^2 \) on exports of the input to countries 1 and 2 respectively, at stage 0. When firms optimize they take the values of each instrument of other countries as given.

Gross profits of parent firm, affiliate, and firm 2 are \( \pi^1 \), \( \pi^0 \) and \( \pi^2 \), respectively. Gross profits of the MNF is \( \pi^M = \pi^1 + \pi^0 \). Profits tax rates in each country are \( \tau^1 \), \( \tau^0 \) and \( \tau^2 \) respectively. After-tax profit of firm 2 is
\[ \Pi^2 = (1-\tau^2)\pi^2. \] After-tax profit of the MNF depend on the tax system in country 1, i.e. whether taxation is based on a residence principle or source principle.\(^2\) In what follows we will analyze the most general after-tax profit function (country 1 follows the source principle) of the MNF, namely \(\Pi^M = (1-\tau^1)\pi^1 + (1-\tau^0)\pi^0.\) Results under the residence principles are special cases from results under the source principles and are therefore discussed after the general results.

3. THE FINAL GOODS MARKET

The price \(p\) of the final good in country 1 and country 2 is given by the inverse demand curve \(p = p(Y)\) where \(p'(Y) < 0\) and \(Y = y^1 + y^2\) represents aggregate output. The gross profits of the parent company are

\[ \pi^1 = p\,z^1 + (p-\tau^2+s^1)(y^1-z^1)-ry^1. \] (1)

Due to a tariff and a subsidy the effective price of exports of the final good may differ from the price of domestic consumption. In what follows we assume that \(z^1 = z^1(p)\) with \(z^1_p = \partial z^1(p)/\partial p < 0.\)

The gross profits of the affiliate are, since \(x^0 = y^1 + x,\)

\[ \pi^0 = (r-u^1-v^1-d^0)y^1 + (r-u^2-v^2-d^0)x. \] (2)

---

\(^2\)The following three cases are possible:

i) residence principle: \(\tau^1 > \tau^0\), with full tax credit: \(\Pi^M = (1-\tau^1)(\pi^1 + \pi^0),\)

ii) resid. princ.: \(\tau^1 < \tau^0\), with partial tax cred.: \(\Pi^M = (1-\tau^1)\pi^1 + (1-\tau^0)\pi^0.\)

iii) source principle: \(\Pi^M = (1-\tau^1)\pi^1 + (1-\tau^0)\pi^0.\)
If tariffs on imports of the input differ between country 1 and country 0 the effective prices of exports to country 1 and to country 0 differ.

Therefore, the MNF’s after-tax profit function (in the general case) can be written as:

\[
\Pi^M = (1-\tau^1)(\bar{z}^1+[p-\bar{c}-(1-\alpha)r-\alpha d^1]y^1) + (1-\tau^0)(r-d^2)x,
\]

(3)

where the net output tariff is \( \bar{c} = t^2-s^1 \) and the relative tax factor is \( \alpha = (1-\tau^0)/(1-\tau^1) \), measuring how the MNF values a marginal increase in the affiliate’s profit relative to a marginal increase in the parent’s profit.

\( d^i \equiv u^i+v^i+d^0 \), both \( i=1,2 \), is the marginal cost (after policy affecting input trade from country 0 to country i) of input production in country 0.

Since \( x = y^2-x^2 \) and defining \( \delta^2 \) as the cost of firm 2’s own supplies of inputs, the gross profits of the firm are

\[
\pi^2 = py^2-r(y^2-x^2)+w^2x^2-\delta^2(x^2).
\]

(4)

We first consider firm 2’s choice between using its own or imported supplies of the inputs. Firm 2 produces \( x^2 \) (\( \geq 0 \)) so as to maximize

\[
\Pi^2 = (1-\tau^2)\pi^2,
\]

where \( \pi^2 \) is given in equation (4) for given levels of \( y^1, y^2 \) and \( r \). The first order condition is

\[
r+w^2-\delta^2_x(x^2) \leq 0 \ (= 0 \text{ if } x^2 > 0),
\]

(5)

where \( \delta^2_x(x^2) \) represents firm 2’s marginal cost of production of the input. If firm 2 produces the input, equation (5) implicitly defines the supply of
the input: $x^2 = x^2(r+w^2)$ with $x_1^2 > 0$ (using subscripts to represent partial derivatives).

At the stage 2 Cournot equilibrium for the final good, the MNF sets its output $y^1$ to maximize (3), given $y^2$ and the prior committed values of government instruments. Similarly, firm 2 chooses $y^2$ to maximize its after-tax profit, given $y^1$ and the values of government instruments. The first order conditions are

$$\Pi^1_1 = (1-\tau^1)[iz^1p' + p'y^1 + p - (1-\alpha)r - \alpha d^1] = 0, \quad (6)$$

$$\Pi^2_2 = (1-\tau^2)(p-r + p'y^2) = 0. \quad (7)$$

Equation (6) shows how the profit-shifting motive of the MNF, which arises from the difference in profit tax rates, $1-\alpha \neq 0$, affects the output production; when $\tau^1 > \tau^0 \iff 1-\alpha < 0$ the input price positively affects the MNF's marginal revenue. Solving (6) and (7) simultaneously, the Cournot equilibrium levels of output can be expressed as a function of $r$, $i$, and $u^1 = u^1+v^1$, i.e. $y^1 = y^1(r,i,u^1)$ and $y^2 = y^2(r,i,u^1)$. Country 2's import tariff $u^2$ and production subsidy $w^2$ do not directly affect output production. However, since the taxes $u^2 = u^2+v^2$ reduce the amount that the MNF gets for its exports of the input, they affect the equilibrium by changing the price charged for the input. The subsidy $w^2$ affects the price $r$ by changing firm 2's demand for the inputs. To determinate comparative static effects (derived in Appendix A) we have assumed, as usual, that the second order conditions for profit maximization hold and the Cournot equilibrium is unique and that one firm's own marginal profit declines with an increase in the output of the other firm (see Bulow et al, 1985), i.e.
\( \Pi_{11}^M < 0; \Pi_{12}^M < 0; \Pi_{22}^2 < 0; \Pi_{21}^2 < 0 \) and \( \Pi_{11}^M \Pi_{22}^2 - \Pi_{12}^M \Pi_{21}^2 > 0 \). To get the unambiguous effects of the input price on the output produced we have to assume in addition:

Assumption 1: The profit tax rate in countries 1 and 0 are assumed to be restricted such that i) \( 2 - \alpha > 0 \);
ii) \( 1 - \alpha < [(1 - \tau^2) \Pi_{12}^M] ÷ [(1 - \tau^1) \Pi_{22}^2] = (\Gamma + p' + p'' y^1)/(2p' + p'' y^2) > 0 \);
iii) \( 1 - \alpha < [(1 - \tau^2) \Pi_{11}^M] ÷ [(1 - \tau^1) \Pi_{21}^2] = (\Gamma + 2p' + p'' y^1)/(p' + p'' y^2) > 0 \);
where \( 1 - \alpha = (\tau^0 - \tau^1)/(1 - \tau^1) \) and \( \Gamma = i_z p (p'')^2 + i_z p p'' \).

These restrictions follows from the fact i) that the input price affects both the MNF's and firm 2's marginal revenue and ii) that the sign of effect of the input price on the MNF's marginal revenue depends on the difference between tax rates. It is shown in Appendix A that the condition i) implies \( Y_r < 0 \); the condition ii) implies \( y_r^1 > 0 \); and the condition iii) implies \( y_r^2 < 0 \). Note that Spencer and Jones's (1991) analysis satisfies all above conditions, since then \( \tau^1 = \tau^0 \). If \( \tau^1 > \tau^0 \), the conditions ii) and iii) are satisfied for sure, but the condition i) can be violated. If both tax rates are less than half, the condition i) is satisfied.

Table 1: Comparative statics for output produced.

<table>
<thead>
<tr>
<th></th>
<th>MNF's output</th>
<th>Firm 2's output</th>
<th>Total output</th>
</tr>
</thead>
<tbody>
<tr>
<td>input price</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>output export subsidy</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>import tariff</td>
<td>-</td>
<td>+</td>
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</tr>
<tr>
<td>input trade tax</td>
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</tr>
</tbody>
</table>

The effects of the output export subsidy and the output import tariff on
output produced are familiar from the Brander and Spencer type models. Since the input trade taxes increase the MNF’s output production cost they affect negatively MNF’s output and positively the rival’s output. Under Assumption 1 the input price affects positively the MNF’s output and negatively the rival’s output such that its effect on the total output produced is negative.

As in Spencer and Jones (1991) what is of importance in the following is the sign \( \Pi_{2}^{M} \); the effect of an increase in firm 2’s output on the MNF’s profits holding \( y^{1} \) and \( r \) fixed. Let \( M(r, i, u^{1}, u^{2}) \) denote \( \Pi_{2}^{M} \) when the outputs are at their Cournot equilibrium levels; thus from (3) using (6)

\[
M(\cdot) = (1 - \tau^{0}) (r - d^{2}) - (1 - \tau^{1}) (p - \bar{i} - \alpha d^{1}) - (\tau^{1} - \tau^{0}) r. \tag{8}
\]

\( M(\cdot) \) depends on the difference in after-tax profit margins from the affiliate’s export of the inputs to the firm 2 and the parent company’s export of the output to country 2. The term \( (\tau^{1} - \tau^{0}) r \) arises from the fact that if the profit tax rates differ and if \( \tau^{0} \) is relevant for the MNF the transfer price affects the after-tax profit of the MNF. If \( \tau^{0} = \tau^{1} \) or country 1 follows the residence principle and \( \tau^{1} > \tau^{0} \) (see footnote 2), expression (8) reduces in principle to the same as as in the Spencer and Jones’s paper. The effect of the input price on \( M(\cdot) \) is

\[
M_{r} = (1 - \tau^{1}) (1 - p' Y'_{r}). \]

In what follows we assume that \( M_{r} > 0. \)

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4. THE EXPORT MARKETS FOR THE INPUT

In this section we will follow Spencer and Jones’s analysis and will discuss only those aspects which differ from their results. Firm 2’s derived demand for imported supplies is firm 2’s output of the final good at the Cournot equilibrium less its own production of the input:

\[ x(r, i, u^1, w^2) = y^2(r, i, u^1) - x^2(r + w^2), \]  

(9)

where \( x_r = y_r^2 - x_r^2 < 0 \) from (5) and since \( y_r^2 < 0 \). Vertical foreclosure occurs if the MNF charges a prohibitive price for the input, denoted as \( r^P \), at which firm 2’s demand for imported supplies is forced to zero. Setting \( x(\cdot) = 0 \) implicitly defines the foreclosure price as a function \( i, u^1, \) and \( w^2 \) where

\[ r^P_i = -y_i^2 / x_i > 0; \quad r^P_{u^1} = -y_{u^1}^2 / x_r > 0; \quad r^P_{w^2} = x_{w^2}^2 / x_r < 0. \]  

(10)

An increase in the output export subsidy and a reduction in the input and output import tariffs all increase the MNF’s output produced, decreasing firm 2’s output and the price \( r^P \) at which firm 2 ceases to use imported supplies. The input production subsidy \( w^2 \) increases firm 2’s input production and thus decreases the price \( r^P \). Note, that the MNF cannot use a price higher or lower than \( r^P \) as a transfer price, since \( r^P \) is the price prevailing in country 2 and countries 1 and 0 are assumed to apply the price \( r^P \) to their taxation. Thus the upper limit of the input price is \( r^P \). That is \( r \leq r^P \).

We now turn to the MNF’s stage 1 choice of the price \( r \) to charge its rival
for the input. Taking into account the second stage relationship, the MNF’s profits are a function of the input price \( r \) as well as tariffs and subsidies set by the three governments. In stage 1, the MNF sets price \( r \) to maximize profit subject to \( x \geq 0 \).⁴ Thus we exclude the possibility that firm 2 imports input to the MNF. At vertical supply equilibrium from (3) and (6) and since \( (1-\tau^1)(1-\alpha) = \tau^0 \tau^{-1} \)

\[
\Pi^M_r = (1-\tau^0)((r-d^2)\bar{x}_r + x) + (1-\tau^1)(iz^1_p + p'y^1_y)\bar{y}_r + (\tau^1 - \tau^0)y^1_y = 0. \tag{11}
\]

There are two extra terms in condition (11) as compared to the optimal condition of the input price in Spencer and Jones’s (1991) analysis. The first is the term \( (\tau^1 - \tau^0)y^1_y \) which follows from the direct effects of the input price on the MNF’s after-tax profits. The second is the term \( iz^1_p > 0 \), which takes into account the effect of change of consumption in country 1 on the MNF’s profits. The second term in (11) captures the “strategic effect” of \( r \) on the profits earned from output produced. In the case of perfectly segmented output markets this effect is positive, since an increase in the input price decreases firm 2’s production, increasing the output price and thus the value of the MNF’s production. When these

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⁴To obtain the conditions for a maximum, define \( L = \Pi^M + \mu x \). The foc w.r.t. \( r \) is then \( L_r = \Pi^M_r + \mu x_r = 0 \) and \( L_{\mu} = x \geq 0, \mu \geq 0, L_{\mu \mu} = 0 \). We assume that \( \Pi^M_r \) is strictly concave for all \( r \leq r^P \). If demand and supply functions are linear then the second order condition is \( \Pi^M_r = (1-\tau^1)(2-p'Y^1_x)_r y^2_r - 2(1-\tau^0)_r x^2_r + (\tau^1 - \tau^0)_r Y^1_r \), except at \( r + w^2 \leq \delta^2_x \), where \( \Pi^M_r \) is continuous but not differentiable. However, \( \Pi^M_r \) remains strictly concave in \( r \) at \( \delta^2_x - w^2 \), since \( x^2_r = 0 \) for \( r + w^2 \leq \delta^2_x \) and \( x^2_r > 0 \) for \( r + w^2 \geq \delta^2_x \), making the left-hand derivative \( \Pi^M_{rr} \) less negative than the right-hand derivative. To consider the sign of \( \Pi^M_{rr} \) we first note that \( x^2_r > 0, y^2_r < 0 \) and \( Y^1_r < 0 \). Second, \( (2-p'Y^1_x) > 0 \), so that the sufficient condition for stability is \( \tau^1 - \tau^0 > 0 \).
markets are perfectly unsegmented the strategic effect is positive if 
\[ \varepsilon(z)_{p}^{1} + py_{1}^{1}/(iz_{1}) > 0, \] where \( \varepsilon(z)_{p}^{1} \) is the price elasticity of demand in 
country 1. The size of the strategic effect is higher the more inelastic 
demand is, the higher the value of MNF's production and lower the level of 
consumption in country 1 is. Vertical foreclosure occurs when \( \Pi_{r}^{M} > 0 \) at 
r = \( r^{D} \). Thus the higher the strategic effect and the higher the difference 
of the profit tax rates between the countries 1 and 0 is, the more likely 
it is that the MNF refuses to supply inputs to its rival.

Let us now turn to consider how trade policy instruments affect first the 
input price and second the MNF's vertical supply and foreclosure decision. 
First, condition (11) defines the input price as a function \( r(\bar{t},u_{1},u_{2},w) \) 
of the government policies set previously at stage 0. Comparative statics 
more general than in Spencer and Jones (1992) are derived in Appendix B. We 
know that without any additional assumptions

\[ r_{s_{1}} = -r_{s_{2}}; r_{u_{1}} = r_{u_{2}}; r_{u_{2}} = r_{v_{2}} > 0; \text{ and } r_{w_{2}} < 0. \]  
(12)

Thus the effects of the output trade taxes and of the input trade taxes, 
affecting input trade to country 1, on the input price are ambiguous, in 
general.\(^5\) We know, however, that the effect of the output export tax (i.e. 
\( -s_{1}^{1} \)) set by country 1 on the input price is equal to the effect of the 
output import tariff set by country 2 on the input price, since only the

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\(^5\) However, if we assume linear demand functions: \( r_{s_{1}} > 0 \), iff 
\( \alpha > (4-3\gamma^{*})/(5+3\gamma); \text{ and } r_{u_{1}} < 0 \), iff \( \alpha > 4/5 \), where 
\( \gamma^{*} \equiv z_{1}^{p}p^{1}(1-z_{1}^{p})^{-1} > 0. \) Thus if the tax rate in country 1 is higher than 
in country 0 an increase in output export subsidy increases the input price 
and an increase in input import tariff decreases it.
output subsidy-tariff margin affects the MNF’s and firm 2’s behaviour and thus determination of the input price. Since only the total amount of input trade taxes, targeted to import of country 1, has an effect on firms’ behaviour, \( r_{u1} = r_{v1} \). The input price depends positively (negatively) on the input trade taxes, affecting to trade to 2, (the input production subsidy), since an increase in the trade tax (a reduction in the input production subsidy) increases the MNF’s marginal revenue with respect to the input price.

Second, the MNF engages in vertical supply if and only if a reduction in \( r \) below the foreclosure price \( (r^P) \) increases its overall profits; i.e. if and only if from (11) using \( x_1 = y_1^2 x_1^2 \), \( x = 0 \) and (8),

\[
\Pi^M_r(r^P, \cdot) = M(r^P, \cdot) y_1^2 (1-\tau^0)(r^P-d^2) x_1^2 + (\tau^1-\tau^0) y_1^1 < 0.
\] (13)

When \( \tau^1 = \tau^0 \) or \( \tau^1 > \tau^0 \) and country 1 follows the residence principle the third term vanishes in (13) and from (8) one obtains that \( M(\cdot) = (1-\tau^1)(r-d^2-(p-i-d^1)) \). Since the export of input to country 2 is profitable and \( y_1^2 < 0 \) and \( x_1^2 > 0 \), the sufficient condition for the MNF supplying its rival is \( M(\cdot) > 0 \) at foreclosure price. This is the result in Spencer and Jones (1991). When \( \tau^1 \neq \tau^0 \) and \( \tau^0 \) is relevant for the MNF, if \( \tau^0 > \tau^1 \) (\( \tau^0 < \tau^1 \)) the third term in (13) is negative (positive) and the third term in (8) is positive (negative). The tax difference thus affects incentive to vertical supply, firstly, by changing the effect of rival’s production (constant \( y_1^1 \) and \( r \)) on the MNF’s profit and secondly, by changing the the effect of the input price (constant \( y_1^2 \)) on the MNF’s profit.
In their first paper (1991) Spencer and Jones consider the effects of conditions in the output importing country on the vertical supply and foreclosure decision. In addition to the trade policy, two aspects of local production conditions prove to be important for the vertical foreclosure decision: the total quantity of input supplies available at the foreclosure price and the responsiveness of these supplies. They present three propositions. The first one considers the case when it is prohibitively expensive to produce the input in country 2. When \( s^1 = \tilde{u}^1 = 0 \), it shows that i) in the absence of a tariff, the vertically integrated firm (VIF) will vertically foreclosure, and ii) a small tariff on imports of final product will induce the VIF to supply its rival with the input. This should not be surprising: with no production of the input in country 2, vertical foreclosure prevents the entry of firm 2, giving the VIF a monopoly of the market for the final product. The second and third propositions examine the case when the input is available in the output importing country. The second one shows that i) under linear demand and supply conditions, an exogenous increase in firm 2’s production of the input at the foreclosure price increases the VIF’s incentive for vertical foreclosure, and ii) a sufficient large tariff on imports on the final product will induce vertical supply. Whereas the third one shows that an exogenous increase in the responsiveness of input supply in country 2 with respect to input

\[ ^6 \text{In their second paper (1992) Spencer and Jones show that the vertically integrated firm (VIF) charges its rival a price for the input that exceeds the independent monopoly supplier level when the import tariff on the final product be below the prohibitive level, at which the final good imports are reduced to zero. This follows from the fact that the VIF takes into account that an increase in the price charged the rival for imported supplies reduces rival’s production, increasing the price that the VIF receives for its product.} \]
price, at the foreclosure price, increases the VIF’s incentive for vertical supply.

It can be shown that our extension to allow a vertically integrated firm to be a multinational firm and to take the transfer price effect into account does not change the qualitative results of Spencer and Jones’s second and third propositions. Therefore, we turn to their first proposition to consider whether the tax rates matter. To determine the effects of supply conditions in the output importing country it is useful to relate the effects of firm 2’s production on the MNF’s profits, holding \( y^1 \) and \( r \) fixed, to the quantity of local supplies of input in that country. From (7) (setting \( y^2 = x^2(r^2w^2) \) and \( s^1 = u^1 = 0 \)) and from (8)

\[
M(t) = (1-\tau^1)(r^P-p+\tau^2)-(1-\tau^0)u^2 = (1-\tau^1)(p^x-x^2+\tau^2)-(1-\tau^0)u^2. \tag{14}
\]

Suppose that it is prohibitively expensive to produce the input in country 2; that is \( x^2(r^P+w^2) = 0 \). The MNF supplies the inputs to its rivals when from (13) and (14)

\[
[(1-\tau^1)t^2-(1-\tau^0)u^2]y^2+(\tau^1-\tau^0)y^1 < 0. \tag{15}
\]

The term in the squared brackets, i.e. the difference between effective tariffs, can be obtained from equation (14) by setting \( x^2 = 0 \), i.e. it is the effect of an increase in firm 2’s output on the MNF’s profits, holding \( y^1 \) and \( r \) fixed, when firm produces no input. The second term is the direct effect of the input price on the MNF’s profit, i.e. the transfer price effect. Thus we have obtained:
Proposition 1: (assume $s^1 = u^1 = u^2 = 0$). Suppose that it is prohibitively expensive to produce the input in country 2,
i) when $\tau^1 = \tau^0$ any small tariff on output will induce the MNF to supply its rival with the input,
ii) but when $\tau^0 > \tau^1$ the MNF will vertically supply even in absence of tariffs; in contrast when $\tau^1 > \tau^0$ any small tariff on output will not induce the MNF to supply its rival with input.

The first condition is identical with the result in Spencer and Jones, 1991. The second one follows from that when $\tau^0 > \tau^1$ the MNF has an incentive to decrease the input price to transfer part of its profits to country 1, whereas the opposite case it has an incentive to increase the input price.

Consider, finally, the case of vertical supply ($\Pi^M_r = 0$ in (11)). The effects of firm 2's production on the MNF's profits, holding $y^1$ and $r$ fixed, at a vertical supply equilibrium is strictly positive (negative), i.e. $M(\cdot) > 0$ ($< 0$) if $(1 - \tau^0)[(r - d^2)\lambda x^2 - x] - (\tau^1 - \tau^0)y^1 > 0$ ($< 0$). Thus the output produced in country 1 does not affect after-tax profit margin when $\tau^1 = \tau^0$, i.e. when the transfer price effect does not matter. In the next section, we turn to the optimal policy of the output exporting country.

5. OPTIMAL POLICY OF THE OUTPUT EXPORTING COUNTRY

This section is concerned with policy incentives in the output exporting country. We consider a subsidy ($s^1$) on final product exports as well as a tax ($u^1$) on imports of the input. The welfare function in country 1
consists of three parts; first, consumers’ utility and other sectors of the economy; second, the MNF’s net profits and third, government income. The welfare function is:

\[ W^1 = U(z^1)p + \Pi^M - s^1(y^1 - z^1) + u^1 + R^1, \]  

where \( R^1 \) is the profit tax revenue of country 1. Depending on the tax system prevailing in country 1 (see footnote 2), the expression of \( R^1 \) differs. However, independent of the tax system in country 1,

\[ \Pi^M + R^1 = \pi^1 + (1 - \tau^0)\pi^0. \]

The output exporting country sets \( s^1 \) and \( u^1 \) to maximize welfare as in (16). In the case of vertical foreclosure, where exports of the input to firm 2 are zero, the subsidy on final product exports satisfies (see Appendix D)

\[ \frac{\partial W^1}{\partial s^1} = W^1_{s^1} + W_{s^1}^1p^1 = -z^1p'(\partial Y/\partial s^1) + [s^1(\partial y^1/\partial s^1) + \tau^2(\partial y^2/\partial s^1)]p^1 \]
\[ \quad + p^1y^1(\partial y^2/\partial s^1) - (s^1 - u^1)(\partial y^1/\partial s^1) \]
\[ \quad - \tau^1\alpha(r^p - d^1)(\partial y^1/\partial s^1) - \tau^0y^1_{s^1}p^1 = 0, \]

where \( r^p_{s^1} < 0, \quad \partial y^1/\partial s^1 = y^1_{s^1} + y^1_{r^p_{s^1}} > 0, \quad \partial Y/\partial s^1 = Y^1_{s^1} + Y^1_{r^p_{s^1}} > 0, \]

\[ ^7 \text{Consumer utility is assumed to be based on the additive utility function, } V = U(z^1) + F^1, \text{ where } U(z^1) \text{ is the utility from the consumption of } z^1, \text{ and } F^1 \text{ is the utility from the consumption of a numeraire good ensuring that the marginal utility of income is equal to 1. The marginal product of labour in the production of } z \text{ is assumed to be constant, fixing a wage rate } (\omega^1) \text{ and a wage bill } (\omega^1L), \text{ since } L \text{ is constant. Setting total income (including the tariff revenue, the subsidy payments and the profit tax revenue as well as the MNF’s net profits) at equal to total expenditure the welfare function is (16) when constant variables } F^1 \text{ and } \omega^1L \text{ are left out.} \]
\[ \frac{\partial y^2}{\partial s^1} = y^2_s + y^2_r^p s^1 < 0 \] and \[ d^1 = u^1 + \nu^1 + d^0. \]

The first row measures domestic consumption effects, i.e. effects of \( s^1 \) on consumer surplus and on the value of export subsidy and tariff costs, which are due to changes in domestic consumption. The second row shows the Spencer and Brander (1983) result (when \( u^1 = 0 \)) that an export subsidy increases welfare in the exporting country when there is Cournot competition between two firms in different countries. The last two terms are new ones measuring the net effects (relevant for country 1) of \( s^1 \) on total surplus from input trade from country 0 to country 1, since

\[ \frac{\partial}{\partial s^1} (r-d^1)y^1 = (r-d^1)(\partial y^1 / \partial s^1) + y^1 r^s. \]

The tax weights follow from that a change in input import affects the parent’s gross profits at rate of

\[ -\alpha (r-d^1) \]

and the affiliate’s gross profits at the rate of \( (r-d^1) \). Since country 1 takes into account the parent’s gross profits and the affiliate’s net profits, the net welfare effect of the input import via the value of input trade is thus

\[ -\alpha \tau^1 (r-d^1)(\partial y^1 / \partial s^1), \]

where

\[ -\tau^1 \alpha = 1 - \tau^0 \alpha. \]

The input price affects the parent’s gross profits at rate of \( -y^1 \) and the affiliate’s net profits at rate of \( (1-\tau^0)y^1 \). The net welfare effect is thus

\[ -\tau^0 y^1 r^p s^1. \]

The sign of the output export subsidy at optimum depends on the input import tariff and the tax rates. To evaluate their role let us consider the last two rows. The first term in the second row is positive, since an increase in the export subsidy decreases firm 2’s output, increasing the output price and thus the value of the MNF’s production, as well as the last term in the third row, since an increase in the export subsidy decreases the input price, decreasing country 0’s profit tax revenue and thus increasing the parent’s gross profits. In contrast, the first term in the last row is negative when \( r^p > d^1 \), since the MNF maximizes its net
profits whereas country 1 maximizes the parent’s gross profits. The sign of the tax difference $s^1-u^1$ is, thus, ambiguous. Since an increase in $u^1$ increases $d^1$ and thus decreases the effect of the output export subsidy via the MNF’s output on the value of input trade, the higher the input import tariff, the higher the output subsidy.

The tax rate in country 1 negatively affects the output export subsidy, since the lower the tax rate the more the MNF pays attention to its parent company’s gross profits. The low tax rate thus reduces the harmful welfare effect coming from the change in the value of input import. The high tax rate in country 0 provides an incentive to country 1 to reduce the affiliate’s profits by reducing the input price. Therefore the higher the tax rate in country 0 and the lower the tax rate in 1, the higher the optimal export subsidy.

