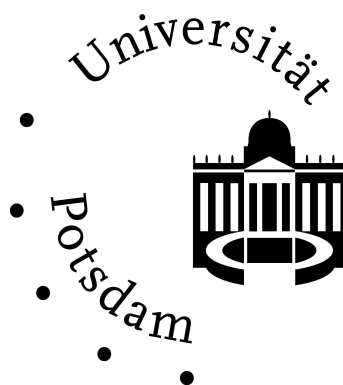# UNIVERSITÄT POTSDAM

WIRTSCHAFTS- UND SOZIALWISSENSCHAFTLICHE FAKULTÄT

VOLKSWIRTSCHAFTLICHE DISKUSSIONSBEITRÄGE

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INTERNATIONALER HANDEL UND RÄUMLICHE MÄRKTE – HANDELSPOLITIK AUS SICHT DER RÄUMLICHEN PREISTHEORIE

International Trade and Spatial Markets

- Trade Policy from a Theory of Spatial Pricing Perspective -

by

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Contents

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1. Introduction

In a time marked by enlarged economic regions transcending national borders and continuously growing international trade the question rises anew, if traditional Ricardian theory and Neo-Ricardian approaches to the theory of international trade hold as valid and sufficient explanations of international trade flows. Early doubts by August Lösch, raised in an age of protection and autarchy, despite not having provoked a substantial rethinking among scholars over the past sixty years, they have become ever more appropriate through the emergence of integrated regional markets in Europe and elsewhere around the world. Therefore, it seems worthwhile to take a closer look at Lösch's competing, explicitly spatial approach.

As much as Lösch regards the theory of comparative costs as suitable to explain the interpersonal division of labour, as unsuitable an instrument it is in his opinion to determine international specialization (Lösch [1938], [1939]). To explain the international division of labour, the theory of comparative costs assumes spaceless national territories, and thus uniform production conditions across each country. These conditions, however, are not at all identical across different regions of a national economy. "Diese Degradierung der Länder zu Punkten erleichtert die Irrlehre von ihrer wirtschaftlichen Einheit" (Lösch [1944], p. 176). Moreover, transport costs within countries are supposed to be zero and are considered between countries at best. Yet, the location of a production facility within a country may determine greatly its export perspectives. Quite often the total costs of transportation are higher within a country than between countries, whether due to lower charges of naval compared to surface freight-rates, or due to respective proximity to a common border. Finally, the theory of comparative costs proceeds from a uniform national price level, cutting short at the national border. But if this does not apply to the domestic territory, since transportation costs increase the commodity price from the place of production onwards, and consequently there is no uniform domestic price level, this conception cannot apply to international trade either. International trade rather connects domestic and foreign prices at the border. Price increases do not lift one single domestic price level, they spread across economic space changing the respective delivered price at every consumer's location, possibly affecting the foreign country likewise. Now, what does Lösch's proposal, countering the theory of comparative costs, look like? "Staaten sind", according to Lösch (Lösch [1944], p. 178), "... wirtschaftlich gesehen völlig willkürliche Bezugsgebilde. Da bleibt nichts übrig, als die Erzeugung aller Standorte zunächst ohne Rücksicht auf die politischen Grenzen festzustellen, diese Grenzen dann einzuzeichnen und ihre Wirkungen auf die Ausdehnung der Marktgebiete zu berücksichtigen. Dann sind alle Waren, deren Absatzgebiete von den Grenzen durchschnitten werden, Ausfuhrgüter, wenn das Erzeugungszentrum diesseits, und Einfuhrgüter, wenn es jenseits der Grenze liegt."

Apart from the few theoretical contributions combining spatial and international economics listed below, this approach has greatly been lying idle, even though it offers novel insight into international trade. One reason might be the sustained lack of a comprehensive synthesis between these two fields of economic theory. Now as before - this applies by and large - space is not included in the theory of international trade, and spatial economics do not deal with trade across national borders.