How should country 1 set the input import tariff? It can be shown that the welfare effect of the input import tariff, $u^1$, is positive when the output export subsidy, $s^1$, is set at its optimum. Firstly, an increase in $u^1$ increases country 1’s tariff revenue (at the rate of $y^1$) and decreases the MNF’s profits (at rate of $(1-\tau^0)_y^1$), thus increasing the welfare at rate of $\tau^0y^1$. Secondly, $u^1$ affects welfare via the output produced by the MNF and firm 2, as $s^1$ does. Since both $s^1$ and $u^1$ affect the behaviour of firms only by changing the MNF’s marginal revenue with respect to output produced the proportional property that $y^1_s/y^1_u = y^2_s/y^2_u = -(1-z^1_p)/\alpha \equiv -\gamma$ holds.

After having multiplied the optimal condition for $u^1$, i.e.

$$\partial W^1/\partial u^1 = W^1_u + W^1_{r^1} = 0,$$

by the term ($\gamma$) we can substitute the condition (17) into it to get $\partial W^1/\partial u^1 = \gamma^0y^1 > 0$. One candidate for the corner solution is that $\pi^0 = 0$ implying $r^p_d^1 = 0$ and therefore $u^1 = r^p_v^1 - d^0$.
In the case of vertical supply, the optimal value of \( s^1 \) satisfies
\[
\frac{\partial W^1}{\partial s^1} = W^1_{s^1} + W^1_{r^1 s^1} = 0
\]
and the optimal value of \( u^1 \) satisfies
\[
\frac{\partial W^1}{\partial u^1} = W^1_{u^1} + W^1_{r^1 u^1} = 0.
\]
Since \( \gamma W^1_{u^1} = -W^1_{s^1} + \gamma y^1 \), the optimal value of \( u^1 \) satisfies (18b), i.e.
\[
W^1_{r^1 (r^1 s^1 + \gamma u^1)} + \gamma y^1 = 0,
\]
when \( s^1 \) is set at its optimum and when the condition \( \Pi^M_r = 0 \) is taken into account in the expression of \( W^1_{r^1} \).

The condition (18b) can be substituted back into the optimal condition for \( s^1 \) to get (18a), i.e.
\[
W^1_{s^1} - \gamma y^1 [r^1_{s^1} / (r^1 s^1 + \gamma u^1)] = 0, \quad r^1_{s^1} + \gamma u^1 \neq 0^8
\]

\[
\frac{\partial W^1}{\partial s^1} = -z^1 p' Y^1_{s^1} + (s^1 y^1_{s^1} + \tau^2 y^2_{s^1})z^1 p' + p'y^1 y^1_{s^1} - (s^1 u^1) y^1_{s^1}
\]
\[
+ (1-\tau_0)(r-d^2) y^2_{s^1} - \alpha \tau (r-d^1) y^1_{s^1} - \tau^0 y^1 [r^1_{s^1} / (r^1 s^1 + \gamma u^1)] = 0,
\] (18a)

\[
\frac{\partial W^1}{\partial u^1} = \left( -z^1 p' Y^1_r + (s^1 [y^1_r + (1-\tau^1) y^2_r] + \tau^1 r^2 y^2_r) z^1 p' + \tau^1 p' y^1 y^1_r
\]
\[
- (s^1 u^1) y^1_r - \alpha \tau (r-d^1) y^1_r - \tau^1 y^1 (r^1 s^1 + \gamma u^1) \right) + \tau^0 y^1 = 0,
\] (18b)

where \( Y^1_r < 0, y^2_r < 0, y^1_r > 0, Y^1_{s^1} > 0, y^2_{s^1} < 0, y^1_{s^1} > 0 \), and, in the case of linear demand functions \( z^1(p) \) and \( z^2(p) \), \( r^1_{s^1} > 0, r^1_{u^1} < 0 \), and 
\( r^1_{s^1} + \gamma u^1 \) > 0 (see Appendix B).

At the general equilibrium, the optimal condition for the output export subsidy includes its effect via input and output production and consumption and its effect via the input price on welfare. This last effect vanishes if the tax rate in country 0 is zero, since then the direct welfare effect of 

\[ ^8 \text{Noted that } r^1_{s^1} + \gamma u^1 = 0 \text{ when } z^1_p = 0, \text{ i.e. consumption in country 1 is perfectly price inelastic or the output markets are perfectly segmented. In this case } u^1 \text{ should be set as high as possible to shift profits from country 0 to country 1.} \]
the input import tariff vanishes. The first two terms in (18a) take into
account the effects through consumption in country 1. The next two terms
show the Brander and Spencer result (in the case of constant input price).
The fifth term is the new one measuring the net effects (relevant for
country 1) of \( s^1 \) on the total value of the input trade to country 2. The
net effect comes from the fact that both country 1 and the MNF take into
account the share of \( (1-\tau^0) \) from the affiliate’s profits. The tax weight
related to the input trade to country 1 is \( -\tau^1 \alpha = 1-\tau^0 \alpha \), as in the case of
vertical foreclosure.

The optimal condition for the output export subsidy can be considered via
special cases. Assume first that \( \tau^1 = \tau^0 = 0 \). Then, if \( \tau^2 = 0 \), the first
and second terms are positive. Thus the sufficient condition for \( s^1 > u^1 \) is
that the effect of firm 2’s output on the MNF’s profits holding \( y^1 \) and \( r \)
fixed is negative, i.e. \( p’y^1+r-d^2 = M(r) < 0 \). Second, if \( \tau^1 > \tau^0 = 0 \), the
net effect of \( s^1 \) on total surplus from input import of country 1 emerges in
equation (18a). Since the MNF may overinvoice or underinvoice this term
cannot be signed. Finally, when \( \tau^0 > 0 \) and when demand functions are
linear, i.e. \( r_s < 0 \), the last term in (18a) gives additional reason to
subsidize output export.

At the general equilibrium, the optimal condition for the input import
tariff includes the effect of the input price on welfare and the direct
effect of the input import tariff on that part of the affiliate’s profit
belonging to country 0. The welfare effect of the input price, the large
brackets in (18b), include the six terms: the first two take into account
the effects contributed by country 1’s consumption and the last four are,
in principle, the same as the last two rows in equation (17), except that

73
the tax weights of the third and sixth terms differ. The different tax weights result from that the MNF’s optimal choice of the input price is substituted into equation (18b) and since the MNF maximizing its parent’s net profit and the government maximizing its gross profits.

The optimal condition for the input import tariff can be considered via special cases. Assume first that \( \tau_1^1 = \tau_0^0 = 0 \). Then from (18b)

\[ u^1 y_r^1 = s^1 y_r^1 + (z^1 - s^1 z_p^1) y_r \]

and therefore the sufficient condition for \( u^1 > s^1 \) is positive \( s^1 \). This is the result by Spencer and Jones (1991), when output markets are perfectly segmented. Second, when \( \tau_1^1 > \tau_0^0 = 0 \) the effect of the input price on country 1’s profit tax revenue, which the MNF does not take into account, appears in the condition for optimality.

Finally, if \( \tau_0^0 > 0 \), we have to take into account the direct effect of the input import tariff on that part of the affiliate’s profit belonging to country 0. Proposition 2 summarizes the section:

**Proposition 2:** If the output export subsidy is set at its optimum,

i) in the case of vertical foreclosure the input import tariff should be set so high that the affiliate makes no profits at all,

ii) in the case of vertical supply the above result is valid when the output consumption in country 1 is perfect price inelastic.

This follows from that the output export subsidy \( s^1 \) affects welfare only via the decision variables of the firms whereas the input import tariff \( u^1 \) has, in addition, the direct welfare effect, since country 1 pays attention to the affiliate’s net profits. In the case of vertical foreclosure, both the output export subsidy and the input import tariff affect the behaviour of firms only by changing the MNF’s marginal revenue (with respect to the
output produced) and therefore the proportional property that $y^1_s/y^1_u = r^1_s/r^1_u = -\gamma$ holds. This implies that when $s^1$ is set at its optimum the welfare effects of $u^1$ via the decision variables of the firms vanish and therefore the interior solution of $u^1$ is not valid due to its direct welfare effect. In the case of vertical supply, the proportional property, $r^1_s/r^1_u = -\gamma$, holds only if domestic consumption does not matter. When $r^1_s/r^1_u \neq -\gamma$, the interior solution for the input import tariff is possible.

6. OPTIMAL TRADE POLICY OF DIFFERENT COUNTRIES AND DIFFERENT CUSTOMS UNIONS

In this section we compare the optimal trade policy of different countries and customs unions to clarify how the strategic behaviour of firms and the profit-shifting motive of the MNF affect the behaviour of the governments. Customs union welfare is defined as the sum of its members' welfare. To simplify the analyses let us make the following assumptions: 1) every country's welfare function depends only on producer surplus and government tariff and tax revenue, 2) country 1 follows the source principle 3) output markets are perfectly segmented implying that $z^1$ stays constant in analysis and 4) the output demand function in country 2 is linear. Although these assumptions seem to be very restrictive, they are often used in the literature.

In Appendix E, the optimal conditions for each country and customs union are summarized in Tables E2 and E3. Table E2 (E3) shows the necessary conditions for optimality in the case where the MNF vertically forecloses
(supplies) its rival. We do not consider all cases in the text, but picking up mainly those studied by Spencer and Jones. This section is divided into two sub-sections, depending on whether the MNF forecloses or supplies.

A: Vertical foreclosure

Let us consider three cases more closely. First, the customs union consisting of countries 1 and 0, sets the output export subsidy \(s^1\) and the input import tariffs \(\tilde{u}^1\) to maximize their joint welfare function, i.e. \(W^{10} = W^1 + W^0 = \pi^1 + \pi^0 - s^1(y^1 - z^1) + u^1 y^1\). When the output export subsidy is at its optimum, policy instruments concerning input trade do not matter since profit-shifting between countries 1 and 0 makes no sense; thus \(\tilde{u}^1 = 0\).

The optimal value of \(s^1\) satisfies

\[
\frac{\partial W^{10}}{\partial s^1} = p^1 y^1 \left( \frac{\partial y^1}{\partial s^1} \right) \left[ s^1 - (1 - \alpha)(\tau^0 - d^0) \right] \left( \frac{\partial y^1}{\partial s^1} \right) = 0.
\]

(19)

Since the tax revenue shifting between countries 0 and 1 does not matter the tax weight of the volume effect on excess surplus from input trade is \(1 - \alpha = (1 - \tau^0) + \tau^0 \cdot \alpha\), where the tax weight \(1 - \tau^0\) \((\tau^0)\) measures how country 1 (country 0) values the affiliate’s gross profits whereas the relative tax factor \(\alpha\) measures how the MNF values a marginal increase in its affiliate’s profit relative to a marginal increase in its parent’s profit. If \(\alpha = 1\), i.e. \(\tau^1 = \tau^0\), the optimality condition of the output export subsidy is the same as analyzed by Spencer and Jones (1991), i.e. equation (19) shows the Brander and Spencer result that an export subsidy increases domestic welfare when there is Cournot competition between a foreign and a domestic firm. If \(1 - \alpha < 0\), i.e. \(\tau^1 > \tau^0\), the MNF wants to shift its profits to country 0 by importing in some extent more input to country 1 than in the
case of $\tau^0 \geq \tau^1$. This reduces the customs union's need to subsidize the output export to shift excess profits due to Cournot competition from country 2 to country 1. If $1-\alpha > 0$, i.e. $\tau^1 < \tau^0$, the MNF shifts profits from its affiliate to its parent company by reducing the input import or the output produced. This shifts excess profits due to imperfect competition to country 2. This gives an additional incentive to coalition to subsidize output export.

Second, country 2 sets the output import tariff and the input production subsidy to maximize $W^2 = \pi^2 + \tau^2(y^1 - z^1) - w^2x^2$. This is the case studied by Spencer and Jones (1992); while they do not consider the optimal policy, they do calculate the welfare effects of each instrument in turn. The optimal value of $\tau^2$ and $w^2$ satisfy

$$\frac{\partial W^2}{\partial \tau^2} = W_{\tau^2}^2 + W_{r^2}^2 = (p^2 + r^2)y_{t^2}^{-1} - w^2y_{t^2}^{-1} + (z^2 - y^2) = 0, \quad (20a)$$
$$\frac{\partial W^2}{\partial w^2} = W_{w^2}^2 + W_{w^2}^2 = (p^2 + r^2)y_{r^2}^{-1} - w^2y_{r^2}^{-1} = 0, \quad (20b)$$

respectively. Country 2 pays attention to three things: i) that firm 2 takes its rival production as given; ii) how the tariff affects the tariff revenue; and iii) how the input production subsidy changes the net cost of input support. Since $-y^2 > y^1 > 0$ and $-y^2 > y^2 > 0$ and if $z^2 - y^2 > 0$ as assumed, the system of two conditions implies that $\tau^2$ should be so high at optimum that $w^2$ becomes negative. It is then optimal for country 2 to subsidize the domestic firm and to prevent monopoly profits moving abroad.

---

9The equation (20b) follows from that $W_{w^2}^2 = -w^2x^2 = -w^2y^2 = 0$, $W_{r^2}^2 = (p^2 + r^2)y_{r^2}^{-1} - w^2y_{r^2}^{-1}$. When $w^2$ is at its optimum $W_{r^2}^2 = -w^2x^2$, which can be substituted into the first order condition for the output import tariff. This produces (20a), since $-w^2x_{t^2}^2 = w^2y_{t^2}^{-2}$. 77
through the output import tariff to the extent that part of the domestic firm's profits should be taxed by government. Note that when $t^2 = 0$, $w^2$ is positive at its optimum. When $z^2-y^2 = 0$, $w^2 = 0$ and $t^2 = -p'y^2$, i.e. the output import tariff should eliminate the inefficiency, coming from that firm 2 does not internalize the MNF's behaviour.

The global government, when consumer surpluses and welfare distribution between countries do not matter, uses only two policy instruments, namely the output export subsidy and the input production subsidy to maximize $W^G = \pi^1 + \pi^0 + \pi^2 - s^1(y^1-z^1)w^2x^2$. Since only the net output export subsidy $s^1 - t^2$ matters, $t^2$ can be set to zero. When the output export subsidy is at its optimum, policy instruments concerning input trade do not matter since profit-shifting between countries 1 and 0 makes no sense; thus $u^1 = 0$. The optimal value of $s^1$ and $w^2$ satisfy

\[ \frac{\partial W^G}{\partial s^1} = W^G_{s^1} + W^G_{r^2}p^1 = (p'y^1 - w^2)y^2_s + [p'y^2 + (1-\alpha)(r^P + d^1)s^1]y^1_s = 0, \]  \hspace{1cm} (21a)
\[ \frac{\partial W^G}{\partial w^2} = W^G_{r^2} + W^G_{r^1}p^2 = (p'y^1 - w^2)y^2_r + [p'y^2 + (1-\alpha)(r^P + d^1)s^1]y^1_r = 0, \]  \hspace{1cm} (21b)

respectively\(^{10}\). The global union should control three different inefficiencies, coming from the Cournot game in the output market and from profit shifting induced by the profit taxation. Since welfare effects are due to changes in the MNF's output export and firm 2's output produced and since the expression $(y^1_r - y^2_r - y^1_s)$ can be shown to be positive independent of the tax rates, the only solution of the equation system is that

\[ \text{\footnote{\textsuperscript{10}The equation (21b) follows from that}} \quad W^G_{w^2} = -w^2x^2_w = -w^2(y^2_r x^2_r + p'y^2_r + (1-\alpha)(r^P + d^1)s^1)y^1_r - w^2x^2_r. \text{ Thus } W^G_r = -w^2x^2_r, \text{ when } w^2 \text{ is at its optimum. This can be substituted into the first order condition for the output export subsidy. This produces (21a), since } -w^2x^2_r p^1_s = w^2y^2_s. \]
\[ s^1 = p'y^2+(1-\alpha)(p^0d^0) \] and \[ w^2 = p'y^1. \] Thus the global government should tax input production in country 2 to eliminate the negative effect of firm 2's production on the value of the MNF's output export. The sufficient condition for negative output export subsidy to the MNF is that the tax rate in country 1 be higher than that in country 0, since the difference \[ \tau^1 > \tau^0 \] induces the MNF to produce too much from global welfare point of view. By substituting the optimal choice of instruments into the first-order conditions of the firms' profit maximization one obtains
\[ p-d^0 = -p'(y^1+y^2) = p\delta^2, \] so that both countries should be taxed such that the output price-marginal cost margin of both firms is positive and of equal size. Proposition 3 summarizes the section:

**Proposition 3:** In the case of vertical foreclosure,

i) the customs union consisting of both the parent's and the affiliate's home country should subsidize the output export less (more) than the Spencer and Jones (1991) result suggests when \( \tau^0 < \tau^1 \) (\( \tau^0 > \tau^1 \)),

ii) country 2 should tax both output import and input production,

iii) the global government should tax both firms such that their true output price-marginal cost margins are positive and of equal size.

**B: Vertical supply**

The vertical supply case differs from the vertical foreclosure case in two ways. First, the effects of trade policy instruments on excess surplus from input trade to country 2 have to be taken into account. Second, whenever country 1 belongs to the customs union, the set of optimality conditions includes the necessary condition for optimality of the input price. We will consider the same three cases as in the case of vertical foreclosure more
closely. First, the customs union consisting of countries 1 and 0 sets the output export subsidy \( s^1 \) and the input export tax \( v^2 \) to maximize \( W^{10} = \pi^1 + \pi^0 - s^1 (y^1 - z^1) + v^2 (y^2 - x^2) \). The input trade taxes \( \tilde{u}^1 \) do not matter since profit-shifting between countries 1 and 0 makes no sense; thus \( \tilde{u}^1 = 0 \). The optimal value of \( s^1 \) and \( v^2 \) satisfies

\[
\begin{align*}
\frac{\partial W^{10}}{\partial s^1} &= [p^1 y^1 + (r-d^2) + v^2] y^2 \frac{y^1}{y^2} - [s^1 - (1-\alpha)(r-d^1)] y^1_{s^1} = 0, \quad (22a) \\
\frac{\partial W^{10}}{\partial v^2} &= \tau^1 p^1 y^1 \frac{y^2}{\bar{y}} - [s^1 - (1-\alpha)(r-d^1)] y^1 - (\tau^1 - \tau^0) y^1 + v^2 (y^2 - x^2) = 0. \quad (22b)
\end{align*}
\]

The condition \( (22a) \) includes three inefficiencies: firstly, the MNF plays the Cournot game with firm 2, and secondly and thirdly, the MNF may overinvoice/underinvoice the input trade both to country 1 and to country 2. Let us compare the condition \( (22a) \) with the condition \( (18a) \), where country 1 maximizes its own welfare. The tax weights of the three terms in the second row of the condition \( (18a) \) are \( 1 - \tau^0 \), \( -\alpha \tau^1 \) and \( \tau^0 \), respectively. If one adds the tax rate \( \tau^0 \) (note that \( W^1 \) depends on \( (1-\tau^0) \pi^0 \) whereas \( W^{10} \) on \( \pi^0 \)) to these weights, one obtains the tax weights 1, \( 1-\alpha \), and 0, respectively. The custom union maximizing the sum of \( W^1 \) and \( W^{10} \) thus values the price-cost margin of the input trade to country 2 \( (r-d^2) \) by the weight 1 and it values that of the input trade to country 1 \( (r-d^1) \) by the weight \( 1-\alpha \). The same way one can obtain \( (22b) \) from \( (18b) \).

By using \( (6) \) the optimal value of \( s^1 \) satisfies

\[-[s^1 - (1-\alpha)(r-d^1)] Y_{s^1} = 0. \text{ When } \alpha = 1, \text{ we obtain } \text{Spencer and Jones's} \ (1991) \text{ result that the export subsidy negatively depends on the difference in profit margins from the export of the intermediate and the final products to country 2. If } 1-\alpha < 0 \ (1-\alpha > 0) \text{ the MNF wants to shift its profits to country 0 (country 1) by importing in some extent more (less) input to}\]

80
country 1 than the case of \( \alpha = 1 \). This affects the customs union’s need to subsidize or tax the output export to shift excess profits due to Cournot competition from country 2 to country 1. Unfortunately, we cannot sign \( s^1 \) since the difference in profit margins can be positive or negative and since then MNF may overinvoice or underinvoice the input price.

To consider (22b) assume that \( \tau^1 = \tau^0 \). Then the optimal input export tax depends on \( s^1 \), i.e. \( \nu^2 = s^1 y^1_t / x^1_t \) as in Spencer and Jones (1991). The sign of \( \nu^2 \) depends thus on the sign of \( s^1 \): an active commercial policy requires a subsidy on both exports or a tax on both exports. When the tax rates differ several new terms emerge in the condition since the MNF considers its net profits whereas the coalition considers gross profits, so that no simple policy rule can be given.

Second, country 2 sets the output and input import tariffs and the input production subsidy to maximize \( W^2 = \pi^2 + t^2 (y^1 - z^1) + u^2 (y^2 - x^2) - w^2 x^2 \). The optimal value of \( t^2 \), \( w^2 \) and \( u^2 \) satisfy

\[
\begin{align*}
\frac{\partial W^2}{\partial t^2} &= (p^2 y^2 + t^2) y^1_t + u^2 y^2_t + (z^2 - y^2) - (y^2 - x^2)(r^2_t / r^2_u) = 0 \quad (23a) \\
\frac{\partial W^2}{\partial u^2} &= [(p^2 y^2 + t^2) y^1_t + u^2 y^2_t - (u^2 - w^2) x^2_t - x_t] r^2_u + x = 0 \quad (23b) \\
\frac{\partial W^2}{\partial w^2} &= 0 \iff u^2 + w^2 = -x / x^1_t \quad (23c)
\end{align*}
\]

respectively. The conditions (23) differ from the conditions (20), since the tariff revenue from the input import matters in the case of vertical supply. When \( x = 0 \), implying \( u^2 = -w^2 \), the conditions (23) reduces to the

\[1\]

The condition (23b) can be presented as \( W^2_t r^2 u^2 + x = 0 \). Since \( \frac{\partial W^2}{\partial t^2} = W^2_t + W^2_t r^2 t^2 = 0 \) and \( \frac{\partial W^2}{\partial w^2} = W^2_t r^2 (u^2 + w^2) x^2_w = 0 \), we can substitute (23b) into both conditions to get (23a) and (23b), since \( r^2_w / r^2_u = x^2_w / x^1_t \).
conditions (20). Equation (23c) shows that the sum of the input import tariff and the input production subsidy is positive since $u^2 + w^2 = -\frac{1}{\eta}e(\lambda)$, where $e(\lambda)$ ($< 0$) is the price elasticity of input import. Thus the inverse elasticity rule, common in different fields of public economics, determines the optimal input production protection and support. It is interesting to relate this to the result in the paper by Spencer and Jones (1992), where they have evaluated the effects of the input import subsidy (-$u^2$) on welfare at $t^2 = w^2 = u^2 = 0$. Their result is that a small input import subsidy increases welfare. Since the policy instruments affect welfare via many different canals, we cannot derive the signs of the instruments at optimum.

The global government, when consumer surpluses and welfare distribution between countries do not matter, has to use only three policy instruments, namely the output export subsidy, the input import tariff and the input production subsidy to maximize $W^G = \pi^1 + \pi^0 + \pi^2 + s^1(y^1 - z^1) + u^2(y^2 - x^2) - w^2 x^2$. The optimal values satisfy

\begin{align}
\partial W^G/\partial s^1 &= [p'y^1 + (r-d^2) + u^2] y^2_s + [p'y^2 + (1-\alpha)(r-d^1) - s^1] y^1_s = 0 \quad (24a) \\
\partial W^G/\partial u^2 &= [p'y^1 + (r-d^2) + u^2] y^2_r + [p'y^2 + (1-\alpha)(r-d^1) - s^1] y^1_r = 0 \quad (24b) \\
\partial W^G/\partial w^2 &= u^2 + w^2 + (r-d^2) = 0. \quad (24c)
\end{align}

The conditions (24a) and (24b) differ from the conditions (21a) and (21b) in the sense that now the effects of firm 2’s input import on the value of the input trade to country 2 and on the value of the input import tariff revenue appear in the conditions for optimality. Since the expression \[\text{condition (24b)}\]

\[\text{condition (24a) and (24c)}\]
$(y_{r}^{2}-y_{s}^{2}1)$ is positive independent of the tax rates, at optimum
$s^1 = p'y^2+(1-\alpha)(r-d^1); u^2+w^2 = -(r-d^2); \text{ and } w^2 = p'y^1$. Thus the export
subsidy and the input production tax should be set according to the same
rules as in the case of vertical foreclosure. The input import tariff
should be set such that the total input production support eliminates the
inefficiency due to that the MNF may overinvoice or underinvoice the input
trade to country 2. Substituting the optimal choice of instruments into the
first-order conditions of the firms’ profit maximization one obtains the
same result as in the case of vertical foreclosure: both firms should be
taxed such that the output price-marginal cost margin of both firms are
positive and of equal size. Proposition 4 summarizes the results.

*Proposition 4:* In the case of vertical supply,
i) if $\tau^1 \neq \tau^0$ the Spencer and Jones (1991) result that active commercial
policy of the customs union consisting of both the parent’s and the
affiliate’s home country requires a subsidy on both input and output export
or a tax on both exports are not valid in general,
ii) country 2 should support firm 2’s input production such that the sum of
the specific input import tariff and the specific input production subsidy
is positive,
iii) the global government should tax both firms such that their true
output price-marginal cost margins are positive and of equal size.

In this case we cannot obtain as clear results as in the case of vertical
foreclosure, since i) the effects of trade policy instruments on excess
surplus from input trade to country 2 have to be taken into account and ii)
the determination of the the input price differ considerably. Only the
global union behaves in the same way in both cases, i.e. it eliminates all
inefficiencies which the model involves.

We conclude the section by considering how the sum of the input import tariff and the input production subsidy in country 2 depends on economic integration. These instruments affect welfare of different countries directly and indirectly via the input price. Let us consider the case where countries 1 and 2 form the customs union as an example. Since i) $r_u^2 r_w^2 = x_w^2 r_r^{x^2}$, where $x_w^2 = x_r^{x^2}$ and ii) $\partial W_{12}^2/\partial u^2 = W_{r/r_2}^{12} + c^0 x = 0$ and $\partial W_{12}^2/\partial w^2 = W_{r/r_2}^{12} - [u^2 + w^2 + (1 - c^0)(r - d^2)]x_w^2 = 0$, we can substitute the condition for $u^2$ into the condition for $w^2$ to get that

$u^2 + w^2 = -(1 - c^0)(r - d^2) + c^0 x/r_r$, i.e. the total input production support depends on the effective input price-cost margin $(r - d^2)$ and the inverse elasticity term (note that $x/r_r = r/e(x)$, where $e(x)$ is the price elasticity of input import). These two terms can be derived as follows.

Firstly, an increase in $u^2$ increases country 2's tariff revenue (at the rate of input import $x$) and decreases the affiliate's profits at the same rate. The tax weights of these two effects depend on coalition structures.

Secondly, an increase in $w^2$ increases the net value of production support in country 2 (at the rate of $\partial [-u^2(y^2 - x^2) + w^2 x^2]/\partial w^2 = x^2 + (u^2 + w^2)x_w^2$), increases firm 2's profits (at the rate of $x^2$) and decreases the affiliate's profits (at the rate of $(r - d^2)x_w^2$). Again, the coalitions give different values to these three effects.

The tax weights of the effective input price-cost margin and the inverse elasticity term (see table 2) can be derived as follows. Since country 2 does not pay any attention to the affiliate's profits the input production support depends only on the inverse elasticity term. The customs union consisting countries 1 and 2 values the country 2's tariff revenue at the
rate of 1 and affiliate’s profits at the rate of $1-\tau^0$, implying the tax weight $\tau^0$ to the inverse elasticity term and the tax weight $1-\tau^0$ to the effective input price-cost margin. The customs union consisting countries 0 and 2 values the affiliate’s profits at the rate of $\tau^0$. Therefore the tax weight of $x/x_r$ is $1-\tau^0$ and $(r-d^2)$ is $\tau^0$. Finally, the customs union 102 takes into account the affiliate’s gross profit and thus $u^2+w^2 = -(r-d^2)$. Proposition 5 summarizes the result.

Table 2: The total input production protection in different coalitions.