This essay seeks to combine those contributions based on the Löschian ideas in a spatial model of an international oligopoly, i.e. with at least one supplier's market area stretching across a national border. In an early paper, Benson and Hartigan [1983] demonstrate that import tariffs may reduce the (profit-maximizing) mill price, even that of the domestic firm. In further papers, these authors also tackle the effects of import quotas [1984] and the distributional incidence of tariffs [1987]. An early discussion of welfare effects in the mentioned analytical framework can be found for certain special cases in Porter [1984] as well as, with endogenous revenue and protective tariffs, in Schöler [1990]. Heffley and Hatzipanayotou [1991] investigate the impact of tariffs on population distribution and land rents as well as on consumers' mobility. Furthermore, alternative conjectural variations and heterogenous goods are treated by Heffley, Hatzipanayotou und Mourdoukoutas [1993] in a spatial market model with tariffs. Hass [1996] extends the analysis to alternative models of spatial competition on the one hand, and to endogenous welfare maximizing tariff rates on the other hand. This kind of endogenous welfare maximizing tariff rates, though calculated in a different fashion, is also applied by Schöler [1997]. Finally, Hass and Schöler [1999] reach a differentiated welfare-theoretical assessment of export subsidies. Certainly, not all the above-mentioned evidence can be shown here, thus in the present paper we will concentrate on the major lines of analytical reasoning.

The paper is organised as follows: In section 2, the assumptions and the basic spatial market model with free trade are illustrated, i.e. in a situation without administrative impediments to trade. Section 3 is committed to tariff policy. We investigate exogenous tariffs as well as endogenous tariff rates under three alternative aims: Total protection of domestic firms, public revenue maximization and social welfare maximization. Section 4 deals with non-tariff barriers to trade, specifically import quotas and export subsidies. Concludingly, in section 5, we discuss some aspects regarding the stability of the market results and hint to remaining open questions.

2. Free trade in a spatial market

It is appropriate to formulate some of the assumptions common to the spatial pricing literature in order to keep the model manageable:

$A1$: Domestic and foreign consumers continuously occupy a homogenous line $\overline{0R}$ at uniform density equal to 1. The locations of the firms are exogenously given at the left and right ends of this line, i.e. at 0 for the domestic firm and at R for the foreign competitor. ($A1.1$) The foreign firm exports part of its production to the domestic market, so that it serves the foreign market between its location R and the national border R_G as well as the domestic market between the national border R_G and the market area boundary R_C. The domestic firm delivers to the remaining part of the domestic market, covering $\overline{0R_C}$. ($A1.2$) Alternatively, the domestic firm could export part of its production to the foreign country. In this case it serves the domestic market between its location 0 and the national border R_G as well as the foreign market between the national border R_G and the market boundary R_C. The foreign firm then delivers to the remaining part of the foreign market, covering $\overline{R_C R}$. From the domestic perspective, we have imports in case $A1.1$ ($R_C < R_G$) and exports in case $A1.2$ ($R_C > R_G$).

$$0 - - - - - - - - R_C - - - - - - - - - R_G - - - - - - - - - R \qquad imports$$

$$0 - - - - - - - - R_G - - - - - - - - - R_C - - - - - - - - R \qquad exports$$

$A2$: To keep the algebra less cumbersome we assume domestic and foreign individual consumer demand to be identical with respect to utility and expenditure functions, and represented by a linear function ϕ of the respective delivered price $p(r)$:

$$q_I = \phi(p_I), \quad p_I = m_I + r, \quad \phi' < 0, \quad r \in [0,\ R], \qquad (1)$$

$$q_A = \phi(p_A), \quad p_A = m_A + r, \quad \phi' < 0, \quad r \in [0,\ R]. \qquad (1')$$

The delivered prices of the domestic firm $p_I(r)$ and the foreign firm $p_A(r)$ are the sum of the mill prices m_I or m_A, respectively, and the transportation costs between the production and consumption locations r, with r signifying the distance between the two locations. The freight rate per quantity and distance unit for both domestic and foreign transportation is assumed to equal 1. The results for the special case of linear individual consumer demand are provided in the appendix.

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A3: Production technology and cost functions are identical in both countries. Hence, the cost functions read:

$$K_I = K_A = K_f, \tag{2}$$

with variable costs set to zero.

A4: The firms aim at maximizing their profits under Löschian competition. The consumers aim at maximizing their consumers' surplus and purchase the good from the firm which offers the lowest delivered price.

A5: The model is confined to the short run analysis, i.e. relocations are neither undertaken nor expected of the competitors.