<table>
<thead>
<tr>
<th>Coalition</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>country 2:</td>
<td>$u^2+w^2 = -x/x_r$</td>
</tr>
<tr>
<td>country 1 and 2:</td>
<td>$u^2+w^2 = -(1-\tau^0)(r-d^2)-\tau^0 x/x_r$</td>
</tr>
<tr>
<td>country 0 and 2:</td>
<td>$u^2+w^2 = -\tau^0 (r-d^2)-(1-\tau^0) x/x_r$</td>
</tr>
<tr>
<td>global union:</td>
<td>$u^2+w^2 = -(r-d^2)$</td>
</tr>
</tbody>
</table>

*Proposition 5*: The optimal input production protection and support for firm 2 in the different customs unions are the weighted sum of the inverse elasticity term and the difference between the input price and the marginal cost of input trade to country 2.

7. SUMMARY AND CONCLUSION

Many large firms have secured their access to important inputs by integrating backwards so as to produce the inputs within the corporation. If a vertically integrated firm can produce inputs at lower cost than its foreign rivals, this poses the question of whether the low-cost firm should supply a key input to rivals which are important producers of the final
product. In many cases vertically integrated corporations are multinational firms, whose affiliates produce inputs in developing countries where corporate profit tax rates are lower than in industrial countries. This incorporates the profit-shifting motive of the MNF into the strategic considerations, if the transfer price of the input in the trade inside the MNF has to be the same as the input price charged to the foreign rivals. This chapter analyzes a world where the MNF cannot segment the input markets.

In examining the conditions under which a low-cost vertically integrated MNF will export an input lowering the costs of a rival producer of the final product and will shift the profits between the parent and the affiliate company, this chapter considers the optimal trade policy of the three countries: the input importing and output exporting country (country 1), the input and output exporting country (country 2), and the input importing country (country 0). Moreover, the chapter analyzes the four cases in which the countries establish customs unions.

The results show that the roles of the trade policy instruments depend on 1) the objective functions, i.e. whether a country maximizes its own welfare or has formed customs unions with other countries, maximizing their joint welfare function, 2) what instruments a country or a customs union can use. Many instruments are needed to exploit excess profits originating from imperfect competition in the input and output markets and from transfer pricing due to corporate profit tax rates differentials in different countries.
REFERENCES


Holm, P., Multinational firm with vertically related markets and international tax policy, chapter 4 in this collection of essays.


APPENDIX A: Comparative statics for outputs produced.

Defining \( \Gamma = iz^1_{pp}(p')^2 + iz^1_{pp}p'' \) one obtains that

\[
\begin{align*}
\Pi_{11}^M &= (1-\tau^1)(\Gamma + 2p'p''y^1); & \Pi_{21}^2 &= (1-\tau^2)(p' + p''y^2) \\
\Pi_{12}^M &= (1-\tau^1)(\Gamma + p'p''y^1); & \Pi_{22}^2 &= (1-\tau^2)(2p' + p''y^2) \\
\Pi_{11}^M &= -(1-\tau^1)(1-\alpha); & \Pi_{2r}^2 &= -(1-\tau^2); \\
\Pi_{11}^M &= -(1-\tau^1)z^1_{p'p''}; & \Pi_{2i}^2 &= 0; \\
\Pi_{1u}^M &= -(1-\tau^1)\alpha; & \Pi_{2u}^2 &= 0.
\end{align*}
\]

In considering comparative statics we assume that \( \Pi_{12}^M \) and \( \Pi_{21}^2 \) are negative, implying that reaction functions in output space have negative slopes, or equivalently, that the outputs produced by each firm are strategic substitutes (Bulow, Geanakoplos, and Klemberer, 1985). In addition, the second order conditions for profit maximization are assumed to hold and the Cournot equilibrium is unique: \( \Pi_{11}^M < 0, \Pi_{22}^2 < 0 \), and \( H = \Pi_{11}^M \Pi_{22}^2 - \Pi_{12}^M \Pi_{21}^2 > 0 \). The comparative statics are

\[
\begin{align*}
y_r^1 &= \left[ (1-\tau^1)(1-\alpha)\Pi_{22}^2(1-\tau^2)\Pi_{12}^M \right] / H \\
y_r^2 &= -(1-\tau^1)(1-\alpha)\Pi_{21}^2 + (1-\tau^2)\Pi_{11}^M \right] / H \\
y_i^1 &= (1-\tau^1)(1-z^1_{p'p''})\Pi_{22}^2 / H \\
y_i^2 &= -(1-\tau^1)(1-z^1_{p'p''})\Pi_{21}^2 / H \\
y_u^1 &= (1-\tau^1)\alpha\Pi_{22}^2 / H \\
y_u^2 &= -(1-\tau^1)\alpha\Pi_{21}^2 / H.
\end{align*}
\]

\(\text{At equilibrium, } Y = z^1(p) + z^2(p) = z \Rightarrow p = p(Y). \text{ Thus } p' = \partial p/\partial Y = (z^1_p + z^2_p)^{-1}. \text{ Then } (1-z^1_{p'p''}) = z^1_p(z^1_p + z^2_p)^{-1} > 0.\)
APPENDIX B: Comparative statics for input price; vertical supply case.

Recall equation (11) \( \Pi_r^M = M(\gamma)r_y^2(1-\tau_0)(r-d_2)x_1^2+(1-\tau_0)(y_2-x_1^2)+(\tau_1-\tau_0)y_1^1 \),
where \( M(\cdot) = (1-\tau_0)(r-d_2)+(1-\tau_1)(p'p'p'y_1^1) \). From that \( \partial \Pi^M_r / \partial \Pi^r_r \) where \( I \) refers to trade policy instruments and \( \Pi^M_r \) is negative (footnote 4). Now since \( x_1^2 = 0 \)

\[
\Pi_r^M = M y_1^2 + M y_1^2 + (1-\tau_0)d_1^2 + (1-\tau_0)(y_1^2 - x_1^2) + (\tau_1 - \tau_0)y_1^1.
\]

(B1)

First, since \( y_1^2 = -y_2^2, M = -M, y_1^2 = -y_1^2 \), \( y_1^2 = -y_1^2 \), \( x_1^2 = x_1^2 = d_1^2 = 0 \), and second \( y_1^2 = y_1^2, M = M, y_1^2 = y_1^1 \), \( y_1^2 = y_1^1 \), \( y_1^2 = y_1^2 \), \( x_1^2 = x_1^2 \), \( d_1^2 = d_1^2 \), and third \( M = M, y_1^2 = y_1^2 \), \( y_1^2 = y_1^2 \), \( x_1^2 = x_1^2 \), \( d_1^2 = d_1^2 \),

\[
r_1^2 = -x_1^2; \quad r_1 = -y_1^2; \quad r_1^2 = -r_1^2.
\]

(B2)

Since \( \Pi^M_r = -(1-\tau_0)x_r \) and \( \Pi^M_w = -(1-\tau_0)x_w^2 \), \( r_1^2 > 0 \) and \( r_1^2 < 0 \) and

\[
r_1^2 / r_1^2 = x_1^2 / x_1^2
\]

To get some concrete results let us consider the case where demand functions \( z^1(p) \) and \( z^2(p) \) are linear. Then \( M = -(1-\tau_0)d_1^2 \)

\( +(1-\tau_1)(z_1^1p'p'y_1^1) \) and since from Appendix A \( y_1^2 = [1/(3p')](1+\alpha) \).
therefore \( y_1^2 = 0 \). Calculation gives

\[
\Pi^M_r = \frac{(1-\tau_1)^{\gamma}}{3p'} \left[ \frac{4}{3} - \alpha \gamma \right] \frac{1}{\gamma} \gamma \]

(B3)

where \( \gamma = (1 - z_1^1p') \alpha^{-1} \) and \( \gamma = \alpha \gamma \). Therefore, using \( \gamma = z_1^1p' \gamma \)

89
\[ r_s^1 > 0 \land r_t^2 < 0 \iff \frac{(1-\tau^0_t)}{(1-\tau^1_t)} > \frac{4/3 - \gamma^*}{5/3 + \gamma^*}, \quad (B4) \]

\[ r_u^1 < 0 \land r_v^1 < 0 \iff \frac{(1-\tau^0_t)}{(1-\tau^1_t)} > \frac{4}{5}. \]

From (B3) \( r_{s^1} + \gamma r_{u^1} = -(r_{t^2} - \gamma r_{v^1}) = \left( -\frac{1}{\Pi M} \right) \left[ \left( \frac{(1-\tau^1_t)}{3\gamma} \right) \left( \frac{-z^1_p}{\gamma} \right) (1+\alpha) \right] > 0. \)

**APPENDIX C: Effects of trade policy instruments on gross profits.**

The functions are, when \( d^1 \equiv u_{1}^1 + v_{1}^1 + d^0 \) and \( d^2 \equiv u_{2}^1 + v_{2}^1 + d^0 \),

\[ \pi^1 = (t^2 - s^1)z^1 + (p - t^2 + s^1 - r)y^1, \quad (C1) \]
\[ \pi^0 = (r - d^1)y^1 + (r - d^2)x, \quad (C2) \]
\[ \pi^2 = (p - r)y^2 + (r + w^2)x^2 - \delta^2(x^2), \quad (C3) \]

From (C1) using (6), from (C2), and from (C3) using (5) and (7) we get the following effects on profits:

**Input price r:**

\[ \pi^1_r = (iz^1_p + p'y^1)y^2_r - \alpha(r - d^1)y^1_r - y^1, \quad \pi^0_r = (r - d^1)y^1_r + (r - d^2)x + y^1 + x \]
\[ \pi^2_r = p'y^1_r - x \]

**Output export subsidy s^1 set by country 1:**

\[ \pi^1_s = (iz^1_p + p'y^1)y^2_s - \alpha(r - d^1)y^1_s + y^1 - z^1, \quad \pi^0_s = (r - d^1)y^1_s + (r - d^2)y^2_s \]
\[ \pi^2_s = p'y^1_s \]

**Input import tariff u^1 set by country 1:**

\[ \pi^1_u = (iz^1_p + p'y^1)y^2_u - \alpha(r - d^1)y^1_u, \quad \pi^0_u = (r - d^1)y^1_u + (r - d^2)y^2_u - y^1 \]
\[ \pi^2_u = p'y^1_u \]
Output import tariff $t_2^2$ set by country 2:
\[ \pi_{t_2}^1 = (\tau_{p_2}^1 p^1 + p^1 y_1^1) y_2^2 - \alpha (r-d_1^1) y_2^1 - y_1^1 + z_1^1 \]
\[ \pi_{t_2}^0 = (r-d_1^1) y_2^1 + (r-d_2^1) y_2^2 \]
\[ \pi_{t_2}^2 = p^1 y_2^1 y_2^1 \]

Input import tariff $u_2^2$ set by country 2:
\[ \pi_{u_2}^1 = 0 \quad \pi_{u_2}^0 = -x; \quad \pi_{u_2}^2 = 0 \]

Input production subsidy $w_2^2$ set by country 2:
\[ \pi_{w_2}^1 = 0 \quad \pi_{w_2}^0 = -(r-d_2^1) x_2^2 \quad \pi_{w_2}^2 = x^2 \]

Input export tax $v_1^1$ on trade to 1 set by country 0:
\[ \pi_{v_1}^1 = (\tau_{p_1}^1 p^1 + p^1 y_1^1) y_1^2 - \alpha (r-d_1^1) y_1^1 \]
\[ \pi_{v_1}^0 = (r-d_1^1) y_1^1 + (r-d_2^1) y_1^2 - y_1^1 \]
\[ \pi_{v_1}^2 = p^1 y_1^1 y_1^1 \]

Input export tax $v_2^2$ on trade to 2 set by country 0:
\[ \pi_{v_2}^1 = 0 \quad \pi_{v_2}^0 = -x \quad \pi_{v_2}^2 = 0 \]

**APPENDIX D: Optimal policy of the output exporting country.**

The exporting country sets $s^1$ and $u^1$ to maximize (16), subject to the constraint $x(\cdot) \geq 0$. Let $L^* = W^1(\cdot) + \mu x(\cdot)$, where $\mu \geq 0$ represents the Lagrange multiplier. At the maximum, $s^1$ and $u^1$ satisfy the first order conditions:

\[ \begin{align*}
\partial L^*/\partial s^1 &= \partial W^1/\partial s^1 + \mu (\partial x/\partial s^1) = 0; \\
\partial L^*/\partial u^1 &= \partial W^1/\partial u^1 + \mu (\partial x/\partial u^1) = 0; \\
\partial L/\partial \mu &= x \geq 0.
\end{align*} \tag{D1} \]

If $\mu > 0$, then $x = 0$ and from (9) $\partial x/\partial s^1 = x_r p_{s_1}^1 + y_{s_1}^2 = 0$ and $\partial x/\partial u^1 = x_r p_{u_1}^1 + y_{u_1}^2 = 0$; thus $\partial L^*/\partial s^1 = \partial W^1/\partial s^1$ and $\partial L^*/\partial u^1 = \partial W^1/\partial u^1$. We assume that the second order conditions $\partial^2 W^1/(\partial s^1)^2 < 0$, $\partial^2 W^1/(\partial u^1)^2 < 0$, and $[\partial^2 W^1/(\partial s^1)^2]_{s^1} - [\partial^2 W^1/(\partial u^1)^2]_{u^1} > 0$, are satisfied. These conditions hold if $p^{**}(Y) = 0$ and $x_{rr}^2 = 0$. When the definition
\[ W^1_r = -(z^1 s^1 \delta^1 p^1 \gamma r^1 + (z^1 p^1 + \gamma^1 y^1) y^1_r - \alpha^1 (r - d^1) y^1_r + (1 - \gamma^0) (r - d^2) x_r + (1 - \gamma^0) x - \gamma^0 y^1 \] is used, from (D1), (16) and appendix B, the optimal values \( s^1 \) and \( u^1 \) satisfy (since \( U' = p = 0 \))

\[
\frac{\partial W}{\partial s^1} = (s^1 z^1 p^1 - z^1 p^1 \gamma y^1_r + (z^1 p^1 + \gamma^1 y^1) y^2_s - (s^1 - u^1 + \alpha^1 (r - d^1) y^1_s
\]
\[ + W^1_{s} = 0, \quad (D2) \]

\[
\frac{\partial W}{\partial u^1} = (s^1 z^1 p^1 - z^1 p^1 \gamma y^1_u + (z^1 p^1 + \gamma^1 y^1) y^2_u - (s^1 - u^1 + \alpha^1 (r - d^1) y^1_u
\]
\[ + W^1_{u} = 0, \quad (D3) \]

Define \( \gamma = (1 - z^1 p^1) \gamma / \alpha \). From Appendix A we get \( y^1_s = -\gamma y^1_u; \quad y^2_s = -\gamma y^2_u \); and \( Y_s = -\gamma Y_u \). By substituting these into (D3) and then (D2) into (D3) one gets

\[
(r^1 + s^1 \gamma r^1) W^1_r + \gamma r^0 y^1 = 0. \quad (D4) \]

Thus the optimal values for \( s^1 \) and \( u^1 \) can be calculated from (D2) and (D4).

We have to analyze optimal conditions in two cases: first, when the MNF vertically forecloses and second, when it vertical supplies.

**Da:** Vertical foreclosure: \( r = r^p; \quad x = 0 \). Because from (10) \( r^p_s = -s^p_u \) and \( \gamma > 0 \) (see footnote 2), \( u^1 \) should be set as high as possible if \( \gamma^0 = 0 \) and when \( s^1 \) is at its optimum. One candidate for the corner solution is that \( \pi^0 = 0 \) implying \( u^1 = r^p - v^1 - d^0 \). A second is that \( u^1 = 0 \). Because from (10) \( r^p_s = -s^p_y / x^r \), (D2) reduces to

\[
\frac{\partial W^1}{\partial s^1} = (s^1 z^1 p^1 \gamma (\partial Y / \partial s^1) + (z^1 p^1 + \gamma^1 y^1) (\partial y^2 / \partial s^1)
\]
\[ - (s^1 - u^1 + \alpha^1 (r - d^1)) (\partial y^2 / \partial s^1) - \gamma^0 y^1 r^1_s = 0, \quad (D5) \]
where \( \partial Y/\partial s^1 = Y_s + Y_r p_s' \), \( \partial y^1/\partial s^1 = y_s^1 + y_r^1 p_s' \), \( \partial y^2/\partial s^1 = y_s^2 + y_r^2 p_s' \). Their signs can be derived as follows: we know from Appendix A that \( y_r^1 > 0 \), \( y_r^2 < 0 \), and \( Y_r < 0 \) in all cases under the assumption that every tax rate is less than half. Then from Appendix A we know \( y_s^1 > 0 \), \( y_s^2 < 0 \), \( Y_s > 0 \), and \( r_s^p < 0 \). This implies that \( \partial Y/\partial s^1 > 0 \) and since at \( r = r_s^p \) \( \partial x/\partial s^1 = 0 \) so that \( \partial y^2/\partial s^1 = x_s^2 r_s^p < 0 \) and therefore \( \partial y^1/\partial s^1 > 0 \).

\[ \text{Db: Vertical supply: } \Pi^M = 0. \text{ Since in general } r_s + \gamma u = 0 \text{ (only if } 1 - \gamma \alpha = z_p^1 p' = 0, \text{ } r_s + \gamma u = 0), \text{ the optimal condition of } u^1 \text{ (D4) becomes, after using (11)} \]

\[ (r_s + \gamma u)(-z^1 p' Y_r + z^1 p'[s^1(\gamma_r^1 + (1 - \tau) y^2_r) + \tau^1 y^2_r] - (s^1 - u^1) y_r^1) + \gamma y^0 y^1 = 0. \]  

(D6)

The optimal condition of \( s^1 \) is equation (D7)

\[ \partial W/\partial s^1 = -(z^1 - s^1 z_p^1)p' Y_s + [iz_p^1 p' + p' y^1 + (1 - \tau^0) y^2_s] y^2_s - [s^1 - u^1 + \alpha \tau^1 (r - d)^1] y^1_s - \tau^0 \gamma y^1 [r_s/(r_s + \gamma u)] = 0. \]  

(D7)

APPENDIX E: Derivation of optimal trade policy of different customs unions.

In this appendix we show the optimal policy of different countries and customs unions. We simplify analysis by assuming that every country’s welfare function depends only on producer surplus and government tariff and tax revenue. The welfare functions are presented in table E1.
Table E1: Welfare functions

Country 1: \(W^1 = \pi^1 + (1 - c^0) \pi^0 - s^1 (y^1 - z^1) + u^1 y^1\)
Country 0: \(W^0 = \pi^0 + c^0 y^1 + v^2 (y^2 - x^2)\)
Country 2: \(W^2 = \pi^2 + t^2 (y^1 - z^1) + u^2 (y^2 - x^2) - w^2 x^2\)
Customs Union 10: \(W^{10} = \pi^1 + \pi^0 - s^1 (y^1 - z^1) + u^1 y^1 + v^2 (y^2 - x^2)\)
Customs Union 12: \(W^{12} = \pi^1 + \pi^2 + (1 - c^0) \pi^0 + i(y^1 - z^1) + u^1 y^1 + u^2 (y^2 - x^2) - w^2 x^2\)
Customs Union 02: \(W^{02} = \pi^1 + \pi^2 - t^2 (y^1 - z^1) + v^2 y^1 + u^2 (y^2 - x^2) - w^2 x^2\)
Global Union 102: \(W^G = \pi^1 + \pi^0 + i(y^1 - z^1) + u^1 y^1 + u^2 (y^2 - x^2) - w^2 x^2\)

Every country and customs union maximizes its welfare function subject to constraint \(y^2 - x^2 \geq 0\). For the same reason as in Appendix D we can maximize welfare functions w.r.t. policy instruments. In derivation of optimality conditions Appendixes A and B are essential. We simplify analysis by assuming demand functions are linear and output markets are perfectly segmented. Note, that output market segmentation implies that \(\gamma = 1/\alpha\).

Therefore

\[
\begin{align*}
\dot{y}^1_{u_i} &= y^i_w = y^i_v = 0 \quad \text{and} \quad \dot{y}^1_{v_1} = \dot{y}^1_{u_1} = -\alpha \dot{y}^1_{s_1} = \alpha \dot{y}^1_{v_2}, \quad \text{all } i=1,2; \\
Y^2_{u_i} &= Y^2_w = Y^2_v = 0 \quad \text{and} \quad Y^2_{v_1} = Y^2_{u_1} = -\alpha Y^2_{s_1} = \alpha Y^2_{v_2}; \\
\dot{r}^1_{s_1} + (1/\alpha) \dot{r}^1_{u_1} &= \dot{r}^2_{v_1} - (1/\alpha) \dot{r}^1_{v_1} = 0.
\end{align*}
\]

(E1)

The results of analysis are presented in two tables: table E2 considers the case of vertical foreclosure and table E3 the case of vertical supply. The conditions are derived same way as in Appendix D and they are available upon request.
Table E2: Conditions for optimality: vertical foreclosure.

\[ \begin{align*}
W^1 & \quad s^1 & p'y^1(\partial y^1/\partial s^1) - [s^1 - u^1 + \tau^1 \alpha(rP - d^1)] y^1_{s^1} = 0 \\
    & \quad u^1 & \text{as high as possible: (e.g. } u^1 = rP - v^1 - d^0) \\
W^0 & \quad v^1 & [v^1 + \tau^0 (rP - d^1)] y^1_{v^1} + \tau^0 y^1_{r^1} = 0 \\
W^2 & \quad t^2 & (p'y^2 + \tau^2) y^2_{t^2} - w^2 y^2_{t^2} = 0 \\
    & \quad w^2 & (p'y^2 + \tau^2) y^2_{w^2} = 0 \\
W^{10} & \quad s^1 & p'y^1(\partial y^1/\partial s^1) - [s^1 - (1 - \alpha)(rP - d^1)] y^1_{s^1} = 0 \\
    & \quad u^1 & = v^1 = 0, \text{ since at the optimum, they depend linearly on } s^1. \\
W^{12} & \quad s^1 & (p'y^1 - w^2) y^2_{s^1} + [p'y^2 - s^1 + u^1 - \tau^1 \alpha(rP - d^1)] y^1_{s^1} = 0 \\
    & \quad w^2 & (p'y^1 - w^2) y^2_{w^2} + [p'y^2 - s^1 + u^1 - \tau^1 \alpha(rP - d^1)] y^1_{w^2} = 0 \\
    & \quad t^2 & t^2 = 0, \text{ since at the optimum, } t^2 \text{ depends linearly on } s^1. \\
    & \quad u^1 & \text{as high as possible: (} u^1 = rP - v^1 - d^0 \text{)} \\
W^{02} & \quad t^2 & [p'y^2 + \tau^2 + v^1 + \tau^0 (rP - d^1)] y^1_{t^2} - w^2 y^2_{t^2} + (1 - \tau^1) y^1 = 0 \\
    & \quad w^2 & [p'y^2 + \tau^2 + v^1 + \tau^0 (rP - d^1)] y^1_{w^2} - w^2 y^2_{w^2} + \tau^0 y^1 = 0 \\
    & \quad v^1 & v^1 = y^1 = z^1 \\
W^G & \quad s^1 & (p'y^1 - w^2) y^2_{s^1} + [p'y^2 + (1 - \alpha)(rP - d^1) - s^1] y^1_{s^1} = 0 \\
    & \quad w^2 & (p'y^1 - w^2) y^2_{w^2} + [p'y^2 + (1 - \alpha)(rP - d^1) - s^1] y^1_{w^2} = 0 \\
    & \quad u^1 & = v^1 = t^2 = 0, \text{ since at the optimum they depend linearly on } s^1
\end{align*} \]

where \( \partial y^j/\partial I = y^j_{I} + y^j_{r^1}P \). Note that policy instruments concerning directly input trade to country 2 (\( u^2 \) and \( v^2 \)) are irrelevant.

Table E3: Conditions for optimality: vertical supply.

\[ \begin{align*}
W^1 & \quad s^1 & [p'y^1 + (1 - \tau^0)(r-d^2)] y^2_{s^1} - [s^1 - u^1 + \tau^1 \alpha(r-d^1)] y^1_{s^1} \\
    & \quad u^1 & \text{as high as possible.}
\end{align*} \]
\[
\begin{align*}
W^0 & v_1 & [v^1 + \tau^0(v_1) + v^2 + \tau^0(v_2)]y_1^1 + v^2 + \tau^0(x_1) + (1-\tau^0)(y_1 - x_1) = 0  \\
& v_2 & \{[v^1 + \tau^0(v_1)]y_1^1 + [v^2 + \tau^0(v_2)]x_1 + \tau^0(y_1 - x_1)\} r_{u_2} + (1-\tau^0)x = 0
\end{align*}
\]

\[
\begin{align*}
W^2 & t^2 & (p^2 + r^2)y^1_t + u^2 y^2_t + (z^2 - y^2_t)(r^2/r_2) = 0  \\
& u^2 & \{(p^2 + r^2)y^1_r + u^2 y^2_r - (u^2 + w^2)(y^1_r - x^1_r)\} r_{u_2} + x = 0  \\
& w^2 & u^2 + w^2 = -x/r^1
\end{align*}
\]

\[
\begin{align*}
W^{10} & s^1 & [p^1 + (r^2 + v^2)]y^2_s + [s^1 - (1-\alpha)(r^2)]y^1_s = 0  \\
& v^2 & \tau^1 p^1 y^2_s + [s^1 - (1-\alpha)(r^2)]y^1_s - (1-\tau^0)y^1_s + (y^2_s - x^2_s) = 0  \\
& u^1 & t = 0, \text{ since at the optimum, } u^1 \text{ and } v^1 \text{ depend linearly on } s^1
\end{align*}
\]

\[
\begin{align*}
W^{12} & s^1 & [p^1 + (1-\tau^0)(r^2)]y^2_s + [p^2 - s^1 + u^1 - \tau^1 \alpha(r^2)]y^1_s - \tau^0 x/r^2 = 0  \\
& v^2 & (\tau^0 p^1 y^1_s + u^2 y^2_s + [p^2 - \alpha \tau^1(r^2) - s^1 + u^1]y^1_r - \tau^1 y^1 - x - (u^2 + w^2)(y^2_r - x^2_r)\} r_{u_2} + \tau^0 x = 0.  \\
& t^2 & t = 0, \text{ since at the optimum, } t^2 \text{ depends linearly on } s^1  \\
& u^1 & \text{as high as possible.}  \\
& w^2 & u^2 + w^2 = -(1-\tau^0)(r^2 - r^0)x/r^1
\end{align*}
\]

\[
\begin{align*}
W^{02} & t^2 & [p^2 + r^2 + v^1 + \tau^0(r^2)]y^1_t + [\tau^0(r^2) + u^2]y^2_t + (1-\tau^0)y^1  \\
& u^2 & \{(p^2 + r^2 + v^1 + \tau^0(r^2)]y^1_t + [\tau^0(r^2) + u^2]y^2_t - \tau^0(r^2) - u^2 + w^2)(y^1_t - x^1_t)\} r_{u_2} + (1-\tau^0)x = 0  \\
& v^1 & \tau^1 y^1 = z^1  \\
& w^2 & u^2 + w^2 = -\tau^0(r^2 - (1-\tau^0)x/r^1  \\
& v^2 & v^2 = 0, \text{ since at the optimum } v^2 \text{ depends linearly on } u^2.
\end{align*}
\]

\[
\begin{align*}
W^G & s^1 & \{p^1 + (r^2) + u^2\}y^2_s + [p^1 + (1-\alpha)(r^2)]y^1_s = 0  \\
& u^2 & \{p^1 + (r^2) + u^2\}y^2_r + [p^1 + (1-\alpha)(r^2)]y^1_r = 0  \\
& w^2 & u^2 + w^2 = -(r^2)
\end{align*}
\]

\[
\begin{align*}
& u^1 = v^1 = t^2 = 0, \text{ since at the optimum they depend linearly on } s^1.  \\
& v^2 = v^2 = 0, \text{ since at the optimum, } v^2 \text{ depends linearly on } u^2.
\end{align*}
\]

96
Chapter 4

A MULTINATIONAL FIRM WITH VERTICALLY RELATED MARKETS AND AN INTERNATIONAL TAX POLICY

ABSTRACT. This chapter examines the strategic use of corporate tax rates in a model of international Cournot duopoly, in which one firm is a vertically integrated multinational firm (MNF). When the profit tax rate in the affiliate's home country differs from that in the parent company's home country, profit-shifting motive of the MNF affects the outcome of the Cournot game. The optimal corporate tax rates of the three countries are considered as well as the optimal policy of economic unions. The results show that tax rates can be used as strategic trade policy instruments and that harmonization of tax rates are optimal only in some special cases. JEL classification: 612, 821.

1. INTRODUCTION

In this chapter we analyze the same model as in the preceding chapter. Whereas in chapter 3 we analyzed trade policy instruments as Spencer and Jones (1991, 1992) do, the main purpose of this chapter is to determine optimal corporate tax rates in our three countries. Since this model contains several countries it is possible to allow the countries to form economic unions. The optimal tax policy of four different coalitions are therefore considered in addition to the policy of single countries. Optimal tax harmonization of the countries belonging to the same economic unions and the Nash equilibrium of the optimal policies are also considered. European integration and the negotiations for the North American Free Trade Association make studies of the behavior of these coalitions and optimality
of tax harmonization immediately relevant.

Following Spencer and Jones, however, we first briefly examine the private incentives for the MNF to export an intermediate product to its higher cost rival, lowering the rival's cost. We then consider the optimal tax policy interest of the countries.

Since chapter 4 considers different policy instruments as does chapter 3, the structure of the model changes at stage 0. In this chapter every country is assumed to commit its profit tax policy at stage 0, so that when firms optimize they take the value of the profit tax rate of countries as given. Every country has the same trade policy instruments, being assumed to be fixed here, as in chapter 3.

After this short introduction we skip over the model section and start directly with section 3, which to begin with briefly recalls the material from chapter 3. The structure of this chapter is as follows: section 3 is concerned with the Cournot equilibrium for the final product and section 4 with the conditions under which the exporting foreign MNF will supply its rival with the input. Section 5 deals with the optimal tax policy of the output exporting country (country 1). Section 6 studies behavior of the four possible economic unions and the Nash equilibrium of the optimal tax rates. Section 7 contains concluding remarks.

[2. A MODEL: see section 2 in preceding chapter.]
3. THE FINAL GOODS MARKET

The price $p$ of the final good in country 1 and country 2 is given by the inverse demand curve $p = p(Y)$ where $p'(Y) < 0$ and $Y = y^1 + y^2$ represents aggregate output. The gross profits of the parent company are

$$\pi^1 = pz^1 + (p-u^1+v^1+s^1)(y^1 - z^1) - ry^1.$$  \hspace{1cm} (1)

Due to a tariff and a subsidy the effective price of exports of the final good may differ from the price of domestic consumption. In what follows we assume that $z^1 = z^1(p)$ with $z^1_p = \frac{\partial z^1(p)}{\partial p} < 0$.

The gross profits of the affiliate are, since $x^0 = y^1 + x$

$$\pi^0 = (r-u^1-v^1-d^0)y^1 + (r-u^2-v^2-d^0)x.$$ \hspace{1cm} (2)

If tariffs on imports of the input differ between country 1 and country 2 the effective prices of exports to country 1 and to country 0 differ. Therefore, the MNF's after tax profit function (in the general case) can be written as:

$$\Pi^M = (1-\tau^1)(iz^1 + [p-i(1-\alpha)r-\alpha d^1]y^1) + (1-\tau^0)(r-d^2)x,$$ \hspace{1cm} (3)

where the net output tariff is $i = t^2 - s^1$, the relative tax factor is $\alpha = (1-\tau^0)/(1-\tau^1)$, and $d^i = u^i + v^i + d^0$, both $i=1,2$, is the marginal cost (after policy affecting input trade from country 0 and i) of input production in country 0.
Defining $\delta^2$ as the cost of firm 2's own supplies of inputs, the gross profits of the firm are

$$\pi^2 = py^2 - r(y^2 - x^2) + w^2 x^2 - \delta^2(x^2).$$  \hspace{1cm} (4)

We first consider firm 2's choice between using its own or imported supplies of the inputs. Firm 2 produces $x^2 (\geq 0)$ so as to maximize $\Pi^2 = (1-\tau^2)\pi^2$, where $\pi^2$ is given in equation (4) for given levels of $y^1$, $y^2$ and $r$. The first order condition is

$$r + w^2 - \delta^2_x(x^2) \leq 0, \text{ (= 0 if } x^2 > 0)$$  \hspace{1cm} (5)

where $\delta^2_x(x^2)$ represents firm 2's marginal cost of production of the input. If firm 2 produces the input equation (5) implicitly defines the supply of the input: $x^2 = x^2(r + w^2)$ with $x^2_1 > 0$ (using subscripts to represent partial derivatives).

At the stage 2 Cournot equilibrium for the final good, firm 1 sets its output $y^1$ to maximize (3), given $y^2$ and the prior committed values of government instruments. Similarly, firm 2 chooses $y^2$ to maximize its after tax profit ($\Pi^2$), given $y^1$ and the values of government instruments. The first order conditions are

$$\Pi^1_M = (1-\tau^1)[\bar{p}z^1 + \bar{p}yp' + p'y^1 + p - (1-\alpha)r - \alpha d^1] = 0$$  \hspace{1cm} (6)

$$\Pi^2_2 = (1-\tau^2)(p - r + p'y^2) = 0.$$  \hspace{1cm} (7)

Equation (6) shows how the profit shifting motive of the MNF, which arises
from the difference between profit tax rates, $1-\alpha \neq 0$, affects output production. Solving (6) and (7) simultaneously, the Cournot equilibrium levels of output can be expressed as function of $r$, $\tau^1$, $\tau^0$, and $\tau^2$, i.e. $y^1 = y^1(r, \tau^1, \tau^0, \tau^2)$ and $y^2 = y^2(r, \tau^1, \tau^0, \tau^2)$. To determinate comparative static effects (derived in Appendix A) we have assumed, as usual, that the second order conditions for profit maximization hold and the Cournot equilibrium is unique and that one firm’s own marginal profit declines with an increase in the output of the other firm (see Bulow et al, 1985), i.e. $\Pi^M_{11} < 0; \Pi^M_{12} < 0; \Pi^2_{22} < 0; \Pi^2_{21} < 0$ and $\Pi^M_{11} \Pi^2_{22} - \Pi^M_{12} \Pi^2_{21} > 0$. To get the unambiguous effects of the input price on the output produced we have to assume in addition:

Assumption 1: The profit tax rate in countries 1 and 0 are assumed to be restricted such that i) $2-\alpha > 0$; 
ii) $1-\alpha < [(1-\tau^2)\Pi^M_{12}]/[(1-\tau^1)\Pi^2_{22}] = (\Gamma + p' + p'' y^1)/(2 p' + p'' y^2) > 0$; 
iii) $1-\alpha < [(1-\tau^2)\Pi^M_{11}]/[(1-\tau^1)\Pi^2_{21}] = (\Gamma + 2 p' + p'' y^1)/(p' + p'' y^2) > 0$; 
where $1-\alpha = (\tau^0 - \tau^1)/(1-\tau^1)$ and $\Gamma = i z^1_{pp}(p')^2 + i z^1_{pp'}$.

These restrictions follows from the facts i) that the input price affects both the MNF’s and firm 2’s marginal revenue and ii) that the sign of effect of the input price on the MNF’s marginal revenue depends on the difference between tax rates. It is shown in Appendix A that the condition i) implies $Y^1 > 0$; the condition ii) implies $y^1_{r} > 0$; and the condition iii) implies $y^2_{r} < 0$. Note that Spencer and Jones’s (1991) analysis satisfies all above conditions, since then $\tau^1 = \tau^0$. If $\tau^1 > \tau^0$, the conditions ii) and iii) are satisfied for sure, but the condition i) can be violated. If both tax rates are less than half, the condition i) is satisfied.
Table 1: Comparative statics for output produced.

<table>
<thead>
<tr>
<th></th>
<th>MNF's output</th>
<th>Firm 2's output</th>
<th>Total output</th>
</tr>
</thead>
<tbody>
<tr>
<td>input price</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Tax rate in</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>country 1</td>
<td>r &gt; d¹</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>r &lt; d¹</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Tax rate in</td>
<td>r &gt; d¹</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>country 0</td>
<td>r &lt; d¹</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

where \(d^1 = u^1 + v^1 + d^0\) is the marginal cost (after policy affecting input trade from country 0 to country 1) of input production.

Under Assumption 1 the input price affects positively (negatively) the MNF’s output (the rival’s output) such that its effect on the total output produced is negative. The effects of the profit tax rates depend on whether the MNF overinvoices or underinvoices. When the MNF overinvoices, i.e. \(r-d^1 > 0\), (underinvoices, i.e. \(r-d^1 < 0\)) an increase in profit tax rate in country 1 increases (decreases) the MNF’s marginal revenue and thus increases (decreases) production in that country but decreases (increases) production in country 2, whereas the effects of \(\tau^0\) are reversed. If the input price is equal to marginal cost relevant to input trade from country 0 to country 1, the profit tax rates do not affect the MNF’s marginal revenue and thus outputs produced.

4. THE EXPORT MARKETS FOR THE INPUT

Firm 2’s derived demand for imported supplies is firm 2’s output of the final good at the Cournot equilibrium less its own production of the input:
\[ x(\tau, \tau^1, \tau^0, \tau^2) = y^2(\tau, \tau^1, \tau^0, \tau^2) - x^2(\tau). \] (8)

where \( x_\tau = y^2_\tau - x^2_\tau < 0 \) from (5) and Table 1. Vertical foreclosure occurs if the MNF charges a prohibitive price for the input, denoted as \( r^P \), at which firm 2’s demand for imported supplies is forced to zero. Setting \( x(\cdot) = 0 \) implicitly defines the foreclosure price as a function \( \tau^1, \tau^0, \tau^2 \), where

\[ \begin{align*}
  r^P_{\tau^1} &= - y^2_{\tau^1}/x_\tau < 0, \quad \text{iff} \quad r^P - d^1 > 0 \\
  r^P_{\tau^0} &= - y^2_{\tau^0}/x_\tau > 0, \quad \text{iff} \quad r^P - d^1 > 0 \\
  r^P_{\tau^2} &= 0.
\end{align*} \] (9)

When the MNF overinvoiced (underinvoiced), an increase in the tax rate in country 1 and a reduction in the tax rate in country 0 both increase (decrease) the MNF’s production of the final product, decreasing (increasing) firm 2’s output and the price \( r^P \) at which firm 2 ceases to use imported supplies. Note, that the MNF cannot use a price higher and lower than \( r^P \) as a transfer price, since \( r^P \) is the price prevailing in country 2 and countries 1 and 0 are assumed to apply the price \( r^P \) in their corporate taxation. Thus the upper limit of input price is \( r^P \). That is \( r \leq r^P \).

We now turn to the MNF stage 1 choice of the price \( r \) to charge its rival and its internal trade for the input. Taking into account the second stage relationship, the MNF’s profit is a function of the input price \( r \) as well as tariffs, subsidies and profit tax rates set by the three governments. In stage 1, the MNF sets the price \( r \) to maximize profit subject to \( x \geq 0^I \), so

\footnote{To obtain the conditions for a maximum, we proceed as shown in the footnote in the chapter 3.}
that we exclude the possibility that firm 2 supplies input to the MNF. At
vertical supply equilibrium from (3) and (6)

\[ \Pi_T^M(\cdot) = M(\cdot)y^2_1 - (1 - \tau^0)(r - d^2)x^2_1 + (1 - \tau^0)x + (\tau^1 - \tau^0)y^1 = 0. \]  \hfill (10)

where \( M(r, \tau^1, \tau^0, \tau^2) = (1 - \tau^0)(r - d^2) - (1 - \tau^1)(\tilde{t}z^1_p + p'y^1) \). Since this condition
is the same as in the previous chapter, we can immediately turn to the
comparative statics. Condition (10) defines the input price as a function
\( r(\tau^1, \tau^0, \tau^2) \) of the governments' policies set previously at stage 0. The
comparative statics, derived in Appendix B, are

\[ r_{\tau^1} = -\alpha r_{\tau^0}; \quad r_{\tau^2} = 0. \]  \hfill (11)

The tax rate in country 1 and country 0 have opposite effects on the input
price, since only the difference between tax rates in countries 1 and 0
affects the MNF's and firm 2's behaviour and thus determination of the
input price. These effects are ambiguous in general.\(^2\)

We turn next to optimal profit taxation of the three governments. We skip
over the vertical supply and foreclosure decisions of the MNF, since they
have been considered in Spencer and Jones (1991, 1992) and in chapter 3.

\(^2\)However, when the output demand functions are linear, the more likely tax
rate in country 1 (0) affects positively (negatively) the input price the
higher the input import of country 1 relative to the input import of
country 2 is.
5. OPTIMAL POLICY OF THE OUTPUT EXPORTING COUNTRY

This section is concerned with policy incentives in the output exporting country. The welfare function in country 1 consists of three parts; first, consumer utility and other sectors of the economy;\(^3\) second, the MNF’s net profits and third, the government’s income. The welfare function is

\[
W^1 = U(z^1) - pz^1 + \Pi^M + R^1 - s^1(y^1 - z^1) + u^1 y^1,
\]

(12)

where \(R^1\) is the profit tax revenue of the country 1.\(^4\) The expression of \(R^1\) differs depending on the tax system prevailing in country 1; however, independent of the tax system in country 1, \(\Pi^M + R^1 = \pi^1 + (1 - \pi^0) \pi^0\). The output exporting country sets the profit tax rate \((\tau^1)\) to maximize welfare as in (12). As shown in Appendix D, the optimal value of \(\tau^1\) satisfies condition (13) or (14). In the region of vertical foreclosure the optimality condition is

\[
\frac{\partial W^1}{\partial \tau^1} = W^1_{\tau^1} + W^1_{r^1} r^1_{\tau^1} = -z^1 p' (\partial Y / \partial \tau^1) + [s^1 (\partial y^1 / \partial \tau^1) + t^2 (\partial y^2 / \partial \tau^1)] z^1 p' \]

\[
+ p' y^1 (\partial y^2 / \partial \tau^1) - (s^1 - u^1) (\partial y^1 / \partial \tau^1)
\]

\[\alpha \tau^1 (r^p - d^1) (\partial y^1 / \partial \tau^1) - \tau^0 y^1 r^p_{\tau^1} = 0,\]

(13)

where we have used these definitions: \(\partial y^1 / \partial \tau^1 = y^1_{\tau^1} + y^1_{r^1} r^p_{\tau^1} > 0\);
\(\partial y^2 / \partial \tau^1 = y^2_{\tau^1} + y^2_{r^1} r^p_{\tau^1} < 0\); and \(\partial Y / \partial \tau^1 = Y_{\tau^1} + Y r^p_{\tau^1} > 0\). Note that \(r^p_{\tau^1} < 0\). The signs depend on the assumption that \(r^p - d^1 > 0\).

\(^3\) Consumer utility is defined as in the previous chapter.

\(^4\) Effects of taxes on government revenue (\(R^1\)) in the case of an MNF without strategic dependence in input markets are discussed in Kant (1991).
Let us interpret each term in optimal condition (13) in turn. The first row measures domestic consumption effects, i.e. the effects of $\tau^1$ on consumer surplus and on the value of export subsidy and tariff costs which are due to changes in domestic consumption. The second row shows a type of the Spencer and Brander (1983) result that a profit tax increases domestic welfare when there is Cournot competition between a foreign and a domestic firm. The last two terms are new ones measuring the net effects (relevant for country 1) of $\tau^1$ on total surplus from input trade from country 0 to country 1, since $\partial[(r-d^1)y^1]/\partial \tau^1 = (r-d^1)(\partial y^1/\partial \tau^1) + y^1 r^1_{\tau^1}$. The tax weights follow from that the change in input import affects the parent’s gross profits at rate of $-(r-d^1)$, when the MNF optimizes, and the affiliate’s gross profits at rate of $(r-d^1)$. Since country 1 takes into account the parent’s gross and the affiliate’s net profits, the net welfare effect via the value of input trade is thus $-\alpha\tau^1(r-d^1)(\partial y^1/\partial \tau^1)$, where $-\tau^1\alpha = 1-\tau^0\alpha$. The input price affects the parent’s gross profits at rate of $-y^1$ and the affiliate’s net profits at rate of $(1-\tau^0)y^1$. The net welfare effect of the tax rate via the input price is thus $-\tau^0 y^1 r^1_{\tau^1}$. To get more insight into $\tau^1$ at the optimum, assume that all trade policy instruments are equal to zero and the output markets are perfectly segmented; that is, the first row in (13) vanishes. Then $\tau^1$ is clearly positive since $r^P-d^0 > 0$.

The comparison of the optimal condition of the tax rate with that of the output export subsidy (the condition 17 in the previous chapter) produces first proposition:

**Proposition 1:** A government can use either the export subsidy or the tax rate to affect outcome of the game between Cournot competitors in the case
of vertical foreclosure.

The comparison of the conditions reveals that these conditions are similar in the sense that the welfare effects of the both instruments result from the same canals, i.e. the output produced by two firms and the behaviour of the input price. In the case of vertical foreclosure the policy instruments of country 1 affect the input price only via firm 2’s output, depending, in turn, only on the changes in MNF’s output. Since neither the export subsidy nor the tax rate have direct welfare effect, all welfare contributions of these instruments come from their effects on the MNF’s marginal revenue. Since country 1 can manipulate the MNF’s behaviour either by the profit tax rate or the output export subsidy, these instruments are perfect substitutes for welfare maximization.

In the region of vertical supply the optimal value of $\tau^1$ satisfies

$$\frac{\partial W^1}{\partial \tau^1} = W^1_{\tau^1} + W^1_{r_{\tau^1}} = -z^1 p (\partial Y / \partial \tau^1) + \left[ s^1 (\partial y^1 / \partial \tau^1) + r^2 (\partial y^2 / \partial \tau^1) \right] z^1 p^1$$

$$+ p' y^1 (\partial y^2 / \partial \tau^1) - [s^1 u^1 + \alpha^1 (r-d^1)] (\partial y^1 / \partial \tau^1) - \tau^0 y^1 r_{\tau^1}^1$$

$$+ (1-\tau^0) (r-d^2) (\partial x / \partial \tau^1) + (1-\tau^0) x r_{\tau^1} = 0. \quad (14)$$

where we have used these definitions: $\partial y^1 / \partial \tau^1 = y^1_{\tau^1} + y^1_{r_{\tau^1}}$;

$\partial y^2 / \partial \tau^1 = y^2_{\tau^1} + y^2_{r_{\tau^1}}$; and $\partial x / \partial \tau^1 = y^2_{\tau^1} + (y^2_{r_{\tau^1}} - x^2_{r_{\tau^1}}) r_{\tau^1}.$

The first two rows are exactly the same as in the condition (13). The third row measures the effects of $\tau^1$ on total surplus from input export to country 2, since $\partial ((r-d^2)x) / \partial \tau^1 = (r-d^2) (y^2_{\tau^1} + x_{r_{\tau^1}}) + x r_{\tau^1}$. The tax weight $1-\tau^0$ follows from that both a government and the MNF take into account the affiliate’s net profits and that the input trade to country 2 does not.
affect the parent's profit. There are three inefficiencies to which a
government controls: firstly, the MNF does not internalize its rival's
behaviour, and secondly and thirdly, the MNF may overinvoice/underinvoice
the input trade to both countries 1 and 2. Since i) a government and the
MNF give the different value to the parent company's profits and ii) a part
of the affiliate's profits are taxed in country 0, the tax weights play the
import role in the condition for optimality.

Two awkward things in equation (14)\(^5\) are first, that the sign of \(r_1\) is
unclear (see appendix B) and second, that the MNF may underinvoice in input
trade to country 1 or to country 2 or both. One way to interpret condition
(14) further is to analyze how a small positive profit tax rate in country
1 affects welfare in that country in the special case in which all trade
policy instruments and profit tax rates are zero and the output markets are
perfectly segmented, i.e. effects via domestic consumption do not matter.

*Proposition 2*: Assume that all trade policy instruments and profit tax
rates are zero and the output markets are perfectly segmented. Then a small
profit tax rate positively affects welfare.

**Proof**: In this special case, the condition (10) can be written as
\[
(r-d_0)x_1 = -x_1p'y_1^2, \text{ where } x_1 < 0 \text{ and } y_1^2 < 0; \text{ thus the MNF overinvoices.}
\]
By substituting equation (10) into equation (14) and taking into account

---

\(^5\)The optimal condition for the tax rate differs from the optimal conditions
of the output export subsidy and of the import import tariff (the conditions
(18a) and (18b) in the previous chapter) since here a government can use
only one instrument and since the condition (14) does not include the MNF's
optimal choice of the input price.
equation (6) one obtains that \( \partial W^1/\partial \tau^1 = [p'y^1+(r-d^0)]y^2_{t1} = (r-p)y^2_{t1} > 0 \), since we can assume that \( p > r \) and since \( y^2_{t1} < 0 \) when \( r-d^0 > 0 \).

This result can be interpreted as follows. The tax rate affects welfare via three variables: the MNF’s output; firm 2’s output; and the input price. Due to the envelope theorem the second canal is only effective, since welfare depends only on the MNF’s total profits. A reduction in firm 2’s output increases the output price and thus the value of the MNF’s production, increasing welfare, and decreases the input export to country 2 and thus the value of the input export, reducing welfare since the MNF overinvoiced input export. Applying the envelope theorem these two effects reduce to the difference between the input and output price. Since the output-input price margin is positive and since the tax rate has a negative effect on firm 2’s output, an increase in the tax rate improves welfare.

6. ECONOMIC UNIONS AND TAX HARMONIZATION

Let us assume in this section that the countries can join together in the sense that they maximize their joint welfare function, being the sum of the individual countries’ welfare. We can then compare the optimal tax policy of different countries and economic unions to clarify how strategic behaviour of firms and the profit-shifting motive of the MNF affect behaviour of governments. Four coalitions are possible: countries 1 and 0, countries 1 and 2, countries 0 and 2, and all countries together. The welfare functions in the different cases are presented in Table 2. In addition to allowing each economic union to set its tax instruments optimally, we will also consider the optimal tax policy for one country or
union in a Nash tax game. This analysis clarifies under which conditions international tax harmonization will be optimal.

Table 2: Welfare functions

| Country 1: | \( W^1 = \pi^1 + (1-\tau^0)\pi^0 \) |
| Country 0: | \( W^0 = \tau^0\pi^0 \) |
| Country 2: | \( W^2 = \pi^2 \) |
| Coalition 1: countries 1 and 2: | \( W^{10} = \pi^1 + \pi^0 \) |
| Coalition 2: countries 1 and 0: | \( W^{12} = \pi^1 + (1-\tau^0)\pi^0 + \pi^2 \) |
| Coalition 3: countries 0 and 2: | \( W^{02} = \tau^0\pi^0 + \pi^2 \) |
| Coalition 4: countries 1, 0 and 2: | \( W^G = \pi^1 + \pi^0 + \pi^2 \) |

To simplify the analyses let us make the following assumptions 1) every country's welfare function depends only on producer surplus and government profit tax revenue, 2) country 1 follows the source principle, 3) the output markets are perfectly segmented, implying that \( x^1 \) stays constant. Although these assumptions seem to be very restrictive, they are often used in the literature.

Note the different effects of tax instruments. First, \( \tau^2 \) is a lump sum tax in all cases, since it affects neither \( \pi^1 \), \( \pi^0 \) nor \( \pi^2 \) and since it has no direct effect on any welfare functions. Second, \( \tau^1 \) has no direct effect on any welfare functions, whereas \( \tau^0 \) has a direct effect on the welfare functions involving country 0. Third, only the difference between \( \tau^1 \) and \( \tau^0 \) affects the behavior of the firms as can be seen from equation (6). This section is divided into two sub-sections, depending on whether the MNF forecloses or supplies its rival. Table 3 shows the necessary conditions

\[6\text{The conditions for optimality in the different cases can be derived as is} \]
for optimality in the case where the MNF vertically forecloses its rival.

Table 3: The conditions for optimality; vertical foreclosure.

\[
\frac{\partial W^1}{\partial \tau^1} = p' y^1 (\partial y^2/\partial \tau^1) - \alpha \tau^1 (r^P - d^0)(\partial y^1/\partial \tau^1) - \tau^0 (r^P_{\tau^0}) = 0
\]

\[
\frac{\partial W^0}{\partial \tau^0} = (r^P - d^0) y^1 + \tau^0 (r^P - d^0)(\partial y^1/\partial \tau^0) + \tau^0 (r^P_{\tau^0}) = 0
\]

\[
\frac{\partial W^{10}}{\partial \tau^1} = p' y^1 (\partial y^2/\partial \tau^1) + (1-\alpha)(r^P - d^0)(\partial y^1/\partial \tau^1) = 0
\]

\[
\tau^0 \text{ fixed, since at the optimum, } \tau^0 \text{ depends linearly on } \tau^1
\]

\[
\frac{\partial W^{12}}{\partial \tau^1} = p' y^1 (\partial y^2/\partial \tau^1) + [p' y^2 - \alpha \tau^1 (r^P - d^0)](\partial y^1/\partial \tau^1) - \tau^0 (r^P_{\tau^0}) = 0
\]

\[
\frac{\partial W^{02}}{\partial \tau^0} = [p' y^2 + \tau^0 (r^P - d^0)](\partial y^1/\partial \tau^0) + (r^P - d^0) y^1 + \tau^0 (r^P_{\tau^0}) = 0
\]

\[
\frac{\partial W^G}{\partial \tau^1} = p' y^1 (\partial y^2/\partial \tau^1) + [p' y^2 + (1-\alpha)(r^P - d^0)](\partial y^1/\partial \tau^1) = 0
\]

\[
\tau^0 \text{ fixed, since at the optimum, } \tau^0 \text{ depends linearly on } \tau^1
\]

where \( \partial y^2/\partial \tau^1 < 0; \ \partial y^1/\partial \tau^1 > 0; \ \tau^0_{\tau^0} < 0; \ \partial y^2/\partial \tau^0 > 0; \ \partial y^1/\partial \tau^0 < 0; \) and \( r^P_{\tau^0} > 0, \) since \( r^P - d^0 > 0. \)

The first condition in Table 3 is the condition (13) in this special case. The first term in the condition \( \partial W^0/\partial \tau^0 = 0 \) measures the effect of \( \tau^0 \) on welfare (the tax revenue) of the input exporting country when the input price and volume of trade are fixed, whereas the second and the third terms capture the volume of input trade effect and the effect via the input price respectively. The tax weight follows from that the share of \( \tau^0 \) from the affiliate’s profit belongs to country 0. Since the first and the third terms are positive and the second term is negative, the interior solution for the tax rate is possible. When country 2 belongs to any coalition, the

done in Appendix D. The derivations are available upon request.
strategic effect of the tax rate on firm 2’s profits earned from output produced is included in the condition for optimality.

Let us consider more closely the cases where we can find unambiguous results. The first-order condition of $W^{10}$ with respect to $\tau^1$ depends on the strategic effect $p'y^1(\partial y^2/\partial \tau^1)$ and the volume of input trade effect, including the effect via the input price, on surplus from input trade to country 1. The tax weight of the later is $1-\alpha = (1-\tau^0)+\tau^0-\alpha$, where the tax weight $1-\tau^0$ ($\tau^0$) measures how county 1 (country 0) values the affiliate’s gross profits whereas $\alpha$ is the MNF’s relative tax weight of the affiliate’s profits. The direct effect of the tax rate on excess surplus vanishes and the pure input price effect ($y^1$ constant) cancels out since the coalition maximizes the affiliate’s gross profits and thus profit-shifting between countries does not matter. The interior solution in coalition 1 requires that $\tau^1 > \tau^0$ since the first term is positive, and thus the second term should be negative implying that $1-\alpha < 0$. The coalition, consisting of the affiliate’s and parent company’s home countries, thus does not harmonize the tax rate; that is $\tau^1 \neq \tau^0$ at optimum. The interpretation is the following. An increase in the tax rate in country 1, $\tau^1$, decreases firm 2’s production, increasing the output price and thus the value of MNF’s output export, and increases the MNF’s output export, decreasing the parent’s profits (at rate of $-\alpha(r^p-d^0)$) and increasing the affiliate’s profits (at rate of $r^p-d^0$) (see Appendix C). Thus the welfare effect of $\tau^1$ via firm 2’s production is unambiguously positive. Since the coalition maximizes the MNF’s cross profits the welfare effect of $\tau^1$ via the MNF’s output export is positive when $\tau^1 < \tau^0$, i.e. $\alpha < 1$, and negative when $\tau^1 > \tau^0$. Thus we can find the interior solution for $\tau^1$ in the regime of $\tau^1 > \tau^0$. 