The existence of a spatial market implies the following conditions: (a) $m_I < m_A + R$ and $m_A < m_I + R$, respectively: A firm cannot be entirely pushed out of the market via price undercutting by the competitor at the former firm's own location. (b) $\phi(m_I + R_C) > 0$ and $\phi(m_A + R - R_C) > 0$, respectively: At the competition boundary R_C, the delivered price is not allowed to be higher than or equal to the prohibitive price $\phi^{-1}(0)$. (c) $R \leq m_I - m_A + 2R_C$: Due to the fact that at the competition boundary the delivered prices of both firms are identical, we get the admissible distance R between the firms' locations, with R_C being less or equal to the monopoly market size. If at least one of these three conditions is not fulfilled, the market will be divided into one or two spatial monopolies.

Under the assumptions $A1.1$ and $A2$ to $A5$, spatial competition under free trade can be modelled as follows. The domestic firm's profit is given by:

$$\Pi_I = m_I \int_0^{R_C} \phi(m_I + r)dr - K_f. \tag{3}$$

The profit-maximizing domestic mill price, as a function of the market area size, reads:

$$m_I^* = \psi_I(R_C). \tag{4}$$

Given assumption $A1.1$, the foreign firm serves the foreign market between R_G and R as well as a part of the domestic market $\overline{R_C R_G}$. The profit is given by:

$$\Pi_{A/I} = m_{A1} \int_0^{R-R_G} \phi(m_{A1} + r)dr + m_{A2} \int_{R-R_G}^{R-R_C} \phi(m_{A2} + r)dr - K_f. \tag{5}$$

Under free trade and non-discriminatory pricing, the foreign firm sets one single mill price for both the domestic and the foreign market, i.e. $m_{A1} = m_{A2} = m_A$, since the national border does not induce any economic effects. On the other hand, in the presence of tariff or non-tariff trade restrictions, the foreign firm may determine either a common mill

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price for its foreign and domestic market or separate prices in the sense of spatial price discrimination. If we focus on the profit realized by the foreign firm in the domestic market, we can disregard this issue and rewrite the profit function as follows:

$$\Pi_A = m_A \int_0^{R_G - R_C} \phi(m_A + D + r) dr - K_f, \qquad (6)$$

with $D = R - R_G$. The profit-maximizing foreign mill price for the domestic market, as a function of the domestic market size, reads:

$$m_A^* = \psi_A(R_G - R_C, D). \qquad (7)$$

Due to the fact that according to $A4$, the delivered prices of both firms are identical at the competition boundary R_C:

$$\psi_A(R_G - R_C, D) + R_G - R_C = \psi_I(R_C) + R_C, \qquad (8)$$

this boundary with profit-maximizing foreign and domestic mill prices m_A^*, m_I^* can endogenously be derived as

$$R_C^* = R_C^*(R_G, D). \qquad (9)$$

Inserting this result (9) into the price equations (4) and (7), the mill prices will read:

$$m_I^* = \psi_I[R_C^*(R_G, D)] \qquad (10)$$

and

$$m_A^* = \psi_A[R_C^*(R_G, D)]. \qquad (11)$$

At first glance, it might be surprising that due to the equilibrium condition (8), both prices are dependent on the foreign firm's as well as the domestic firm's distance to the national border. Consequently, the firms' profits – apart from the fixed costs – are functions of the transportation costs between the firms' locations and the national border:

$$\Pi_I = \psi_I[R_C^*(R_G, D)] \cdot \Phi\{\psi_I[R_C^*(R_G, D)] + R_C\} - K_f \qquad (12)$$

and

$$\Pi_A = \psi_A[R_C^*(R_G, D)] \cdot \Phi\{\psi_A[R_C^*(R_G, D)] + D + (R_G - R_C)\} - K_f. \qquad (13)$$

Within this basic framework, we are now able to discuss the various tariff and non-tariff barriers to international trade.