112
In the case of global coalition, the strategic effect of the tax rate on firm 1’s profit and that on firm 2’s profit affect welfare. When the strategic effect of the tax rate on firm 1’s profit dominates the global coalition should induce the MNF to produce more and firm 2 to produce less by setting $\tau_1^1 > \tau_0^0$, and vice versa. The tax rates should thus be harmonized only in the case where the sum of these strategic effects is zero. The most interesting results are summarized in proposition 3.

**Proposition 3:** In the case of vertical foreclosure

i) the coalition consisting of countries 1 and 0 should set the tax rate in country 1 higher than that in country 0; thus this coalition does not harmonize the tax rates,

ii) when the strategic effect of the tax rate on firm 1’s profit dominates the strategic effect on firm 2’s profit, $\tau_1^1 > \tau_0^0$ and vice versa; the tax rates should be harmonized only in the case where the sum of the strategic effects is zero.

Table 4 shows the necessary conditions for optimality in the case where the MNF supplies inputs to its rival. Now we have to take into account, in addition, the effects of taxes on excess surplus from input trade to country 2 and the MNF’s optimal choice of the input price. Whereas the model contains three types of inefficiency in the case of vertical foreclosure, it now contains four types. Therefore, and since the signs of many terms (e.g. $r_1^1$ and $r_0^0$) are ambiguous, we cannot obtain clear results about whether the tax rate in country 1 is higher or lower than that in country 0. In what follows we thus evaluate mainly how different coalitions value different inefficiencies.
Table 4: The conditions for optimality: vertical supply.

\[ \partial W^1 / \partial \tau^1 = [p'y^1 + (1-\tau^1)(r-d^0)]y_{\tau^1}^2 - \alpha \tau^1 [(r-d^0)(y_{\tau^1}^1 + x_{\tau^1}) + y^1 + x]r_{\tau^1} = 0 \]
\[ \partial W^0 / \partial \tau^0 = (r-d^0)(y^1 + x) + \tau^0 (r-d^0)(\partial y^1 / \partial \tau^1) + \tau^0 (y^1 + x)r_{\tau^1} = 0 \]
\[ \partial W^{10} / \partial \tau^1 = [p'y^1 + (r-d^0)]y_{\tau^1}^2 + (1-\alpha)(r-d^0)y_{\tau^1}^1 + (1-\alpha)((r-d^0)(y_{\tau^1}^1 + x_{\tau^1}) + y^1 + x)r_{\tau^1} = 0 \]
\[ \tau^0 \text{ fixed, since at the optimum, } \tau^0 \text{ depends linearly on } \tau^1 \]
\[ \partial W^{12} / \partial \tau^1 = [p'y^1 + (1-\tau^0)(r-d^0)]y_{\tau^1}^2 + [p'y^2 - \alpha \tau^1 (r-d^0)]y_{\tau^1}^1 - \alpha \tau^1 [(r-d^0)(y_{\tau^1}^1 + x_{\tau^1}) + y^1 + x]r_{\tau^1} + [p'y^2(y_{\tau^1}^1 - x)]r_{\tau^1} = 0 \]
\[ \partial W^{02} / \partial \tau^0 = (r-d^0)(y^1 + x) + \tau^0 (r-d^0)(\partial y^1 / \partial \tau^1) + \tau^0 (y^1 + x)r_{\tau^1} + p'y^2(\partial y^1 / \partial \tau^0) - x r_{\tau^1} = 0 \]
\[ \partial W^G / \partial \tau^1 = [p'y^1 + (r-d^0)]y_{\tau^1}^2 + [p'y^2 + (1-\alpha)(r-d^0)]y_{\tau^1}^1 + (1-\alpha)((r-d^0)(y_{\tau^1}^1 + x_{\tau^1}) + y^1 + x)r_{\tau^1} + [p'y^2(y_{\tau^1}^1 - x)]r_{\tau^1} = 0 \]
\[ \tau^0 \text{ fixed, since at the optimum, } \tau^0 \text{ depends linearly on } \tau^1 \]

Comparison of the condition for optimality of country 1 (objective function \( W^1 \)) with that of coalition 1 (objective function \( W^{10} \)) shows first, that the tax weights of last two terms change from \((-\alpha \tau^1)\) to \((1-\alpha) = -\alpha \tau^1 + \tau^0\), and second, that the tax weight of the partial effects \((r \text{ constant})\) of \( \tau^1 \) on excess surplus from input trade to country 2 changes from \((1-\tau^1)\) to \((1 = 1-\tau^0 + \tau^0)\). The changes arises from coalition 1 taking into account the affiliate’s profits as a whole, whereas country 1 taking into account only the share \((1-\tau^0)\). When country 2 belongs to coalitions the effect of the tax rates on firm 2’s profits, i.e. \( \partial (\pi^2) / \partial \tau^1 = p'y^2(\partial y^1 / \partial \tau^1) - x r_{\tau^1} \), appears conditions for optimality. The first term comes from that the firm 2 takes the MNF’s production as given and the second measures how the tax rate
changes the firm 2’s input import bill via the input price.

One way to interpret conditions further is to analyze how a small positive profit tax rate affects welfare at the point where the profit tax rates are zero. Consider the effect of the tax rate on welfare of the global coalition. After using equations (6) and (7) one obtains that

$$\frac{\partial W^G}{\partial \tau} = (r-p)(y^2_{\tau,1} + y^1_{\tau,1}) + [(r-p)y^1_{\tau,1} - x]r^1_{\tau},$$  

where $y^1_{\tau,1} > 0$ and $y^1_{\tau} > 0$. The tax rate affects welfare via three canals: i) the firm 2’s output, which the MNF takes as given; ii) the MNF’s output export, which firm 2 takes as given; and iii) the input price, which firm 2 takes as given. Applying the envelope theorem the welfare effects of the tax rate via outputs produced depend on the difference between the input and output price. Since an increase in the tax rate in country 1 increases the total output supplied the first term in the condition (15) is negative. The second term, i.e. the effects of the tax rate on firm 2’s profits via the input price, follows from that firm 2 does not optimize the input price, as the MNF does, in the first stage of the model. We know that an increase in the input price decreases firm 2’s profits. But since we cannot sign the effect of the tax rate on the input price, the welfare effect remains ambiguous.

Finally we turn to the optimal policy for one country in the Nash tax game both in the case of vertical foreclosure and supply and consider the situation where countries 1 and 0 both maximize their own welfare. Since only the difference between the tax rates affects the decision variables of the firms we obtain the proportional property that $y^1_{\tau,1} = -\alpha y^1_{\tau,0};$
\[ y_{t1}^2 = -\alpha y_{t0}^2; \quad Y_{t1} = -\alpha Y_{t0}; \quad r_{t1}^P = -\alpha r_{t0}^P; \quad \text{and} \quad r_{t1} = -\alpha r_{t0}. \] Therefore, we can first multiply the optimal condition \( \partial W^0 / \partial \tau^0 = 0 \) by the tax factor \((-\alpha)\) and substitute it then into the condition \( \partial W^1 / \partial \tau^1 = 0 \), producing in the case of vertical foreclosure

\[
\partial W^1 / \partial \tau^1 = p'y^1(\partial y^2 / \partial \tau^1) - \alpha(r^P-d^0)y^1 + (1-\alpha)(r^P-d^0)(\partial y^1 / \partial \tau^1) = 0, \tag{16}
\]

and producing in the case of vertical supply

\[
\partial W^1 / \partial \tau^1 = p'y^1(\partial y^2 / \partial \tau^1) - \alpha(r-d^0)y^1 + (1-\alpha)(r-d^0)(\partial y^1 / \partial \tau^1) - \alpha(r-d^0)x + (r-d^0)(\partial x / \partial \tau^1) + xr_{t1} = 0. \tag{17}
\]

In the case of vertical foreclosure the relative magnitude of the tax rates depends on two terms: the first positive one measures the strategic effect of \( \tau^1 \) on the MNF’s profits from output produced and the second negative one depends on the direct effect of \( \tau^0 \) on country 0’s tax revenue multiplied by the tax factor. If the first term is larger (smaller) than the second term in absolute value, the third term should be negative (positive), i.e. \( 1-\alpha \) should be negative (positive), and thus the tax rate in country 1 is higher (lower) than that in country 0 at optimum. The tax weight of the volume effect of the tax rate on the excess surplus from input trade to country 1 (the third term) comes from the fact that the input export, \( y^1 \), affects the parent’s cross profits at rate of \(-\alpha(r^P-d^0)\) and the affiliate’s cross profits at rate of \((r^P-d^0)\). The economic interpretation is that by increasing its tax rate country 1 reduces firm 2’s output and thus increases the output price, implying that the value of the MNF’s production increases and thus country 1’s welfare improves. Country 0 can increase its tax revenue by increasing its tax rate. When the strategic effect is larger
than the direct effect of $\tau^0$ on country 0's tax revenue weighted by the tax factor (-$\alpha$) country 1 prefers higher tax rate than country 0 does, and thus $\tau^1 > \tau^0$.

The first row in (17) measures the same effects as equation (16) whereas the second row takes into account the effects of the tax rate on the total surplus from input trade to country 2. The tax weight of the last two terms measures how countries 1 and 0 value the affiliate's profits, i.e.

$1 = 1 - \tau^0 + \tau^0$. Since the signs in the second row are ambiguous in general, we cannot say whether the difference between the tax rates $\tau^1 - \tau^0$ is positive or negative in the Nash equilibrium in the case of vertical supply.

However, we can conclude the section by stating:

**Proposition 4:** The Nash tax game between countries 1 and 0 does not produce the harmonized tax rates in general.

7. CONCLUSION

Many large firms have secured their access to important inputs by integrating backwards so as to produce those inputs within the corporation. If a vertically integrated firm can produce inputs at lower cost than its foreign rivals, this raises the question of whether the low-cost firm should supply a key input to rivals which are important producers of the final product. In many cases vertically integrated corporations are multinational firms, whose affiliates produce inputs in developing countries where corporate profit tax rates are lower than in industrial countries. This incorporates the profit-shifting motive of the MNF into the
strategic considerations if the transfer price of the input in the trade inside the MNF has to be the same as the input price charged to the foreign rivals. This chapter analyzes a world where an MNF cannot segment input markets.

This chapter has considered the optimal tax policy of three countries: the home country of the parent company, that of the affiliate, and that of the rival firm. Moreover, the chapter has analyzed the three cases in which the countries have formed different coalitions. The general results are as follows: first, the difference between the profit tax rate in the parent firm's and in the affiliate's home country is relevant to the analysis, and the profit tax rate in the rival firm's home country is always a lump-sum tax. Second, the profit tax rates have very similar effects on the behavior of the MNF to those which traditional trade policy instruments have in trade theory based on imperfect competition; tax rates can be used to increase the welfare of the countries. Third, it is unlike that the global coalition harmonizes the tax rates. Finally, in the Nash equilibrium, the tax rates probably differ.
REFERENCES


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APPENDIX A: Comparative statics for outputs produced.

Defining $\Gamma = i z^1_{pp} (p')^2 + i z^1_{pp} p''$ one obtains that

$$\begin{align*}
\Pi^{M}_{11} &= (1-\tau^1)(\Gamma+2p+p''y^1); \\
\Pi^{M}_{12} &= (1-\tau^1)(\Gamma+p'+p''y^1); \\
\Pi^{M}_{1r} &= -(1-\tau^1)(1-\alpha); \\
\Pi^{M}_{11} &= \alpha(r-d^1); \\
\Pi^{M}_{1r} &= -(r-d^1);
\end{align*}$$

$$\begin{align*}
\Pi^{2}_{21} &= (1-\tau^2)(p'+p''y^2) \\
\Pi^{2}_{22} &= (1-\tau^2)(2p'+p''y^2); \\
\Pi^{2}_{2r} &= -(1-\tau^2); \\
\Pi^{2}_{2t^1} &= 0; \\
\Pi^{2}_{2t^0} &= 0.
\end{align*}$$

In considering comparative statics we assume that $\Pi^{M}_{12}$ and $\Pi^{2}_{21}$ are negative, implying that reaction functions in output space have negative slopes, or equivalently, that the outputs produced by each firm are strategic substitutes (Bulow, Geanakoplos, and Klemberer, 1985). In addition, the second-order conditions for profit maximization are assumed to hold and the Cournot equilibrium is unique: $\Pi^{M}_{11} < 0$, $\Pi^{2}_{22} < 0$, and $H = \Pi^{M}_{11} \Pi^{2}_{22} \Pi^{M}_{12} \Pi^{2}_{21} > 0$.

The comparative statics are

$$\begin{align*}
y^1_r &= \frac{[(1-\tau^1)(1-\alpha)\Pi^{2}_{22} - (1-\tau^2)\Pi^{M}_{12}]}{H} \\
\Pi^{2}_{22} &= \frac{-(1-\tau^2)(1-\alpha)(p'/H)}{H} \\
y^1_{t^1} &= \frac{\Pi^{2}_{22}[-(\alpha(r-d^1))]}{H} \\
y^1_{t^0} &= \frac{\Pi^{2}_{21}[-(r-d^1)]}{H} \\
y^1_{t^2} &= 0
\end{align*}$$

$$\begin{align*}
y^2_r &= \frac{[-(1-\tau^1)(1-\alpha)\Pi^{2}_{21} + (1-\tau^2)\Pi^{M}_{11}]}{H} \\
\Pi^{2}_{21} &= \frac{-(p'/H)(1-\tau^2)\alpha(r-d^1)]}{H} \\
y^2_{t^1} &= \frac{\Pi^{2}_{21}[\alpha(r-d^1)]}{H} \\
y^2_{t^0} &= \frac{\Pi^{2}_{21}[-(r-d^1)]}{H} \\
y^2_{t^2} &= 0
\end{align*}$$

where $d^1 = u^1 + v^1 + d^0$ is the marginal cost (after policy affecting input trade from country 0 to country 1) of input production.
APPENDIX B: Comparative statics for input price; vertical supply.

Recall equation (10) $\Pi^M_R = M(\cdot)y^2_{r}-(1-\tau^0)(r-d^2)x^2_{r}+(1-\tau^0)(y^2_{z}x^2_{r}+(\tau^1-\tau^0)y^1_{z})$, where $M(\cdot) = (1-\tau^0)(r-d^2)+(1-\tau^1)(iz^p_{p}+p^z_{r}y^1_{z})$. From that $\partial\tau/\partial I = -\Pi^M_{rr}/\Pi^M_{r}$, where I refers to instruments and $\Pi^M_{rr}$ is assumed to be negative (see footnote 3). Now

\[
\frac{\partial\Pi^M_R}{\partial \tau_1} = M^*\frac{\partial y^2_{r}}{\partial \tau_1} + \frac{\partial M}{\partial \tau_1}x^2_{r} + y^1_{z}-(1-\tau^0)y^2_{z}+(\tau^1-\tau^0)y^1_{z}, \tag{B1}
\]

\[
\frac{\partial\Pi^M_R}{\partial \tau_0} = M^*\frac{\partial y^2_{r}}{\partial \tau_0} + \frac{\partial M}{\partial \tau_0}x^2_{r} + x^0+(r-d^2)x^2_{r}+(1-\tau^0)y^2_{z}+(\tau^1-\tau^0)y^1_{z}, \tag{B2}
\]

\[
\frac{\partial\Pi^M_R}{\partial \tau_2} = M^*\frac{\partial y^2_{r}}{\partial \tau_2} + \frac{\partial M}{\partial \tau_2}x^2_{r} + (1-\tau^0)y^2_{z}+(\tau^1-\tau^0)y^1_{z}. \tag{B3}
\]

From Appendix A $y^1_{t^1} = -\alpha y^1_{t^0}; y^2_{t^1} = -\alpha y^2_{t^0}; Y_{t^1} = -\alpha Y_{t^0}; y^2_{t^2} = y^1_{t^2} = Y_{t^2} = 0$. Using these equalities we get $\partial(y^2_{t^1})/\partial \tau^1 = -\alpha \partial(y^2_{t^0})/\partial \tau^0$ and $\partial(y^2_{t^2})/\partial \tau^2 = 0$.

From (10) $(\partial M/\partial \tau^1)y^2_{t}+y^1 = -\alpha[(\partial M/\partial \tau^0)y^2_{t}-x^0+(r-d^2)x^2_{t}]$ and $(\partial M/\partial \tau^2) = 0$. By substituting these into (B1)-(B3) one gets

\[
\tau_{t^1} = -\alpha \tau_{t^0}; \tau_{t^2} = 0. \tag{B4}
\]

Let us next evaluate the sign of $\tau_{t^1}$ and $\tau_{t^0}$ in the case where demand functions $z^1(p)$ and $z^2(p)$ are linear. From Appendix A we get

\[
(1-\tau^0)y^2_{t^1} + (\tau^1-\tau^0)y^1_{t^1} = [\alpha/(3p^z)](r-d^1)(2-\alpha) \tag{B5a}
\]

\[
(1-\tau^0)y^2_{t^0} + (\tau^1-\tau^0)y^1_{t^0} = [1/(3p^z)](r-d^0)(\alpha-2). \tag{B5b}
\]

Under Assumption 1 the sign of (B5a) is negative (positive) when $r-d^1 > 0$ ($< 0$) and the sign of (B5b) is positive (negative) when $r-d^1 > 0$ ($< 0$).
know that \( y_{r_t}^2 = (1+\alpha)/(3p') < 0 \) and therefore \( y_{r_t}^2 = (\alpha/p')(1-\tau^1)^{-1} < 0 \) and \( y_{r_t}^0 = (-1/p')(1-\tau^1)^{-1} > 0 \). From (10) \( M_{r_t} = -(iz_1^1 p'y_1^1 - (1-\tau^1)p'y_{r_t}^1) \) and \( M_{r_t}^0 = -(r-d^2)(1-\tau^1)p'y_{r_t}^1 \), and \( M \) can be calculated from (10) at vertical supply equilibrium. By substituting these terms into (B1) and (B2) we see that signs of \( r_{t,1} \) and \( r_{t,0} \) are ambiguous. To get concrete results let us evaluate \( r_{t,0} \) and \( r_{t,1} \) at \( r-d^1 = r-d^2 = 0 \). Then \( r_{t,0} < 0 \) iff \( M_{r_t}^0 = M_y^2 > 0 \) since \( y_{r_t}^1 = y_{r_t}^2 = 0 \), all \( i=1,2 \), which is equivalent to

\[
r_{t,0} < 0 \iff M < x^0/y_{r_t}^2 = (-p')(1-\tau^1)x^0 > 0.
\]

(B6)

From (10) \( M = (-p')(1-\tau^1)(\alpha x^0 - y^1)(1+\alpha)^{-1} \). By substituting this into (B6) we get the relation

\[
r_{t,1} > 0 \land r_{t,0} < 0 \iff \alpha = \frac{(1-\tau^0)}{(1-\tau^1)} < \frac{1}{2} + \frac{3}{2} \frac{Y^1}{X^0}.
\]

(B7)

APPENDIX C: Effects of profit tax rates on \( \pi^1, \pi^0, \) and \( \pi^2 \).

Recall equations (1), (2) and (3) when \( d^i = u^i + v^i + d^0 \), \( i=1,2 \),

\[
\pi^1 = (t^2 - s^1)z^1 + (p - t^2 + s^1 - r)y^1
\]

(C1)

\[
\pi^0 = (r - d^1)y^1 + (r - d^2)x
\]

(C2)

\[
\pi^2 = (p - r)y^2 + (r + w^2)x^2 - s^2(x^2).
\]

(C3)

From (C1) using (6), from (C2), and from (C3) using (5) and (7) we get the following effects on profits, where \( \alpha = (1-\tau^0)/(1-\tau^1) \).
Input price $r$: 

$$
\pi^1_r = (iz^1_p + p'y^1)y^2_r - \alpha(r-d^1)y^1_r - y^1$
$$
$$
\pi^0_r = (r-d^1)y^1_r + (r-d^2)x_r + y^1 + x$
$$
$$
\pi^2_r = p'y^2y^1_r - x$

profit tax rate $\tau^1$

$$
\pi^1_{r1} = (iz^1_p + p'y^1)y^2_{r1} - \alpha(r-d^1)y^1_{r1}$

in country 1:

$$
\pi^0_{r1} = (r-d^1)y^1_{r1} + (r-d^2)x_{r1}$
$$
$$
\pi^2_{r1} = p'y^2y^1_{r1}$

profit tax rate $\tau^0$

$$
\pi^1_{r0} = (iz^1_p + p'y^1)y^2_{r0} - \alpha(r-d^1)y^1_{r0}$

in country 0:

$$
\pi^0_{r0} = (r-d^1)y^1_{r0} + (r-d^2)x_{r0}$
$$
$$
\pi^2_{r0} = p'y^2y^1_{r0}$

profit tax rate $\tau^2$ in country 2:

$$\pi^1_{r2} = \pi^0_{r2} = \pi^2_{r2} = 0.$$

APPENDIX D: Optimal policy of the output exporting country.

The exporting country sets $\tau^1$ to maximize (12), subject to the constraint $x(\cdot) \geq 0$. Let $L^* = W^1(\cdot) + \mu x(\cdot)$, where $\mu \geq 0$ represents the Lagrange multiplier. At the maximum, $\tau^1$ satisfies the first order conditions:

$$
\frac{\partial L^*}{\partial \tau^1} = \frac{\partial W^1}{\partial \tau^1} + \mu (\partial x/\partial \tau^1) = 0; \quad \partial L^*/\partial \mu = x \geq 0.
$$

(D1)

If $\mu > 0$, then $x = 0$ and from (9) $(\partial x/\partial \tau^1) = x_r p^2 + y^2_r = 0$, so that

$$
\frac{\partial L^*}{\partial \tau^1} = \frac{\partial W^1}{\partial \tau^1}.
$$

We assume that the second order condition

$$
\frac{\partial^2 W^1}{\partial \tau^1 \partial \tau^1} < 0
$$

is satisfied. This condition holds if $p''(Y) = 0$ and $x^2_{rr} = 0$. When the definition $W^1_r = -(z^1_s z^1_p Y_r - (s^1 - u^1)y^1_r + (iz^1_p + p'y^1)y^2_r - \alpha \tau^1(r-d^1)y^1_r + (1-\tau^0)(r-d^2)x_r + (1-\tau^0)x - \tau^0 y^1_r$, is used, from (9), (12) and Appendix C, the optimal value $\tau^1$ satisfies since $U^\prime - p = 0$ and $x_{r1} = y^2_{r1}$.
\[ \frac{\partial W_1^1}{\partial \tau^1} = -(z^1 s^1 z^1_p)p' Y_{\tau} + (s^1 - u^1) y_{\tau} + i(z^1 p' + p y^1) y^2_{\tau} \\
- \alpha^1 (r - d^1) y^1_{\tau} + (1 - \tau^0) (r - d^2) y^2_{\tau} + W^1 r = 0, \] (D2)

We have to analyze the necessary condition for optimality in two cases; first, when the MNF vertically foreclosures and second, when it vertically supplies.

**D1a:** Vertical foreclosure: \( r = r^P; x = 0; x_{r^1} + x_{r^2} = 0. \) Since from (9) \( r^P_{\tau} = -y^2_{\tau}/x_{r_{\tau}} \) (B2) reduces to

\[ \frac{\partial W}{\partial \tau^1} = -(z^1 s^1 z^1_p)p' (\partial Y/\partial \tau^1) - (s^1 - u^1)(\partial y^1/\partial \tau^1) \\
+ (i(z^1 p' + p y^1)(\partial y^2/\partial \tau^1) - \alpha^1 (r - d^1)(\partial y^1/\partial \tau^1) - \tau^0 y^1_{r^1}, \] (D3)

where \( \partial Y/\partial \tau^1 = Y^1_{\tau} + Y^2_{r^1} \) and \( \partial y^i/\partial \tau^1 = y^i_{\tau} + y^i_{r^1}, i=1,2. \) Their signs can be derived as follows: from Appendix A \( y^1_{\tau} > 0, y^2_{r} < 0, \) and \( Y_r < 0 \) in all cases assuming that every tax rate is less than half and \( r^P - d^1 > 0 \) and \( r^P \) is always the upper limit of the input price (see footnote 4). Then from Appendix A and (9) we know that \( r^P - d^1 > 0 \iff y^1_{\tau} > 0 \land y^2_{r} < 0 \land Y_{\tau} > 0 \land r^P_{\tau} < 0. \) Then \( \partial Y/\partial \tau^1 = (Y^1_{\tau} + Y^2_{r^1}) > 0 \) and since at \( r = r^P \) \( \partial x/\partial \tau^1 = 0 \iff \partial y^2/\partial \tau^1 = x_{r^2} > 0 \) and therefore \( \partial y^1/\partial \tau^1 > 0. \)

**D1b:** Vertical supply: \( r < r^P, \Pi^M_r = 0. \) By substituting (9) into the definition of \( W^1_r \) to get

\[ W^1_r = -(z^1 s^1 z^1_p) Y^1_r - \alpha^1 (r - d^1) y^1_r + (r - d^2) x + y^1_{r} \]

- \( (s^1 - u^1) y^1_r. \) Substitution of this into (D2) provides the optimality condition.

Note, that derivation of the coalitions' optimal policies are available upon request.
Chapter 5

EFFECTS OF THE GATT PROPOSAL FOR AGRICULTURAL SUPPORT ON WELFARE AND OPTIMAL POLICY IN THE PRESENCE OF IMPERFECT COMPETITION.

ABSTRACT. This chapter assesses the effects of the GATT proposal to reduce price and export support for agriculture on welfare and optimal agricultural policy in the case of an international duopoly in final product markets. The model concerns vertically related agricultural intermediate and final product markets in the presence of agricultural intermediate product surplus dumped onto rest of the world. The results show that a reduction in the amber support, implying restriction on the sum of the total value of internal price support and export support for agricultural intermediate product, increases consumer surplus and decreases farmer surplus. The effects on output producer surplus is ambiguous. In the presence of the GATT proposal, a marketing levy charged to farmers to finance export costs of agricultural product and a food industry export subsidy are perfect substitutes for welfare maximization.

JEL classification: 612, 821, 1713

1. INTRODUCTION

Agricultural policy in advanced countries has been characterized by strong protection of domestic producers by means of trade restrictions and direct price support. Despite significant progress made toward trade liberalization in manufactured commodities through GATT multilateral trade negotiations, agricultural protectionism has persisted and even strengthened in recent decades. For OECD countries as a whole, agricultural protection expressed in terms of the Producer Subsidy Equivalents soared from 28 per cent in 1980 to 47 per cent in 1986 (Rayner et al 1993).
Protection was particularly high in Japan, the Efta countries and the EU and rose sharply in the USA.

One reason for massive agricultural support is the influence of different interest groups (Winters, 1993). Many interest groups press for protection, but those in agriculture are widely believed to be among the best organized and most influential in Western countries. Farm lobbies are not without their allies. If the 'agro-industries' can earn rent on their sales to or purchases from farmers, they too have a strong interest in maintaining agricultural output. Since, for example, the large grain companies in the USA and the chemicals giants on the both sides of the Atlantic appear to have substantial market power, it is not surprising to find them lobbying in support of agriculture.

Visible symptoms of agricultural policy included large costs to national budgets and agricultural product surpluses. For example, it has been estimated that protection given to EU producers under the Common Agricultural Policy led to the community being a net exporter rather a net importer of many commodities in the early 1980s (Rayner et al 1993). Competitive subsidization by exporters attempting to dump surpluses in a restricted import market depressed international prices and created trade tensions. Conflicts were created between the major players - the EU and the USA.

In the Uruguay Round negotiations in the GATT a high priority was given to reforming domestic farm policies which distort agricultural trade. Some measure of consensus exists amongst the major participants (the EU and the USA) on the need to reduce the budget costs and international trade
frictions associated with current farm support programs, but the specific
objectives of the principal contestants had not coincided and as a result
the negotiations had been difficult and protracted until December 1993.
However, the USA and EU have shared a common purpose in seeking reforms
that, firstly, would improve market access, secondly, would reduce domestic
price support, and thirdly, would reduce export subsidies (see Rayner et
al, 1993). Improved import access would reduce customs duties, including
those resulting from the tarification of all non-tariff barriers (e.g.
import quotas, variable levies and minimum import prices). In December
1993, the EU and the USA reached the agreement according to which countries
should reduce the internal price support at the rate of 20 per cent, should
reduce the import tariffs at the rate of 36 percent on average, and should
reduce the export support at the rate of 36 per cent. The transition period
will start from 1st of January 1995, and it will continue until the end of
1999 (Kettunen 1993).

The developed countries dominate most aspects of world agricultural trade;
as exporters and/or importers they were involved in 87 per cent of the food
trade in 1988. Some 50 per cent of this commerce takes place among
developed countries. The USA was the single largest exporter of food in
1989 with 14.5 per cent of the world total trade (Rayner et al 1993).
According to Josling (1993) one important pressure on agriculture and on
agricultural policy has come from the growing interdependence of the US and
the EU economies both between themselves and with other countries. In the
USA, a high proportion of crop output is exported and world market weakness
triggers problems for domestic policy. In the EU, low world market prices
often cause budget crises in farm spending. The political position of
agriculture in both the USA and the EU depends largely on the silent
acquiescence of agro-industries. Whereas US agribusiness has been an advocate of reform, EU food and feed processing firms have tended to take the view that their interests are best served by a large and prosperous domestic agricultural sector.

We consider whether an imperfectly competitive food industry changes the common view that the most efficient transfers are those that do not distort production or consumption decisions\(^1\). The main purpose of this chapter is to study the effects of the GATT proposals on welfare and optimal policy in developed countries. Before the GATT agreement, the USA insisted in the GATT negotiations that there must be separate and specific commitments to (i) reducing internal support, (ii) improving import access, and (iii) reducing subsidies. The EU would go no further than advancing the 'formula approach' to reduce support and protection, spanning all three of these aspects, based upon an agreed Aggregate Measure of Support (AMS) (see Rayner et al, 1993). Until section 5 we follow the EU's negotiation target and assume that the GATT proposal restricts 'the amber support', i.e. the sum of the total value of internal price support and export support. Although the EU and the USA have reached the agreement it is interesting to study the effects of the GATT proposals since the GATT agreement itself is a weak, although important, discipline, implying that liberalization process will continue.

\(^1\)Such 'decoupled' agricultural policies have long been advocated by economists, but rejected by farmers, with the tacit acceptance of agro-industries, as a form of welfare. There are ways of partially decoupling price support, in particular by tying full support payments to some form of supply restriction. The effect is to reduce the amount by which output exceeds that in the non-subsidized situation, and thus reduce the efficiency loss from the transfer.
This chapter examines a very simplified model trying to capture some main characteristics of the agricultural sector, trade in agricultural products and agricultural policy harmonization. Firstly, the agricultural sector is divided into farming and an imperfectly competitive food industry. Family farmers produce intermediate products (e.g. meat, milk, grain) for the food industry which produces consumer goods (e.g. processed meat, dairy products, grain products).²

Secondly, consumer goods are traded between developed countries and not exported to developing countries. Since developed countries restrict intermediate product imports by tariffs or non-tariff barriers and since they support domestic production, implying agricultural intermediate products surpluses, there is no intermediate products trade between developed countries. Developed countries attempt instead to dump processed surpluses (e.g. butter, milk powder, frozen meat, flour) onto the rest of the world at low world market prices relative to price levels in developed countries.

Thirdly, the GATT proposal is assumed to imply reduction in the price support given to farmers and reduction in both processed intermediate

²Caveats of this simplified structure are, at least, firstly, that one can image a three level production structure in the case of some agricultural products; e.g. grain is produced by family farmers and sold to large grain companies, having market power, which produce flour for small competitive bakeries; secondly, some agricultural products like flour is traded both between developed countries and with developing countries; thirdly, agricultural policy in almost every industrialized country is very complicated and includes numerous policy measures varying across products.
agricultural products and consumer goods export subsidies. The GATT proposal can be adequately represented by these instruments, since the paper assumes that the food industry in developed countries has to pay regulated contract input prices (being higher than the world market prices) for their domestic intermediate products. If the world market prices cum customs duties, including tariffication of non-tariff barriers (the Dunkel proposal), are lower than the domestic contract prices, domestic food processing firms would buy foreign intermediate products. This is not a viable situation for the domestic country and therefore domestic import tariffs are assumed to be calibrated such that the world market prices cum custom duties are equal to the contract input prices. Thus a reduction in price support implies a reduction in import tariff of intermediate product.

The partial equilibrium model contains two countries (the EU and the USA) and the rest of the world (see figure 4 in chapter 1), one agricultural product being input in food industry and two food processing firms, one located in the EU and the other in the USA. Family farmers produce an intermediate product (e.g. meat, milk) for the food industry, producing a consumer good (e.g. processed meat, dairy product). In considering the market for a consumer good in two countries, we abstract from the possibility that a consumer good might be traded with the rest of the world. If markets in the rest of the world are segmented from those in the two countries this involves no loss of generality. The food processing firms are assumed to be Cournot competitors.

For some reason, internal price support is so large that overproduction of intermediate agricultural product prevails in both countries. Since surplus must be dumped to the rest of the world at the world market price, being
much lower than the internal input price, overproduction causes input export costs to be partly paid by taxpayers and partly by farmers by means of a marketing levy. Overproduction is no problem when the internal price equals the world market price, but surplus resulting from price support causes large export costs to national budgets. To keep the model more tractable we have made the simplification, in addition to the trade flow restriction and the choice of agricultural policy measures, that the world market intermediate agricultural product price is constant. The argument is that the GATT proposal itself is a weak (almost non-existent) discipline.3

This chapter can be integrated into the literature as follows. First, Munk (1990) considered only the case in which consumption of agricultural product is final and perfect competition in production prevails, analysing the optimality of the following agricultural support instruments: lump-sum transfers, subsidies to primary factors, deficiency payments and price support. This chapter extends his instrument set by including a marketing levy paid by farmers in the case of overproduction of agricultural products. The methodological difference between Munk’s paper and this chapter is that Munk has analysed the second-best problem, i.e. government’s budget constraint is binding, whereas the first-best problem is analysed here. Second, in the papers by Spencer and Jones (1991 and 1992; which can by no means be applied to agriculture) input and output

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3There are many studies which estimate the extent to which world commodity prices are lowered by protection or, conversely would be raised by liberalization. Tyers and Anderson (1988) estimate that eliminating all OECD protection policies would raise real international food prices by an average of some 30 per cent by 1995 in comparison to the levels likely to occur if the protection levels of the mid 1980s were continued with.
markets are vertically integrated in one country and this vertically integrated firm has a Cournot competitor in the other country. We extend the structure of vertical integration used by Spencer and Jones such that the market structure constitutes a few cooperative firms which are owned by large groups of farmers or farmers' trade unions, producing final goods from cultivated inputs.\footnote{The practical arguments for cooperative firms are that, first, they are the dominant form of firm in the food industry in Nordic and many EU countries and, second, farmers' trade unions have remarkable effects on agricultural policy in almost every industrialized country. Since after implementation of the GATT proposal farmers' trade unions will lose part of their opportunity to affect their income via the political process, they may turn their interest to the behaviour of firms in the food industry, i.e. many firms may become cooperative. The theoretical argument is that a standard private firm is a special case of a cooperative firm.}

The chapter is organized as follows: Section 2 presents the basic model of a vertically integrated international duopoly and the GATT proposal for agricultural support. Section 3 solves the model, and section 4 examines the welfare effects of international reduction in the amber support. Section 5 is divided into two sub-sections: the first considers optimal policy in the presence of the GATT proposal and the second under the current support system. In this latter case, we can evaluate the welfare effects of the USA's proposal. Finally, section 6 contains concluding remarks.
2. A MODEL

The model contains two cooperative firms, owned by farmers’ trade unions, and two countries. Firm 1 located in country 1 may export a final product to country 2 in competition with a rival, firm 2, located in country 2. In both countries there are many independent farmers producing an intermediate product or inputs for firms. The important feature is that when the farmers as a group decide on output production it maximizes a firm’s net profit and farmers’ aggregate net income. But an individual farmer maximizes only his/her own net income when deciding his/her own input production. When a group decides its firm’s output production it takes into account the behaviour of individual farmers, whereas an individual farmer takes the output production as given.

We assume that governments in both countries control the input prices. For some reason, internal price support is set so high that overproduction of input prevails in both countries. Therefore, both firms have to use domestic agricultural inputs and there is no input trade between countries 1 and 2, but overproduction has to be dumped onto the rest of the world at a constant price. Overproduction causes an input export cost partly paid by farmers by means of a marketing levy and partly by taxpayers resulting from the differences between the contract input prices and the world market price. The marketing levy skews the effective input price relevant to farmers from the contract input price.

Next, we consider the behaviour of farmers. We then turn to modeling the input price system after implementation of the GATT proposal. Finally we will consider the behaviour of output producers in the case of imperfect
competition.

Farmers' behaviour

There are $n^i$ identical input producers in country $i$, $i=1,2$, whose profit function is

$$l^i = r^i x^i - d^i(x^i),$$

where $r^i$ is the effective input price for farmers in country $i$ ($r^i$ will be defined in next sub-section), $x^i$ is the input production of a single producer and $d^i(x^i)$ is its cost function with $d^i_x > 0$ and $d^i_{xx} > 0$. Note, that in what follows $d^i_{xx}$ is assumed to be constant for simplicity. The aggregate income from input production is $L^i = n^i l^i$, aggregate production is $X^i = n^i x^i$ and the aggregate input production cost is $D^i = n^i d^i$.

Input price system

Overproduction is assumed to prevail in both countries causing an export cost due to internal price support. Many OECD countries try to control large export costs to national budgets either by quantity restrictions or via price mechanisms. The acreage reduction programs in Europe have been insignificant compared to those in the USA. In the USA the voluntary set-aside program was introduced in the late 1980s, but the effect has been very slight in cutting overproduction.\footnote{Ervin (1988) points out the weaknesses of area controls for supply management. Farmers participating in programs use their lowest net return areas for a set-aside. Furthermore, they may apply more inputs to their}
have to pay part of the export costs by means of a marketing levy (in the EU this is called the joint responsibility levy).  

The marketing levy is assumed to be proportional to production, i.e. the marketing levy is equivalent to a production price reduction. The effective price for farmers is then

\[ r^i = q^i - \beta^i, \quad \text{when } X^i > Y^i \]  \hspace{1cm} (2a)

\[ = q^i, \quad \text{when } X^i \leq Y^i, \]  \hspace{1cm} (2b)

where \( q^i \) is the contract input price (which is relevant for output producing firm \( i \) as explained in next section) and \( \beta^i \) is the marketing levy (per unit of production). To take into account one important feature in agricultural policy, the marketing levy depends on the domestic input surplus

\[ \beta^i = \lambda^i(X^i - Y^i), \]  \hspace{1cm} (2c)

where \( Y^i \) is the domestic demand for input and thus \( X^i - Y^i \) is the domestic remaining areas. It is also possible that the farmers not participating may farm their area more intensively if they expect that area reduction will raise market prices in the future. The obligatory and rotational set-aside may avoid part of these problems in principle.

\(^6\) Of course, we could consider both quantity and price control instruments. However, there is large literature about differences and similarities between price and quantity controls in different fields of economics, e.g. Weitzman (1977). It is well-known that in the case of uncertainty the effects of price and quantity controls differ, whereas in the case of certainty price and quantity controls are perfect substitutes for welfare maximization.
intermediate product surplus and $\lambda^i (> 0)$ is a parameter determining the farmers' marketing levy. The fact that the marketing levy depends on surplus reflects many countries' willingness to produce their own agricultural products, e.g. for security reasons.

The export cost paid by taxpayers is the total export cost deducted by the farmers' contribution to the export cost:

$$G^i = (q^i - \hat{q})(X^i - Y^i) - \beta^iX^i,$$

(3)

where $\hat{q}$ is the world market input price.\(^7\)

Now we turn to consider how the GATT proposal affects determination of the contract input price. We assume that the GATT proposal (following the EU negotiation target) will restrict the total value of trade-distorting amber support, being the sum of internal price support and export support.\(^8\) The total value of the amber support is defined as

$$R^i = (q^i - \hat{q})Y^i + G^i = (r^i - \hat{q})X^i,$$

(4)

\(^7\)If government $i$ does not pay any export costs $G^i = 0$ and (2a) becomes $r^i = q^i\omega^i + \tilde{\omega}(1-\omega^i)$, where $\omega^i = Y^i/X^i$, i.e. the effective input price is the weighted average of the contract and world market input prices.

\(^8\)Note, firstly, that we have assumed the tarification of all non-tariff barriers, i.e. those support measures which are very 'red' in distorting trade are phased out and, secondly, that there is no agreement yet about precisely which policy instruments are covered by GATT proposal (belonging to amber category) and which 'green' instruments, those deemed not to distort trade, are exempt (see Rayner et al 1993).
where $G^i$ comes from (3). Since farmers’ contributions to export cost are collected using the marketing levy only, the value of the amber support can be calculated by multiplying the difference between the effective input price and the world market price with total input production. Thus after the implementation of the GATT proposal the value of the amber support is restricted ($R^i = R^1$) implying that the contract input price is determined via equation (4). Before the GATT agreement the contract input price is assumed to be the government instrument and the value of the amber support $R^1$ does not matter.

**Firms’ behaviour**

Technological relationships are simplified by assuming that one unit of the input is required to produce one unit of output with linear cost function and that there are no other factors of production. It is assumed that country 1 (the USA) has a comparative cost advantage and therefore it potentially exports output (and input after agricultural policy liberalization) to country 2 (the EU). Firm 1’s profit is thus

$$\pi^1 = pZ^1 + (p-t+s)(Y^1-Z^1) - q^1Y^1 = iZ^1 + (p-i-q^1)Y^1,$$

where $Z^1$ and $Y^1$ are output consumption and output production respectively in country 1, $Y^1-Z^1$ is output export to country 2, $t$ is a specific tariff on output imports set by country 2, and $s$ is a specific subsidy on the output exports set by country 1, $i = t-s$. The firm has to pay the contract input price $q^1$ for inputs. A tariff and a subsidy may alter the effective price of output exports from the price of consumption in country 1.
The profit of the firm 2 is

\[ \pi^2 = (p-q^2)Y^2, \]  \hspace{1cm} (6)

where \( q^2 \) is the contract input price in country 2.

3. SOLUTION OF THE MODEL AFTER IMPLEMENTATION
   OF THE GATT PROPOSAL

The firms are either 'normal' ones maximizing their own profits or
cooperative ones maximizing the sum of their own net profits and farmers’
aggregate net profits. We first specify the objective function of the firms
as if they are the cooperative ones; i.e. the firms are vertically
integrated and owned by the coalition of input producers. This market
structure is called the vertically integrated duopoly case. The other
market structures, vertically semi-integrated duopoly (one firm is
non-integrated and the other is integrated) and duopoly are special cases.

Each firm decides output production taking into account the reaction
function of farmers and determination of contract input price in its own
country. But each firm takes the other firm's action and government
instruments as given. The sales of the homogeneous final product are
assumed to be determined by Cournot competition. Since there are many
farmers in both countries, each farmer makes his/her own production
decisions independently maximizing his/her own profit function and assuming
that his/her own actions have no effects on total input production and
therefore on output production and on the effective input price \( r^1 \).
Since an output producing firm (a farmers' trade union) is assumed to be the Stackelberg leader with respect to farmers, we first consider farmers' behaviour. From (1) using (2a) the input producer optimum is

\[ r^i = d_x^i(x^i). \]  

From (7) we get \( n^i x^i = X^i = X^i(q^i, Y^i, \lambda^i) \) with partial effects as \( X_{q^i}^i > 0, X_{Y^i}^i > 0 \) and \( X_{\lambda^i}^i < 0 \) (see Appendix A). The aggregate input production depends positively on the effective input price, which in turn depends positively on the contract input price and the domestic input consumption but negatively on the marketing levy parameter.

Next we turn to consider determination of the contract input price relevant to firms after implementation of the GATT proposal. From (4) using (2a) the contract input price becomes

\[ q^i = \tilde{q}^i + \beta^i + R^i/X^i \]  

(8)

implying, given (7), that \( q^i = q^i(\tilde{q}^i, \lambda^i, R^i, Y^i) \) with the partial effects as:

\[ \partial q^i/\partial \tilde{q}^i > 0, \partial q^i/\partial R^i > 0, \partial q^i/\partial Y^i < 0, \text{ and } \partial q^i/\partial \lambda^i > 0 \]  

(see Appendix B).

When international agreements effectively restrict the value of the amber support, an increase in the world market input price and in the amber support restriction increase the contract input price. An increase in the parameter affecting the farmers' marketing levy decreases the export cost to the national budget and this gives the room for price support, thus increasing the contract input price. The effect of the output on the contract input price is important in what follows. Given input production \( X^i \), an increase in firm i's output, \( Y^i \), decreases the marketing levy (at
rate of $\lambda^1$), reducing the contract input price, $q^1$. Since the input produced depends on the contract input price and on the output produced such that $X_\lambda^{1,q} = \lambda^1 X_\lambda^{1,q}$, the effects of $Y^1$ on $q^1$ via the input produced do not matter. Thus by increasing its production a firm can lower its input price, i.e. a firm faces a downward-sloping input supply curve.

**Proposition 1:** When international agreements effectively restrict the value of the amber support and farmers have to pay part of the export cost by means of the marketing levy, the oligopoly firm faces a downward-sloping input supply curve.

Finally, we turn to the behaviour of output markets. The output price in countries 1 and 2 is given by inverse demand function $p = p(Y)$ where $p'(Y) < 0$ and $Y = Y^1 + Y^2$ represent aggregate output. $Y^1$ and $Y^2$ are output production in countries 1 and 2 respectively. Output consumption is assumed to be $Z^1 = Z^1(p)$ with $Z^1_{dp} < 0$. The vertically integrated firm 1 (owned by a farmers’ trade union) maximizes the sum of firm 1’s profit and the farmers’ aggregate income. Using (5), (1), (2a) and (2c) the objective function is

$$M^1 = (p-\beta^1)Z^1 + (p-t+s-\beta^1)(Y^1-Z^1) + (q^1-\beta^1)(X^1-Y^1) - n^1d^1(x^1),$$

(9)

where $\beta^1 = q^1-r^1$ is the marketing levy per unit paid by farmers. The objective function of the cooperative firm depends on the following four components: 1) the effective value of domestic output consumption, 2) the effective value of output export, 3) the effective value of input surplus and 4) the input production cost. Since $X^1 = X^1(q^1,Y^1,\lambda^1)$ and $q^1 = q^1(q,Y^1,\lambda^1,\lambda^1)$ the first-order condition for a maximum is
\[ \partial M_1^1 / \partial Y^1 = M_1^1 = iZ_p^1 p' + (p' + \lambda_1^1) Y^1 + (p - \bar{q} - q_1^1) = 0. \] (10)

Equation (10) shows that the higher the parameter affecting farmers' marketing levy, \( \lambda_1^1 \), is the more the firm produces. This follows from that an increase in the output decreases the contract input price (at rate of \( \lambda_1^1 \)) after implementation of the GATT proposal. If the marginal effect of production on the input price were larger in absolute value than the marginal effect of production on the output price (\( p' + \lambda_1^1 > 0 \)) the 'strategic term' would be positive implying that the firm, having market power, would have incentive to produce more than a perfect competitive firm. When \( \lambda_1^1 \) is zero, (10) reduces to the condition familiar from the Brander and Spencer type model. Finally, the vertically integrated and the nonintegrated duopoly behave exactly the same way, i.e. the farmers' net income does not affect the production of the vertically integrated duopoly.

This follows from the fact that the GATT proposal makes the contract input price endogenous such that output production has no effect on farmers' aggregate income (see equation (16) in section 5.2).

By starting from general case firm 2 is assumed to be the cooperative one maximizing \( M_2^2 = \pi^2 + L_2^2 \). Since \( X^2 = X^2(q^2, Y^2, \lambda^2) \) and \( q^2 = q^2(q, Y^2, R^2, \lambda^2) \) the first-order condition for a maximum is

\[ \partial M_2^1 / \partial Y^2 = M_2^1 = (p' + \lambda^2) Y^2 + p - q^2 = 0. \] (11)

Since the special cases are obtained the same way as above, let us now turn to comparative statics effects. Solving (10) and (11) simultaneously, the Cournot equilibrium levels of output can be expressed as a function of \( \bar{r}, \bar{q}, \lambda_1^i, R_1^i, i = 1, 2; \) i.e. \( Y^i = Y^i(\bar{r}, \bar{q}, \lambda_1^1, R^1, R^2) \). To determine comparative
static effects (derived in Appendix C) we have assumed, as usual, that the second order conditions for profit maximization hold and the Cournot equilibrium is unique and that one firm's own marginal profit declines with an increase in the output of the other firm (see Bulow et al, 1985), i.e. \( M_{11}^1 < 0; M_{12}^1 < 0; M_{22}^2 < 0; M_{21}^2 < 0; \) and \( M_{11}^1 M_{22}^2 - M_{12}^1 M_{21}^2 > 0. \) To get the unambiguous effects of the instruments on the output produced we have to assume in addition:

Assumption 1: i) The input surplus in both countries is less than 100 per cent. ii) The slope of the demand curve is more than twice as big as the marketing levy parameter, i.e. \( p^i + 2\lambda_i = M_{ii}^i - M_{ij}^i < 0 \) both \( i \neq j. \)

It is shown in Appendix C that the condition i) implies unambiguous effects of the marketing levy parameters to the outputs produced; and the condition ii) implies unambiguous effects of the instruments on the total output produced. Note that due to the stability of Cournot oligopoly, both conditions in ii) cannot be positive. The comparative statics are presented in Table 1.

**TABLE 1: Comparative statics effects on output production.**

<table>
<thead>
<tr>
<th>Instr.</th>
<th>( \dot{q} )</th>
<th>( s )</th>
<th>( t )</th>
<th>( R^1 )</th>
<th>( \lambda^1 )</th>
<th>( R^2 )</th>
<th>( \lambda^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( Y^1 )</td>
<td>?</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>( Y^2 )</td>
<td>?</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>( Y )</td>
<td>-</td>
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<td>+</td>
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<td>+</td>
</tr>
</tbody>
</table>

The effects of the output export subsidy and of the output import tariff on outputs produced are familiar from the Brander and Spencer type models. A reduction in the level of the amber support in one country decreases the
contract input price and thus increases output in that country while
decreasing output in the other country. An increase in the marketing levy
parameter in one country increases production in that country but decreases
production in the other country. Although the parameter affects the
contract input price negatively, it affects the 'strategic term' positively
such that the total effect of parameter $\lambda^i$ on firm $i$'s marginal revenue is
positive when the input surplus is less than 100 per cent. The world market
input price has ambiguous effects on production since an increase in the
world market price decreases the amber support, giving the room for an
increase in the contract input price in both countries. This increases both
firms' production cost and thus the effects on firms' production are
ambiguous.

Proposition 2: When international agreements effectively restrict the value
of the amber support and farmers have to pay part of the export cost by
means of the marketing levy, the marketing levy parameter can be used for
output export promotion as the output export subsidy.

4. WELFARE EFFECTS OF REDUCTION IN THE AMBER SUPPORT

According to the EU's proposal, the GATT negotiations are assumed to imply
restriction on the amber support, i.e. on the total value of internal price
support and input export cost to national budgets. By using this framework
we can evaluate effects of international reduction in the amber support on
welfare in the presence of the new system. (The effects of change in the
system with fixed $R^i$ are not considered here.) Since a policy harmonization
will be partial it is interesting to evaluate the changes in welfare during
transition period. Let us therefore consider equal marginal reduction in
the amber support in both countries. From Table 1 we know how \( R^1 \) and \( R^2 \)
affect \( Y^1 \) and \( Y^2 \) and from (8) how \( R^1 \) and \( R^2 \) affect \( q^1 \) and \( q^2 \) respectively.
From (5) and (6) using (10), (11), (8) and Table 1, one obtains the effects
on firm 1's and firm 2's profits as

\[
\frac{\partial \pi^1}{\partial R} = \frac{\partial \pi^1}{\partial R} + \frac{\partial \pi^1}{\partial R}^2 = (iZ_1^1 p^1 + p^1 Y^1)(Y^2_{R^1} + Y^2_{R^2}) - Y^1 q^1_{R^1},
\]

\[
\frac{\partial \pi^2}{\partial R} = \frac{\partial \pi^2}{\partial R} + \frac{\partial \pi^2}{\partial R}^2 = p^2 Y^2(Y^1_{R^1} + Y^1_{R^2}) - Y^2 q^2_{R^2}.
\]

respectively. The first term measures the effects via one firm's output
which the other firm does not take into account and the second term
measures the effects via the input price.

From (1) using (2a), (7), (8) and Table 1 one obtains the effects on
aggregate input producer surplus in country \( i \) as

\[
\frac{\partial L^i}{\partial R} = \frac{\partial L^i}{\partial R}^1 + \frac{\partial L^i}{\partial R}^2 = (1 - \gamma^i X^i q^i_{R^i}).
\]

The amber support affects aggregate farmers' income only via the contract
input price and the marketing levy paid by farmers, since changes in input
production, given the effective input price for farmers, do not affect
farmers' income due to the envelope theorem. The net effect of the amber
support on the effective input price for farmers results from a direct
change in the contract input price and a change in the input production due
to a change in the contract input price. This follows from two things: i)
the effects of output on the contract input price precisely equals the
opposite value of the effects of output on the marketing levy holding input
production fixed; ii) the direct effect of the output on the input production precisely equals the opposite value of its indirect effect via the contract input price. Since a change in the amber support in one country does not directly affect the contract input price in the other country, the amber support in one country has no effect on the farmers’ income in the other country.

In addition, the effects on the consumer surplus in country i are

$$\partial S_i/\partial R = \partial S_i/\partial R^1 + \partial S_i/\partial R^2 = -Z^i p'(Y_{R^1} + Y_{R^2} + Y_{R^1}^2 + Y_{R^2}^2).$$  \hspace{1cm} (12d)

i.e. only changes in the total output production matter. The general effects of the worldwide reduction in the amber support are summarized in proposition 3.

**Proposition 3:** The worldwide reduction in the amber support
i) increases consumer surplus unambiguously under Assumption 1,
ii) decreases the input producer surplus (the farmers’ aggregate income) unambiguously in both countries,
iii) affects the output producer surplus ambiguously; both firms, however, cannot lose.\(^9\)

**Proofs:** i) From Appendix C \(\partial Y/\partial R^1 < 0\) iff \(p' + 2\lambda^1 < 0\), in both i. ii) Since

\(^9\)In the case of linear demand functions, the effects of a marginal reduction in the amber support on the output producer surplus depends 1) on the relative size of the input production in both countries; 2) on the slope of the demand curve; and 3) on the size of the marketing levy parameter.
\[ X_q^i = (D_{xx}^i + \lambda^i)^{-1}, \] implying that \( 1 - \lambda^i X_q^i > 0 \) and \( q_R^i > 0 \) a reduction in the amber support unambiguously decreases farmer income. iii) From Appendix C we know that \[ \text{sign}(Y_{R1}^i + Y_{R2}^i) = \text{sign}(M_{12}^2 q_R^1 - M_{12}^1 q_R^2) \text{ and sign}(Y_{R1}^2 + Y_{R2}^2) \]
\[ = \text{sign}(M_{11}^1 q_R^2 - M_{12}^2 q_R^1), \] where \( M_{11}^1 < 0, M_{12}^1 < 0, M_{22}^2 < 0, \) and \( M_{21}^2 < 0. \) Since \( q_R^i > 0, \) in both \( i, \) and since \( H = M_{11}^1 M_{22}^2 - M_{12}^1 M_{21}^2 > 0, \) \( \text{sign}(Y_{R1}^i + Y_{R2}^i) \neq \text{sign}(Y_{R1}^2 + Y_{R2}^2). \) In the linear case, \( \text{sign}(Y_{R1}^i + Y_{R2}^i) > 0 \text{ iff } 2(p^* + \lambda^i)/p^* > q_R^i / q_R^1 = A^i x^i / (A^j x^j), \) \( i \neq j, \) where \( A^k \) is defined in Appendix B.

5. OPTIMAL TRADE POLICY BEFORE AND AFTER THE IMPLEMENTATION OF THE GATT PROPOSAL

In this section we consider how implementation of the GATT proposal (the EU version) would affect the optimal agricultural policy of the output exporting country. To do this, the section is divided into two sub-sections: the first one deals with the optimal policy after and the second one before implementation of the GATT proposal. According to the USA's version the GATT proposal will imply a separate and specific reduction in the contract input price the input export support. Simplifying somewhat the latter means a specific reduction in the marketing levy parameter. Therefore, at the same time as we calculate the optimal policy under the current system, we can evaluate the welfare effects of the USA's proposal.

The welfare function of country 1 consists of three parts: first from consumer's utility and other sectors of the economy,\(^{10}\) second from the

\(^{10}\)Consumer utility is assumed to be based on the additive utility function,
profits of the output producing firm and the input producers’ income and third from the government’s income. The welfare function of country 1 is

\[ W^1 = U(Z^1)pZ^1 + \pi^1 + L^1s(Y^1-Z^1) - G^1. \]  

(13)

In the following two sub-sections we analyse the optimal policy after agreement about the GATT proposal and under the current system.

5.1 Optimal policy after implementation of the GATT proposal.

The government in country 1 maximizes its welfare function with respect to an output export subsidy \((s^1)\) and a marketing levy parameter \((\lambda^1)\), taking into account the reaction function of both farmers and firm as well as determination of the contract input price in country 1, but taking the government instruments in country 2 as fixed. The first-order conditions for maximization of the welfare function can then be obtained by differentiating (13). Since \(U' - p = 0\), and using formulas in Appendix D the optimal value of \(s^1\) and \(u^1\) satisfy

\[ \partial W^1/\partial s = -(Z^1 - sZ^1)p^2Y^s_s + \pi Z^1p^2Y^2_s + p^2Y^1Y^2_s - sY^1_s + (q^1 - \lambda^1Y^1 - \tilde{q})Y^1_s = 0, \]  

(14)

\[ V = U(Z^1) + F^1, \]  

where \(U(Z^1)\) is utility from the consumption of \(Z^1\), and \(F^1\) is the utility from the consumption of a numeraire good ensuring that the marginal utility of income is equal to 1. The marginal product of labour in the production of \(Z^1\) is assumed to be constant, fixing a wage rate \((\omega^1)\) and a wage bill \((\omega^1H^1)\), since \(H^1\) is constant. Setting total income (including the subsidy payments and the profit tax revenue, firm 1’s net profit and the farmers’ net profit) at equal to total expenditure, the welfare function is (13), when omitting the constant variables \(F\) and \(\omega H\).
\[ \frac{\partial W^1}{\partial \lambda^1} = -(Z^1 - sZ^2)_{P'} Y_{\lambda^1} + (Z^2 - sY_{\lambda^1} Y^1_{\lambda^1} + (q^1 - \lambda^1 Y^1 - \bar{q}) Y^1_{\lambda^1} = 0, \tag{15} \]

respectively, where \( Y_{\lambda^1} = \Omega Y_{s} (> 0), \ Y^1_{\lambda^1} = \Omega Y^1_{s} > 0, \) and \( Y^2_{\lambda^1} = \Omega Y^2_{s} < 0 \) with \( \Omega = (2Y^1_{s} X^1)/(1-Z^1_{P'}) > 0. \)

The optimal condition (14) can be divided into three components: 1) The first three terms take into account effects of the export subsidy on domestic consumer surplus and on the export cost due to change in domestic consumption. If we had assumed perfect output market segmentation, these three terms would have vanished. 2) The fourth and fifth terms capture just the Spencer and Brander (1983) result that an export subsidy increases domestic welfare when there is Cournot competition between a foreign and a domestic country. 3) The sixth, unambiguously positive term measures the effects on the input export cost paid by taxpayers. This results from the direct effects of the input consumption on the contract input price and on the input surplus, since its effect on the input export cost paid by taxpayers via the input supply is zero. Thus the export cost due to price support causing an input surplus provides an additional motive over and above the profit-shifting due to Cournot competition to subsidy output production. Note, finally, that the determination of output export subsidy does not depend on whether firm 1 is cooperative or not since both types of firms behave the same way.

Since the marketing levy parameter like the export subsidy affect welfare only via the outputs produced and since their effects on the outputs are proportional, following from that both instruments affect only firm 1’s marginal revenue, the export subsidy and the marketing levy parameter are equivalent policy instruments for welfare maximization. The intuitive
reason for this result is that there is only one distortion in this model which firm 1 does not take into account but the government does, namely the behaviour of the rival firm. Therefore only one instrument is needed to correct inefficient allocation. Note, however, that when the output export subsidy is zero, implying that firm 1’s output have no effect on country 1’s budget via the value of export subsidy, only the corner solution for the marketing levy parameter would be relevant, since the effects of $\lambda^1$ on welfare are unambiguously positive. The marketing levy should then be so high that input surplus disappears. Proposition 4 summarizes the results concerning the optimal size of policy instruments.

*Proposition 4:* In the presence of the GATT proposal,

i) the optimality conditions are identical independent of whether firm 1 is cooperative or not,

ii) the export subsidy and the marketing levy parameter are perfect substitutes for welfare maximization,

iii) the input export gives an additional motive over and above the profit-shifting due to Cournot competition to subsidy domestic output production.

5.2 Optimal policy under the current system.

Since the amber support restriction is ineffective and therefore the contract input price is the government’s instrument as well as the output export subsidy and the marketing levy parameter, the behaviour of firms changes as compared to section 3, where we have solved the model after implementation of the GATT proposal. We start solving the model in the presence of the current system by considering the behaviour of firms.
Cooperative firm 1 maximizes (9) taking farmers' behaviour into account and taking $q^1$ and $Y^2$ as given and cooperative firm 2 maximizes the sum of (6) and (1) taking farmers' behaviour into account and taking $q^2$ and $Y^1$ as given. The first order conditions for a maximum are,

$$\partial M^1/\partial Y^1 = iZ^1_\lambda p' + p'Y^1 + (p-i-q^1) + \delta^1X^1(1-X^1_{Y^1}) = 0, \quad (16)$$

$$\partial M^2/\partial Y^2 = p'Y^2 + p-q^2 + \delta^2X^2(1-X^2_{Y^2}) = 0, \quad (17)$$

respectively, where $X^i_{Y^i} = \lambda^i(D^i_{xx} + \lambda^i)^{-1}$, implying that $1-X^i_{Y^i} > 0$, and $\delta^i$ is a dummy variable: in the case of a cooperative firm $\delta^i = 1$ and in the case of a non-cooperative firm $\delta^i = 0$, both $i$. Now a cooperative and a non-cooperative firm behaves differently; the cooperative produces more than the non-cooperative, since the contract input price does not adjust to eliminate the effect of input consumption on the marketing levy. The comparison of equations (10) and (16) suggests that a cooperative duopoly may produce more or less output in the presence of the GATT proposal than in the current system, whereas a nonintegrated duopoly produces more output in the new system than in the old one.

Since the special cases can be obtained the same way as above, we turn to comparative statics. Solving (16) and (17) simultaneously, the Cournot equilibrium levels of output can be expressed as a function of $i$, $q^1$, $q^2$, $\lambda^1$ and $\lambda^2$. The comparative statics effects on $Y^1$, $Y^2$, and $Y$ are calculated in Appendix E. The main result is that the marketing levy parameter in one country does not affect the output produced when the output producing firm in that country is nonintegrated. Only when farmers' income affects the domestic firm's behaviour does this instrument have a positive effect on
the domestic output and a negative effect on the foreign output.

Now we can turn to determining optimal policy in country $1^{II}$. The first-order conditions for maximization of the welfare function can be obtained by differentiating (13) with respect to a contract input price, an output export subsidy and a marketing levy parameter, taking into account the reaction function of both farmers and firm. Since $U^\prime_p = 0$, and using the formulas in Appendix F the optimal value of $s$, $q^1$ and $\lambda^1$ satisfy

$$\partial W^1/\partial s = -(Z^1-sZ^1_p)p^\prime Y_s + (iZ^1_p p^\prime + p^\prime Y^1)Y_s^2 - sY^1_s$$
$$+ [(q^1 - \delta^1 \lambda^1 X^1 - \tilde{q})(1-X^1_Y) + \lambda^1(X^1 - Y^1)X^1_Y]Y^1_s = 0,$$

$$\partial W^1/\partial q^1 = -(Z^1-sZ^1_p)p^\prime Y_q + (iZ^1_p p^\prime + p^\prime Y^1)Y^2_q - sY^1_q$$
$$+ [(q^1 - \delta^1 \lambda^1 X^1 - \tilde{q})(1-X^1_Y) + \lambda^1(X^1 - Y^1)X^1_Y]Y^1_q$$
$$- [q^1 - \lambda^1(X^1 - Y^1) - \tilde{q}]X^1_q = 0,$$

$$\partial W^1/\partial \lambda^1 = -(Z^1-sZ^1_p)p^\prime Y_{\lambda} + (iZ^1_p p^\prime + p^\prime Y^1)Y^2_{\lambda} - sY^1_{\lambda}$$
$$+ [(q^1 - \delta^1 \lambda^1 X^1 - \tilde{q})(1-X^1_Y) + \lambda^1(X^1 - Y^1)X^1_Y]Y^1_{\lambda}$$
$$- [q^1 - \lambda^1(X^1 - Y^1) - \tilde{q}]X^1_{\lambda} = 0,$$

respectively. Let us first compare (18) with (14). The first row in (18) can be found in (14), i.e. both conditions include the effects on consumer surplus, the effects via a change in the domestic consumption and the Spencer and Brander effect. The terms measuring the effect of output export subsidy on the input export costs paid by taxpayers differ. This follows

\footnote{Welfare effects of the USA's version for the GATT proposal, a separate and specific reduction in the contract input price the input export support, could be calculated as done in section 4.}
from the endogeneity of the contract input price which the firm takes into account in the GATT proposal and from the exogeneity of the contract input price in the current system. In addition to the canals how the export subsidy affects welfare, the contract input price and the marketing levy parameter affect welfare by changing the input production and thus farmers' net income.

Consider next the optimal policy mix in the case when firm 1 is non-cooperative, i.e. $\delta^1 = 0$. Since the marketing levy parameter has no effect on the output markets, i.e. $Y^1_{\lambda^1} = Y^2_{\lambda^1} = Y^1_{\lambda^1} = 0$, it should be set such that the effective input price is equal to the world market price. By substituting this result into (18) and (19) we find that the sixth term in (19) vanishes and the term in the square brackets in the second row in both equations reduces to $q^1 - \tilde{q}$. Now equation (18) says that the higher the difference between the domestic and the world market input price is, the higher the domestic export subsidy should be. Since a high contract input price reduces firm 1’s incentive to produce, this should be compensated by a high export subsidy, which would shift excess profit due to Cournot competition to the domestic country. However, the export subsidy and the contract input price are perfect substitutes for welfare maximization, i.e. only one or the other instrument has to be utilized in order for the government to achieve the optimum, since both instruments affect only firm 1’s marginal revenue and thus $Y^1_s = \phi Y^1_{q^1} > 0$, $Y^2_s = \phi Y^2_{q^1} > 0$ and $Y_s = \phi Y_{q^1} > 0$, where $\phi = -(1 - Z^1_p p') < 0$ (see Appendix E).

What about if firm 1 is cooperative? The marketing levy parameter affects the output markets such that $Y^1_s = \psi Y^1_{q^1} = \theta Y^1_{\lambda^1} > 0$, $Y^2_s = \psi Y^2_{q^1} = \theta Y^2_{\lambda^1} < 0$, $Y_s = \psi Y_{q^1} = \theta Y_{\lambda^1} > 0$, where $\psi < 0$ and $\theta > 0$ are defined in Appendix E.
Therefore we can substituted (18) into (19) and (20). When \( s \) is set at its optimum the contract input price and/or the marketing levy parameter should be set such that \( q^1 = \tilde{q} + \lambda^1 (X^1 - Y^1) \) implying from (2a) that the effective input price should be equalized with the world market price.

One interesting case arises assuming that the government cannot use the output export subsidy. In this case, an interior solution for the contract input price is possible since the second term and the second row in (19) is negative whereas the last row is positive. Assume the interior solution for the contract input price and substitute (19) into (20). Then

\[
(r^1 - \tilde{q})X_q^1 [\psi + (X^1 - Y^1)\theta] / \psi = 0,
\]

(21)

where \( \psi + (X^1 - Y^1)\theta = Y^1 - \lambda^1 X^1 X_q^1 > 0 \), when \( \lambda^1 \) is small. Therefore given the assumption of input surplus, we can safely state that the input price distortion should be eliminated at the optimum.

**Proposition 5:** Given the current support system, independent of whether the domestic firm is a cooperative or a non-cooperative

i) the contract input price and/or the marketing levy parameter should be set such that the effective input price for farmers is equal to the world market price, i.e. the domestic input price distortion should be eliminated,

ii) the output export subsidy and the contract input price are perfect substitutes for welfare maximization, when the effective input price for farmers is equal to the world market price.

The interpretation is that the input price distortion should be eliminated
by setting the contract input price and the effective input price for farmers at the world market price, and the export subsidy should be positive, since it increases domestic welfare when there is Cournot competition between a foreign and a domestic firm (Spencer and Brander 1983). When the effective input price is equal to the world market price the only distortion in the model results from the Cournot competition in the output market. Therefore, a government can use either the export subsidy or the contract input price to subsidize domestic production.

6. CONCLUSION

In this chapter we have considered effects of the GATT proposal "the general amber support reduction", implying restriction on the sum of the total value of internal price support and export support, on welfare and optimal policy in the presence of imperfect competition in the food market. In addition to the traditional duopoly model in the international environment we have introduced a special form of vertical integration, where an output-producing firm is owned and controlled by a group of farmers or a farmers' trade union.

The chapter shows that the international amber support reduction i) increases consumer surplus in both countries and ii) decreases farmers' aggregate income unambiguously in both countries. The effects of an international amber support reduction on firms' profit are ambiguous in general. However, both firms cannot lose even in the general case.

The optimal agricultural and trade policies are as follows. In the presence
of the GATT proposal the export subsidy and the marketing levy parameter are equivalent policy instruments. The input export cost, due to price support causing input surplus, gives an additional motive over and above the profit-shifting due to Cournot competition to subsidy domestic output produced. The optimality conditions are identical independent of whether firm 1 is cooperative or not, since both types of firms behave the same way in the presence of the GATT proposal. Given the current support system, independent of whether a domestic firm is a cooperative or a non-cooperative, the contract input price and/or the marketing levy parameter should be set such that the effective input price for farmers is equal to the world market price, i.e. the domestic input price distortion should be eliminated. Then the output export subsidy and the contract input price are perfect substitutes for welfare maximization.

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APPENDIX A: Comparative Statics for \( X^i \).

From (7) \( \partial x_i^i/\partial r^i = 1/d_{xx}^i \). From (2a) \( \partial r^i/\partial q^i = 1-\lambda_i^i X_{q}^i \); \( \partial r^i/\partial Y^i = \lambda_i^i (1-X_Y^i) \); \( \partial r^i/\partial \lambda_i^i = -(X^i - Y^i) \lambda_i^i X_{\lambda}^i \). Defining \( D_{xx}^i = d_{xx}^i/n^i \) we get

\[
X_{q}^i = 1/(D_{xx}^i + \lambda_i^i); \quad X_Y^i = \lambda_i^i/(D_{xx}^i + \lambda_i^i); \quad X_{\lambda}^i = -(X^i - Y^i)(D_{xx}^i + \lambda_i^i).
\]  

(A1)

APPENDIX B: Comparative Statics for \( q^i \).

From (7) using (4) we get \( q^i = \tilde{q} + \lambda_i^i (X^i) - Y^i + R^i/X^i \). Since \( X^i = X^i(q^i, Y^i, \lambda^i) \) with \( X_Y^i = \lambda_i^i X_q^i \) and \( X_{\lambda}^i = -(X^i - Y^i) X_q^i \), we get

\[
\partial q^i/\partial \tilde{q} = 1/A^i; \quad \partial q^i/\partial R^i = (1/X^i)/A^i; \quad \partial q^i/\partial Y^i = -\lambda_i^i; \quad \partial q^i/\partial \lambda_i^i = X^i - Y^i,
\]  

(B1)

where \( A^i = 1 - X^i [\lambda_i^i - R^i/(X^i)^2] = (D_{xx}^i + \lambda_i^i)^{-1} [D_{xx}^i + R^i/(X^i)^2] > 0 \).

APPENDIX C: Comparative statics for \( Y^i \) under the GATT proposal.

Total differentiation of (10) and (11) and using \( X^i = X^i(q^i, \lambda^i, Y^i) \) and \( q^i = q^i(q^i, Y^i, R^i, \lambda^i) \) produces, where \( M_{ij}^i = \partial^2 M_i/\partial Y^i \partial Y^j \), \( i, j = 1, 2, \)

\[
M_{11}^1 = iZ_{pp}^1 (p') + iZ_{p'p'}^1 + 2(p' + \lambda_1^1) + p'' Y^1, \quad M_{22}^1 = 2(p' + \lambda_2^1 + p'' Y^2, \quad (C1)
\]

\[
M_{12}^1 = iZ_{pp}^1 (p') + iZ_{p'p'}^1 + p'' Y^1, \quad M_{21}^2 = p' + p'' Y^2.
\]

\[
M_{11}^1 = -(1-Z_{p'p'})/2, \quad M_{11}^q = -1/A^1, \quad M_{11}^R = -1/(A^1 X^1), \quad M_{11}^2 = 0.
\]

At equilibrium, \( Y = Z^1(p) + Z^2(p) \Rightarrow p = p(Y) \). Thus \( p' = \partial p/\partial Y = (Z_1^1 + Z_2^2)^{-1} \).

12
\[ M_{11}^{1} = 2Y^{1}X^{1}, \quad M_{12}^{1} = 0, \quad M_{22}^{2} = 0, \quad M_{2q}^{2} = -1/A^{2}, \quad M_{2R1}^{2} = 0, \quad M_{2R2}^{2} = -1/(A^{2}X^{2}), \quad M_{2}\lambda^{1} = 0, \quad M_{2}\lambda^{2} = 2Y^{1}X^{1}. \]

In considering comparative statics the following assumptions are made.

First, \( M_{12}^{1} \) and \( M_{21}^{2} \) are negative implying that reaction functions in the output space have negative slopes, or equivalently, that outputs produced by each firm are strategic substitutes.\(^{13}\) Second, the second-order conditions for profit maximization are assumed to hold and the Cournot equilibrium is unique: \( M_{11}^{1} < 0, \quad M_{22}^{2} < 0 \) and \( H = M_{11}^{1}M_{22}^{2} - M_{12}^{1}M_{21}^{2} > 0. \) Third, the input surplus in both countries is less than 100 per cent, i.e. \( 2Y^{i}X^{i} > 0. \) This is due to \( M_{i}\lambda^{i} = Y^{i}q_{i}\lambda^{i} = 2Y^{i}X^{i} \). The parameter \( \lambda^{i} \) affects the marginal revenue by two ways: it affects the 'strategic term' and the contract input price. Using (C1) one obtains

\[
\frac{\partial Y^{1}}{\partial \bar{i}} = \frac{M_{22}^{2}(1-Z_{p}^{1}p')}{H} < 0; \quad \frac{\partial Y^{2}}{\partial \bar{i}} = -\frac{M_{21}^{2}(1-Z_{p}^{1}p')}{H} > 0; \quad (C2)
\frac{\partial Y^{1}}{\partial \bar{q}} = \frac{M_{22}^{2}(HA^{1})-M_{12}^{1}(HA^{2})}{(HA^{1})} < 0; \quad \frac{\partial Y^{2}}{\partial \bar{q}} = -\frac{M_{21}^{2}(HA^{1})+M_{11}^{1}/(HA^{2})}{(HA^{1})} < 0
\frac{\partial Y^{1}}{\partial R^{1}} = \frac{M_{22}^{2}(HA^{1}X^{1})}{(HA^{1}X^{1})} < 0; \quad \frac{\partial Y^{2}}{\partial R^{1}} = -\frac{M_{21}^{2}(HA^{1}X^{1})}{(HA^{1}X^{1})} > 0
\frac{\partial Y^{1}}{\partial R^{2}} = -\frac{M_{12}^{1}(HA^{1}X^{1})}{(HA^{1}X^{1})} > 0; \quad \frac{\partial Y^{2}}{\partial R^{2}} = \frac{M_{11}^{1}(HA^{1}X^{1})}{(HA^{1}X^{1})} < 0
\frac{\partial Y^{1}}{\partial \lambda^{1}} = \frac{-M_{22}^{2}(2Y^{1}X^{1})}{H} > 0; \quad \frac{\partial Y^{2}}{\partial \lambda^{1}} = \frac{-M_{21}^{2}(2Y^{1}X^{1})}{H} < 0
\frac{\partial Y^{1}}{\partial \lambda^{2}} = \frac{M_{12}^{1}(2Y^{2}X^{2})}{H} < 0; \quad \frac{\partial Y^{2}}{\partial \lambda^{2}} = \frac{-M_{11}^{1}(2Y^{2}X^{2})}{H} > 0.
\]

Then \( 1-Z_{p}^{1}p' = Z_{p}^{2}(Z_{p}^{1}+Z_{p}^{2})^{-1} > 0. \)

\(^{13}\)It is possible for the homogeneous outputs to be strategic complements (see Bulow, Geanakoplos and Klemberer, 1985). In the analysis of Cournot oligopoly, this assumption is used in order to ensure stability (Hahn 1962).
APPENDIX D: Effects of instruments on aggregate profits and on input export cost paid by taxpayers in the presence of the GATT proposal

From (3) using (2c) \( G^1=(q^1\lambda^1X^1-\tilde{q})(X^1-Y^1) \) and therefore using (7) and (8) \( \partial G^1/\partial s=-(q^1\lambda^1X^1-\tilde{q})Y_s \) and \( \partial G^1/\partial \lambda^1=-(q^1\lambda^1X^1-\tilde{q})Y_{\lambda^1}X^1-Y^1(X^1-Y^1) \).

Since \( \pi^1+L^1=-(p^-b^1)Y^1+(p^+s-b^1)(Y^1-Z^1)+(q^1-b^1)(X^1-Y^1)-n^1d^1(x^1) \), using (10) \( \partial(\pi^1+L^1)/\partial s=Y^1-Z^1+(\tilde{Z}^1-p^+p^+Y^1)Y^2 \) and \( \partial(\pi^1+L^1)/\partial \lambda^1=(\tilde{Z}^1-p^+p^+Y^1)Y_{\lambda^1}^2(X^1-Y^1)Y^1 \).

APPENDIX E: Comparative statics for \( Y^1 \) under the current system.

Total differentiation of (16) and (17) by assuming that \( D_{xx}^i \) is constant and using \( X^1=X^1(q^1\lambda^1,Y^1) \) produces, where \( M_{ij}^1=\partial^2 M^i/\partial Y^1 \partial Y^j \), \( i,j=1,2 \),

\[
\begin{align*}
M_{11}^1 &= i\tilde{Z}^1_{pp}(p^+)^2+i\tilde{Z}^1_{pp}(p^+)^2+2p^++p^+p^+Y^1 + \delta_1^1\lambda^1X^1_Y(1-\lambda^1_X^1_Y) < 0 \\
M_{12}^1 &= i\tilde{Z}^1_{pp}(p^+)^2+i\tilde{Z}^1_{pp}(p^+)^2+p^+ Y^1 < 0 \\
M_{22}^2 &= 2p^++p^+p^++p^+Y^2 + \delta_2^1\lambda^2X^2_Y(1-\lambda^2_X^2_Y) < 0 \\
M_{21}^2 &= p^+ Y^2 < 0 \\
M_{1s}^1 &= 1-Z^1_p p' > 0; \quad M_{2s}^2 = 0; \\
M_{1q}^1 &= -1+\delta^1\lambda^1X^1_{q}^1(1-\lambda^1_X^1) < 0 \quad M_{2q}^2 = 1; \\
M_{1\lambda}^1 &= \delta^1[(X^1+\lambda^1X^1_{\lambda}^1)(1-\lambda^1_X^1)-\lambda^1X^1_X^1] < 0 \quad M_{2\lambda}^2 = 0; \\
&= \delta^1D^1_{xx}X^1_{q}^1[X^1-\lambda^1X^1_X^1(1-Y^1X^1_{\lambda})] > 0;
\end{align*}
\]

where \( \delta^1 \) is a dummy variable: when firm 1 is cooperative (non-cooperative) \( \delta^1 = 1 \) \( \delta^1 = 0 \). Noted, that we have imposed the same assumptions as in Appendix C. The comparative statics effects on \( Y, Y^2 \) and \( Y \) are:
\[ \frac{\partial Y^1}{\partial s} = M_{22}^2 (-M_{1s}^1)/\mathcal{H} < 0; \quad \frac{\partial Y^2}{\partial s} = -M_{21}^2 (-M_{1s}^1)/\mathcal{H} > 0; \]  
\[ \frac{\partial Y^1}{\partial q^1} = M_{22}^2 (-M_{1q}^1)/\mathcal{H} (> 0) \quad \frac{\partial Y^2}{\partial q^1} = -M_{21}^2 (-M_{1q}^1)/\mathcal{H} (< 0) \]  
\[ \frac{\partial Y^1}{\partial \lambda^1} = M_{22}^2 (-M_{1\lambda}^1)/\mathcal{H} (> 0) \quad \frac{\partial Y^2}{\partial \lambda^1} = -M_{21}^2 (-M_{1\lambda}^1)/\mathcal{H} (< 0), \]

where \( \mathcal{H} = M_{11}^1 M_{22}^2 - M_{12}^1 M_{21}^2 > 0 \). Defining \( \psi = -(1-Z_p^1 p'/[(1-\lambda^1 X_q^1 Y(1-X_q^1 Y)]) < 0 \)

and \( \theta = (1-Z_p^1 p')/(D_{xx}^1 X_q^1 Y(1-\lambda^1 X_q^1 Y(1-2X_q^1 Y)))) > 0 \) one obtains that in the case of cooperative firms \( Y_s^1 = \psi Y_q^1 = \theta Y^1 > 0 \), \( Y_s^2 = \psi Y_q^1 = \theta Y^1 < 0 \), and \( Y_s = \psi Y_q^1 = \theta Y^1 > 0 \).

APPENDIX F: Effects of instruments on aggregate gross profits and on input export cost paid by taxpayers in current system

From (3) using (2a) \( G^1 = (q^1-\lambda^1 X^1-\tilde{q})(X^1-Y^1) \) and \( \pi^1+L^1 = (p-\beta^1) Z^1 + (p-t+s-\beta^1) Y^1 + \delta^1 [(q^1-\beta^1)(X^1-Y^1)-n^1 d^1(x^1)]. \) Using (8) and (16) we get

\[ \frac{\partial G^1}{\partial s} = -(q^1-\lambda^1 X^1-\tilde{q})(1-X^1 Y_s^1) - \lambda^1 (X^1-Y^1) X^1 Y_s^1 \]  
\[ \frac{\partial G^1}{\partial q^1} = (q^1-\lambda^1 X^1-\tilde{q}) X^1 Y_s^1 + (1-\lambda^1 X_q^1 Y^1 Y_q^1) (X^1-Y^1) \]  
\[ \frac{\partial G^1}{\partial \lambda^1} = (q^1-\lambda^1 X^1-\tilde{q}) X^1 Y_s^1 + (1-\lambda^1 X_q^1 Y^1 Y_q^1) (X^1-Y^1) \]

and

\[ \frac{\partial (\pi^1+L^1)}{\partial s} = -Z^1 + Y^1 + (iZ_p^1 p'+p'Y^1) Y_s^2 + (1-\delta^1) \lambda^1 X^1 (1-X_q^1 Y_s^1) \]  
\[ \frac{\partial (\pi^1+L^1)}{\partial q^1} = X^1 Y^1 - \lambda^1 X^1 X_q^1 Y_q^1 + (iZ_p^1 p'+p'Y^1) Y_q^2 + (1-\delta^1) \lambda^1 X^1 (1-X_q^1 Y_q^1) \]  
\[ \frac{\partial (\pi^1+L^1)}{\partial \lambda^1} = -X^1 (X^1-\lambda^1 X^1 X_q^1 Y_q^1 + (iZ_p^1 p'+p'Y^1) Y^2 + (1-\delta^1) \lambda^1 X^1 (1-X_q^1 Y^1) Y_q^1. \]
Chapter 6

AGRICULTURAL POLICY HARMONIZATION AND TRADE LIBERALIZATION IN THE NORDIC COUNTRIES

ABSTRACT. This chapter uses a partial equilibrium analysis to evaluate how a partial agricultural policy harmonization and a trade liberalization affect welfare contributed by the agricultural sector being characterized by a strongly protected intermediate product market and an imperfectly competitive final good market. When an intermediate good surplus prevails, causing export costs paid largely by taxpayers, and when restriction on a final good import is carried out by a quota, it is shown that agricultural policy harmonization, a reduction in price support, unambiguously increases domestic welfare; trade liberalization, an increase in final good import quota, affects welfare ambiguously.

JEL classification: 613, 615, 1717.

1. INTRODUCTION

Finland, Norway and Sweden applied for membership in the EU in the early nineties. From the very beginning it was clear that agriculture would be one of the most difficult matters for the accession. Agricultural policy in the Nordic countries (as in other advanced countries as well) has been characterized by strong protection of domestic producers by means of trade restrictions and direct price support. The price support to farming is relatively larger in the Nordic countries than in the EU and the food industry is less effective in the Nordic countries than in the EU due to lack of competition in the Nordic countries. Support levels measured by the net percentage Producer Subsidy Equivalents (PSEs) are: Finland, 71 %;
Norway, 77%; Sweden, 59%; and EU, 49% (see Kola 1993). In Finland, the percentage shares of cooperative firms over the marketed quantities of agricultural products in 1991 were: milk, 93%; meat, 69%; eggs, 70%; and grain, 53% (Aaltonen 1993).

The Nordic countries' agreement with the EU will probably cause agricultural policy harmonization and trade liberalization. Agricultural policy harmonization implies that price support to farmers will be determined by the rules of the EU’s Common Agricultural Policy; trade liberalization means that the Nordic countries will have to relax import restrictions on final goods.

This chapter evaluates the welfare impacts of the Nordic countries' EU membership on the agricultural sector. According to the Finnish negotiation targets agricultural policy harmonization, i.e. reduction of price support, and trade liberalization, i.e. increase in import quota, is partial (see Kettunen, 1993). The movement toward the Common Agricultural Policy and free trade is step-by-step. So in this chapter we are particularly interested in the effects on welfare during transition period.

In March 1994 Finland and Sweden reached the agreement with the EU.

\[1\] A PSEs capture the flow of transfer to the producers of a farm commodity through the manipulation of the prices (of both inputs and outputs). Transfers that do not pass through market are also included in the OECD figures, as are the provision of services that would otherwise have to be purchased in the market. A large share from support in the Nordic countries (at least, in Finland and Norway) is due to price support. E.g. Finnish producer prices are evaluated to be 30–50% higher than EU prices.
According to the contract Finland and Sweden should apply the agricultural prices prevailing in the EU immediately when the contract is effective (as from 1 January 1995?). However, within the limits of the agreement Finland and Sweden can compensate partly farmers' income losses during the transition period.

Agricultural sector is divided into farming and food industry.\(^2\) Farmers produce intermediate products to food industry, which in turn produces consumer goods. The two stage vertical production structure is surely very simplified description of production system in agriculture. However, this system tries to capture some basic elements in agriculture. Firstly, farmers produce their products (grain, milk) independently, maximizing their profits. Secondly, imperfectly competitive sector buys farmers products for making their products (flour, dairy products). It is assumed that only this second stage products are traded. Of course, flour is an intermediate product for use in making bread. This may call for three stage vertical structure. To keep the model tractable we analyze two level structure.

A special feature in the Nordic countries is that cooperative firms owned by agricultural producers have dominant role in food industry. These firms have substantial market power (see Aaltonen, 1993). We consider, therefore, a vertically integrated production structure in domestic country. A monopoly owned by the farmers' trade union in the food industry produces a final good using domestic agricultural intermediate goods cultivated by

\(^2\)The description of Finnish (the Nordic countries) agricultural policy is based on Kettunen (1993).
many farmers. In the domestic and foreign country the intermediate product price controlled by the government in both countries is so high that surplus prevails.\textsuperscript{3} Due to the surplus in both countries the intermediate product trade between the domestic and foreign countries is totally restricted; the surplus has to be sold to the rest of the world. Since there is imperfect competition in the food industry in the domestic country, thus increasing consumption price over marginal production cost, and foreign producers are perfectly competitive, and since intermediate product price is higher in the domestic than in the foreign country, there is potential final good trade from the foreign country to the domestic country. The final good trade is restricted by quota. The rest of the industries in the domestic country are characterized by constant returns to scale and perfect competition.

This chapter uses a partial equilibrium analysis to consider the effects of partial policy harmonization and trade liberalization on welfare in domestic country. Following Eldor and Levin (1990) we first analyze increase of quota in import of the final good set by either the foreign or domestic government (it is considered as a voluntary export restraint (VER) if it is set by the foreign government)\textsuperscript{4}. Second we study reduction of the

\textsuperscript{3}Input surplus figures of some products in Finland (Sweden) are: milk, 34 \% (0 \%); butter, 84 \% (22 \%); beef, 10 \% (0 \%); cereals, 31 \% (23 \%). The EU has large surplus problems in many agricultural products, e.g. cereals 20 \% and sugar 23 \%. (See Kola, 1993).

\textsuperscript{4}It may well happen that the EU will agree to restrict its export voluntary using a VER but will not use a quota set by the domestic government during the transition period, since the quota rents in the case of VER are captured by the foreign agent. Many economists regard VER as the most rapidly spreading instrument of protectionism in developed countries.
input price level in the domestic country towards the price level in the foreign country. We assume that the input surplus will persist in the domestic country during the entire transition period. This chapter extends the work done by Eldor and Levin, taking into account intermediate product market imperfections and a vertically integrated production structure in the domestic country.

This chapter is organized as follows: after presentation of a model in section 2, the welfare effects of policy harmonization and trade liberalization are derived in section 3; section 4 contains concluding remarks.

2. A VERTICALLY INTEGRATED MONOPOLY

Consider an industry in the domestic country where a vertically integrated monopoly exists in autarky. The monopoly producing a final good from cultivated inputs is owned by a large group of farmers or a farmers’ trade union. The important feature of the vertical structure is that when the farmers as a group decide on output production it is the sum of firm’s profit and farmers’ aggregate income, which is maximized. But an individual farmer maximizes his/her own profits.

It is assumed that a domestic government regulates the intermediate goods market. To support farmers’ income a government sets the input price higher than what a market clearing price level would be. This price support thus implies input surplus, i.e. the domestic input production is higher than the domestic input consumption at the regulated price. Since the price
support prevailing in the foreign country causes an surplus problem in that country, the domestic surplus has to be sold to the rest of the world at a constant world market price. Since the domestic input price is a higher than the world market price, input surplus causes export costs to be paid partly by farmers through a marketing levy and partly by taxpayers.\(^5\)

Another instrument to control surpluses is a set-aside program. For simplicity we have excluded set-aside programs and controlled the marketing levy only.\(^6\)

We now turn to the behavior of a vertically integrated structure. We start by considering farmers. In the given country, there are \(n\) identical input producers, whose profit function is

\[
1 = r x - d(x),
\]

(1)

where \(r\) is the effective input price for farmers (\(r\) will be defined in equation 2), \(x\) is the input production of a single producer and \(d(x)\) is its cost function with \(d_x > 0\) and \(d_{xx} > 0\). The aggregate income from input

\(^5\)In addition to a marketing levies surpluses are controlled by fertilizer taxes and production quotas. Frequently used instrument is the mandatory set-aside provisions which have the effect of controlling production so that production does not occur where "a control producer price" equals marginal cost. Governments, usually, subsidies those farmers participating in set-aside programs.

\(^6\)There is large literature about differences between price and quantity controls in different fields of economics, e.g. Weitzman (1979). It is well-known that in the case of uncertainty the effects of price and quantity controls differ, whereas in the case of certainty price or quantity controls are perfect substitutes for welfare maximization.
production is \( L = nl \), the aggregate production is \( X = nx \) and the aggregate input production cost is \( D = nd \).

Overproduction is assumed to prevail causing an export cost. We assume that farmers have to pay part of the export costs by means of a marketing levy which is assumed to be proportional to production, i.e. the marketing levy is equivalent to a production price reduction. Effective price for farmers is then

\[
\begin{align*}
  r &= q - \beta, \quad \text{when } X > Y, \quad (2a) \\
  r &= q, \quad \text{when } X \leq Y, \quad (2b)
\end{align*}
\]

where \( q \) is the contract input price set by a government and \( \beta \) is the marketing levy (per unit of production). To take into account one important feature in agricultural policy of many industrialized countries, the marketing levy depends on the domestic input surplus

\[
\beta = \lambda(X-Y), \quad \text{when } X > Y, \quad (2c)
\]

where \( X-Y \) is the total input surplus, since \( Y \) is firm's demand for input, and \( \lambda (> 0) \) is a parameter determining the farmers' marketing levy. The fact that the marketing levy depends on surplus reflects many countries' willingness to produce their own agricultural products, e.g. for security reasons.

Since there are many farmers, each farmer makes his/her own production decisions independently, maximizing his/her own profits and assuming that his/her own actions have no effects on total input production and therefore
on output production and on the effective input price \( r \). From (1) the input producer optimum is

\[
\frac{\partial \Delta b}{\partial \lambda} = \frac{D_{xx}}{\lambda} > 0,
\]

(3)

From (3) we get \( n = x = x(q,Y,\lambda) \) with partial effects as

\[
\frac{\partial X}{\partial q} = \frac{1}{(D_{xx} + \lambda)^{-1}} > 0,
\]

\[
\frac{\partial X}{\partial Y} = \lambda \frac{1}{(D_{xx} + \lambda)^{-1}} > 0,
\]

\[
\frac{\partial X}{\partial \lambda} = -(X-Y) \frac{1}{(D_{xx} + \lambda)^{-1}} < 0,
\]

(4)

where \( D_{xx} = \frac{d_{xx}}{n} \) (see Appendix A). Note that \( \lambda \) in denominators follows from the effects of total input production on export costs paid by farmers. The contract input price and the domestic input consumption affect positively and the marketing levy parameter negatively the effective input price for farmers, which in turn has a positive effect on aggregate input production.

Now we turn to the behavior of output markets. The output price in the domestic country is given by the inverse demand function \( p = p(Y+M) \) where \( p'(Y+M) < 0 \) and \( M \) denote the quantity of output imports sold in the domestic country at the monopolist price. Technological relationships are simplified by assuming that one unit of the input is required to produce one unit of output with linear cost function and that there are no other factors of production. The profit of the domestic firm is then

\[
\pi = (p-q)Y.
\]

(5)
The cooperative firm maximizes \( V \equiv \pi + L \). Using (5), (1) and (2) the objective function is

\[
V = (p-q)Y + n\{(q-\lambda)(X-Y)x-d(x)\} \equiv (p-\beta)Y + (q-\beta)(X-Y) - nd(x),
\]

(6)

where \( \beta \equiv q-r \) is the marketing levy per unit paid by farmers. The objective function of the cooperative firm depends on the following three components: 1) the effective value of domestic output production, 2) the effective value of input surplus and 3) the input production cost. If taxpayers finance all export costs the effective price of output production is the consumer price, and the effective price of surplus is the contract input price.

The cooperative firm maximizes (6) with respect to input consumption (output production), taking into account farmers' behavior and taking \( q \) and \( M \) as given. Thus the cooperative firm chooses price discriminating allocation of input and output production. The first order condition for a maximum is

\[
V_Y = \partial V / \partial Y = p'Y + p-q - \beta_Y X = 0
\]

(7)

where \( \beta_Y = \lambda(X_Y-1) < 0 \). The optimality condition for a nonintegrated monopoly can be obtained from (7) by setting \( \beta_Y = 0 \), i.e. a monopoly does not take into account effects of its input consumption on farmers income. Thus, a cooperative monopoly produces more than a nonintegrated one.

The comparative statics effects of the output import, and the contract input price on the output productions can be found as follows:
\[ V_{YY} = p''Y + 2p' - \beta_Y X_Y < 0 \]  
\[ V_{YM} = p''Y + p' < 0 \]  
\[ V_{Yq} = -1 - \beta_Y X_q < 0 \]

since \( \beta_{YY} = \beta_{Yq} = 0 \) by the assumption that \( D_{XX} \) is constant.

Thus an increase of output import decreases the output production, since we assume that own marginal revenue falls as the import increases, as does an increase of contract input price.

3. WELFARE EFFECTS OF TRADE LIBERALIZATION AND POLICY HARMONIZATION

In this section we consider how a partial trade liberalization and a policy harmonization affect welfare contributed by the agricultural sector. The former increases the output import to the domestic country and the latter decreases the contract input price level in the domestic country (see Kettunen, 1993). According to the Finnish EU membership negotiation target, a policy harmonization and relaxation of import restrictions will be partial and a movement towards a harmonized policy and free trade will be

\[ -1 - \beta_Y X_q = -[(D_{xx})^2 + \lambda D_{xx} + (\lambda)^2]/(D_{xx} + \lambda)^2 < 0. \]

This implies that reaction functions in output space have negative slopes, or equivalently, that outputs produced by each firm are strategic substitutes. It is possible for the homogeneous outputs to be strategic complements (see Bulow, Geanakoplos and Klemperer, 1985). In the analysis of Cournot oligopoly, this assumption is used in order to ensure stability (Hahn 1962).

\[ -1 - \beta_Y X_q = -[(D_{xx})^2 + \lambda D_{xx} + (\lambda)^2]/(D_{xx} + \lambda)^2 < 0. \]
step by step. Therefore, it is interesting to evaluate the changes in
domestic welfare during the transition period. It is assumed that input
surplus in the domestic country will prevail also after transition period.

The welfare function of the domestic country consists of three parts: 1) from consumer's utility,\(^9\) 2) from the profits of a monopoly and input producers and 3) from the government's income. The welfare function is

\[
W = U(Y+M)-p(Y+M)+\pi+L-G+(p-p^*)M,
\]

where \(G\) is the export cost paid by taxpayers and \(p^*\) is the foreign output price cum transport cost. The export cost paid by taxpayers is defined as

\[
G = (q-\bar{q})(X-Y) - \beta X = (q-\lambda X-\bar{q})(X-Y),
\]

where \(\bar{q}\) is the world market input price. The first term measures total export cost and the second measures the export cost paid by farmers.

The last term on the RHS of (9) is government's revenues from auctioning off the quota licenses. In the case of a voluntary output export restraint

\(^9\)Consumer's utility is assumed to be based on the additive utility function \(U(Y+M)+F\), where \(U(Y+M)\) is utility from the consumption of \((Y+M)\), and \(F\) is the utility from the consumption of a numeraire good ensuring that the marginal utility of income is equal to 1. The marginal product of labor in the production of \(Z\) is assumed to be constant, fixing wage rate \((\omega)\) and wage bill \((\omega H)\), since \(H\) is constant. Setting total income (including the subsidy payments and the profit tax revenue, the firm's net profit and the farmers' net profit) equal to total expenditure, the welfare function is (9) when the constant variables \(F\) and \(\omega H\) are left out.
(VER) by the foreign country this term does not exist. This section is divided into two sub-sections; first, the case of a voluntary output export restraint (VER) by the foreign country is studied and second, the case of a domestic quota is analyzed.

3.1. A voluntary output export restraint by the foreign country.

The welfare effects can be obtained by using an equation (9). Since $U'-p = 0$ and using the formulas in the Appendixes A and B, the effects of changes in output import quota on welfare can be expressed after some manipulations as

$$\partial W/\partial M = -p'M(Y_M+1) + [p-r-(r-q)(X_Y-1)]Y_M.$$ (11)

Equation (11) shows that voluntary export restraint by the foreign country influences domestic welfare in two ways. The first is an opposite terms of trade effect. That is, an increase in import affects the price that the domestic country pays for its import. This effect is ambiguous (unambiguously positive) in the case of a vertically integrated (nonintegrated) monopoly. The economic forces at work can be described in two stages. In the first stage, before the domestic firm adjusts its output, value of consumer surplus increases by the fall in price (at the rate of $p'$) times consumption. Producer surplus decreases by the fall in price times domestic production. Thus the net welfare effect is the price that the domestic country pays for its import. However, in the second stage, the domestic monopoly reacts by contracting output produced so as to maximize its objective function. This contraction increases the output price and thus decreases consumer surplus.
The second takes into account the effect of the contraction in output production on producer surplus and export cost paid by taxpayers. Using the envelope theorem this can be expressed as the effective price cost margins, i.e. 

\[-p'Y - G_\gamma \] = \[(p - q) + (q - \bar{q}) - (r - \bar{q})X_\gamma \] = \[p - r - (r - \bar{q})(X_\gamma - 1)\] > 0. Thus the price cost margins can be expressed either as the sum of the price cost margin in the output production, in the input export and in the input production or as the sum of the effective price cost margin in the domestic input consumption and in the input export. Since the consumer price is always higher than the effective input price, which is higher than the world market price, and since the domestic input consumption decreases input surplus, this second term is always negative. Thus in the case of nonintegrated monopoly the welfare effect of output import is ambiguous in general, since then \(Y_M + 1 > 0\). In contrast, in the case of a vertically integrated monopoly the sign(\(Y_M + 1\)) = -sign(\(p' - \beta_Y X_Y\)); thus the flatter the demand curve is and the more the domestic input consumption affects the marketing levy and the input production (i.e. the higher the parameter \(\lambda\) is), the more likely domestic output contraction is higher than 1. This, in turn, implies the unambiguously negative welfare effect of output import.\(^{10}\)

The effects of changes in the contract input price on welfare are, after some manipulations,

\[
\frac{\partial W}{\partial q} = -p'MY_q - (r - \bar{q})X_q + [p - r - (r - \bar{q})(X_\gamma - 1)]Y_q.
\] (12)

Equation (12) includes, in principle, the same terms as equation (11).

\(^{10}\)The Eldor and Levin’s (1990) result can be obtained when the input market does not matter, i.e. by setting \(r = q\) and \(X_\gamma - 1 = 0\).
However, the contract input price has no effect, of course, on output import and has a direct positive effect on input production. Since the effective input price is higher than the world market input price and since the contract input price has negative effect on output production, a reduction in the contract input price increases welfare unambiguously, in the case of both vertically integrated and nonintegrated monopolies.

Let us next consider the welfare effects at specific points during the transition period. Assume that before the transition period the output import is zero and that after it the contract input price in the domestic country, the domestic firm's marginal production cost, equals the contract input price in the foreign country, i.e. \( q = q^* > \bar{q} \), and the domestic output price must be equal to the foreign output price cum export costs, \( p^* \), since there is free trade. Before the transition period, when \( M = 0 \), the first term in both (11) and (12) vanishes, implying that the introduction of the "1st unit" of output import reduces welfare independent of whether the monopoly is vertically integrated or nonintegrated. After the transition period, when \( p = p^* \) and \( q = q^* \), and \( p^* = q^* \) assuming zero transport cost, the second term in (11) and the third term in (12) is still negative, if input surplus prevails at new prices.

The size of the first term increases and the size of second term decreases in (11) during the transition period. The later can be shown as follows. Assume, for simplicity, that the taxpayers pay all input export cost, implying \( r = q \) and \( X_Y = 0 \), and the output demand function is linear. Then the sum of the effective price cost margin in the domestic input consumption and in the input export reduces to \( p-\bar{q} \). A reduction in the domestic input price decreases the difference between the domestic consumer
price and the world market input price, since \( \partial(p-\bar{q})/\partial q = \partial p/\partial q = p'\partial Y/\partial q > 0 \). Therefore, the absolute size of second term positively depends on the domestic input price. This suggests a two-part transition period for agricultural policy harmonization and trade liberalization. During the first period the input price level is harmonized and trade liberalization occurs during the second period. The argument is that a reduction in the contract input price increases domestic welfare unambiguously and it decreases input price distortion. An increase in import is a less harmful the smaller input price distortion is. The proposition 1 summarizes the results in this section.

*Proposition 1:* Assume voluntary export restraint by the foreign country.

i) Agricultural policy harmonization, a reduction in contract input price, increases unambiguously domestic welfare, independent of whether a monopoly is vertically integrated or nonintegrated.

ii) Trade liberalization, an increase in output import, affects domestic welfare ambiguously in general. However, the introduction of the "1st unit" of import reduces welfare.

iii) A reduction in the input price increases the likelihood that trade liberalization increases welfare.

3.2. A domestic quota with the auctioning off quota licenses.

We analyze the case where the domestic country is small, i.e. \( p^* \) is exogenously given. When government revenues from auctioning off the quota licenses are significant the welfare effects of output import and contract input price are
\[ \frac{\partial W}{\partial M} = p-p^* + [p-r-(r-\hat{q})(X_Y^{-1})]Y_M \]

\[ \frac{\partial W}{\partial q} = -(r-\hat{q})X_q + [p-r-(r-\hat{q})(X_Y^{-1})]Y_q \]

respectively. The economic interpretation of equation (13) can be described in two stages. At the first stage (before the domestic firm responds), due to the introduction of additional units of import, consumer surplus rises by the fall in price (at rate of \( p' \)) times the amount consumed. This equals precisely the fall in government tariff revenue and producer surplus due to price change. So the net effect in this stage is an increase in government revenue by \( p-p^* \) due to increase in output import. In the second stage, the domestic monopoly reacts by contracting output. This contraction affects the output price and export cost paid by taxpayers.

In equation (13) these effects are grouped in two terms. The first is the direct effect (at constant price) of import on government tariff revenue. The second takes into account the effect of contraction in output production on producer surplus and export cost paid by taxpayers. Thus the effect of output import on domestic welfare is ambiguous in general since the first term is always non-negative and the second term non-positive. In equation (14) the contract input price has a positive effect on input production. Since the effective input price is higher than the world market price the first term is always non-positive and thus a reduction in contract input price increases welfare.

Consider next a special case. When farmers do not pay any input export costs or the effective input price for farmers is equal to the world market price, the price cost margins in the second term in (13) and (14) reduce to
p-\bar{q}. In order to compare the effect of output import in this case with that in Eldor and Levin (1990) we write (13) as

$$\partial W/\partial M = (p-\bar{q})(Y_M+1) + \bar{q}-p^*. \quad (15)$$

The first term in (15) is always positive and the second term always negative. This contradicts Eldor and Levin's result that any increase in import increases welfare prior to free trade. This results from the fact that the world market input price is higher than the reference input price here, whereas in Eldor and Levin the private marginal production cost (assumed to be higher than $p^*$) is the reference input price.\(^{11}\) We can see immediately from equation (15) that in the case of linear demand function ($\partial(Y_M+1)/\partial q = 0$) a reduction in the domestic input price decreases the likelihood that trade liberalization increases domestic welfare, since $\partial p/\partial q > 0$.

Moreover, it can be shown that in this special case, domestic country's welfare unambiguously increases from the point of free trade and harmonized contract input price. Since there is output import at free trade, the domestic output price must equal the foreign output price. Then equation (13) reduces to

$$\partial W/\partial M = (p^* - \bar{q})Y_M. \quad (16)$$

\(^{11}\)Assuming no input surplus, (13) becomes $W_M = (p-q)(Y_M+1)+(q-p^*)$. So far as $q > p^*$ any increase in output import increases welfare. If $q < p^*$ the output import may has negative effect on welfare.
Since $Y_M < 0$ and $p^* > \bar{q}$, any reduction of output import increases welfare. This result supports common agricultural policy in developed countries. If price support is an essential component of agricultural policy and if surplus of agricultural intermediate products causes export costs to taxpayers then restrictions, at least small, on final good imports produce improvement in welfare. Proposition 2 summarizes the section.

**Proposition 2**: Assume a monopoly in the domestic output importing industry of a small country and output import restriction in the form of quota licenses which are auctioned off.

i) Agricultural policy harmonization, a reduction in contract input price, increases domestic welfare, independent of whether a monopoly is vertically integrated or nonintegrated.

ii) The trade liberalization, an increase in output import, affects the domestic welfare ambiguously in general. When farmers do not pay any export cost any reduction in output import increases domestic welfare at the point of free trade and harmonized input price.

iii) A reduction in the input price decreases the likelihood that trade liberalization increases domestic welfare.

4. CONCLUDING REMARKS

This chapter uses a partial equilibrium analysis to evaluate the welfare impacts of the Nordic countries' EU membership on the agricultural sector: farming and food industry. According to the Finnish negotiation targets (Kettunen 1993) agricultural policy harmonization, i.e. reduction of price support, and trade liberalization, i.e. increase in import quota, is
partial. The movement toward the Common Agricultural Policy and free trade is step-by-step. So in this chapter we are particularly interested in the effects on welfare during transition period.

The analysis shows that when an intermediate good surplus prevails, causing export costs paid largely by taxpayers, and when restriction on a final good import is carried out by a quota, agricultural policy harmonization, a reduction in price support, unambiguously increases domestic welfare; trade liberalization, an increase in final good import, ambiguously affects welfare. In the case of the voluntary export restraint by the foreign country a reduction in the domestic input price increases the likelihood that trade liberalization increases welfare, whereas in the case of the output import restriction in the form of quota licenses a reduction in the domestic input price decreases the likelihood that trade liberalization increases welfare.

The analysis is limited in the sense that the welfare effects are defined from an efficiency point of view. Other government objectives are not considered here. Therefore, there remains some room for improvement in these areas.
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APPENDIX A: Comparative Statics for $X$.

From (3) $\partial x/\partial r = 1/d_{xx}$; From (2a) $\partial r/\partial q = 1-\lambda X_q$; $\partial r/\partial Y = \lambda (1-X_Y)$; $\partial r/\partial \lambda = -(X-Y)-\lambda X_{\lambda}$. Defining $D_{xx} = d_{xx}/n$ we get

\[ X_q = 1/(D_{xx} + \lambda); \quad X_Y = \lambda/(D_{xx} + \lambda); \quad X_{\lambda} = -(X-Y)/(D_{xx} + \lambda). \] (A1)

APPENDIX B: Effects of instruments on aggregate gross profits and on input export cost paid by taxpayers

From (10) $G = (q-\bar{q})(X-Y)-\beta X$ and from (6) $\pi + L = (p-\beta)Y + (q-\beta)(X-Y)-nd(x)$.

Using (4) we get

\[ G_Y = -(q-\bar{q}) + (q-\beta-\bar{q})X_Y - \beta_X Y, \] (B1)
\[ G_M = 0, \]
\[ G_q = X-Y + (q-\beta-\bar{q})X_q - \beta_X q. \]

Using (7) one obtains

\[ V_Y = 0, \] (B2)
\[ V_M = p'Y = -(p-q) + \beta_Y X, \]
\[ V_q = X-Y - \beta_X q. \]


VALTION TALOUDELLINEN TUTKIMUSKESKUS

Reino Hjerppe Ylijohtaja

Kansantalouden linja
Seppo Leppänen Tutkimusjohtaja

Verotuksen ja tulonsiirtojen linja
Iikko B. Voipio (vv.) Tutkimusjohtaja
Rolf Myhrman Vs. tutkimusjohtaja

Julkisten palvelujen ja investointien linja
Heikki A. Loikkanen Tutkimusjohtaja

JOHTOKUNTA
Ylijohtaja Sixten Korkman Puheenjohtaja
Ylijohtaja Lasse Arvela
Osastopäällikkö Markku Lehto
Pääjohtaja Markku Mannerkoski
Osastopäällikkö Kari Puumanen
Budjettipäällikkö Raimo Sailas
Ylijohtaja Reino Hjerppe
Erikoistutkija Tuomo Mäki