3. Tariff policy in a spatial market

Tariffs accrue as commodities cross national borders, where the imposition of tariffs on imported goods – as opposed to the imposition on exported goods – is the empirically predominant case, which shall be assumed henceforth. This import duty can be distinguished in two different ways, i.e. with respect to the calculation base and with respect to the purpose of the imposition. Tariffs can be calculated either per quantity (specific tariff) or per value (ad valorem tariff). The arguments in favour of tariffs are threefold, with several subordinate motives in each case: (a) By the imposition of an import tariff, domestic industries can be protected from international competitors. The complete protection rate keeps all foreign goods away from the domestic market. The rate of this protective tariff is optimal, if imports are prevented completely. (b) By imposing a tariff, the government obtains a revenue. The importance of this revenue depends on whether other sources of revenue (taxes, public debt) are available. The rate of this tariff is optimal, if the tariff revenue of the government is maximized. (c) Tariffs do not only influence welfare in the tariff-imposing country but also abroad. A domestic welfare maximizing tariff thereby has an effect on welfare in those countries having a trade relationship with the inland, too. In a two-country-world, welfare of the home country and the foreign country add to *world welfare*, which is influenced by a tariff, too. Retaliatory measures (e.g. tariffs imposed by the foreign country) shall not be considered because $A5$ assumes a short period.

The model can easily be modified to include either tariffs on the value of imports or tariffs on the quantity of imports. In the former case, the amount of the tariff, t, is added to the price of the foreign enterprise, changing foreign profits to

$$\Pi_A = m_A \int_0^{R_G - R_C} \phi(m_A + D + t + r)dr - K_f. \tag{14}$$

In the latter case, the price increases by a constant factor, $(1 + t)$, which yields

$$\Pi_A = m_A \int_0^{R_G - R_C} \phi((m_A + D)(1 + t) + r)dr - K_f, \tag{15}$$

if the value of the freight at the border between the two countries $(m_A + D)$ is taken as reference. The condition for an equilibrium reads

$$\psi_A(R_G - R_C, D, t) + R_G - R_C = \psi_I(R_C) + R_C. \tag{16}$$

This condition which now contains the profit maximizing price of the importing firm based on exogenously given market areas and tariffs, $m_A^* = \psi_A(R_G - R_C, D, t)$, causes the mill price of the domestic firm to depend on the tariff rate, too:

$$m_I^* = \psi_I[R_C^*(R_G, D, t)] \tag{17}$$

and

$$m_A^* = \psi_A[R_C^*(R_G, D, t)]. \tag{18}$$

Not only the classification of tariffs according to their base is important, but also the motivation for imposing a tariff. The following statements are related to this question.

The complete protection tariff rate keeps any foreign goods away from the country. In the spatial model, this means that the national border between the two countries coincides with the border between the market areas: $R_C = R_G$. The equilibrium condition $\psi_A(D, t) = \psi_I(R_G) + R_G$ serve to calculate the lowest tariff rate appropriate to prevent any imports:

$$t_s^* = t_s^*(R_G, D). \tag{19}$$

Consequently, this tariff rate only depends on the distances (and thus the transport costs) between the locations of the firms and the border between the two countries. If, on the other hand, the government aims at maximizing the revenue from tariffs (maximum revenue tariff), the tariff rate to be calculated must permit a certain quantity of imports. The tariff revenue generally equals:

$$T = t \cdot \int_0^{R_G - R_C} \phi(m_A + D + r, t) dr \tag{20}$$

or, considering the equilibrium condition (16) and the profit maximizing foreign mill price for the domestic country (18)

$$T = t \cdot \Phi\{\psi_A[R_C^*(R_G, D, t)] + D + (R_G - R_C^*(R_G, D, t)), t\}. \tag{21}$$

Provided that equation (21) is two times differentiable, maximization with respect to t $[dT/dt = \Phi(\cdot) + t \cdot (\frac{\partial \Phi}{\partial \psi_A} \frac{\partial \psi_A}{\partial R_C^*} \frac{\partial R_C^*}{\partial t} - \frac{\partial \Phi}{\partial R_C^*} \frac{\partial R_C^*}{\partial t} + \frac{\partial \Phi}{\partial t}) = 0]$ yields from the first-order condition:

$$t_f^* = t_f^*(R_G, D). \tag{22}$$

Again, the endogenous tariff rate depends solely on the transport costs between the locations of the firms and the border between the two countries.

The definition of the policy-relevant domestic welfare level determines the welfare maximizing tariff. One plausible definition would be the sum of the profit of the domestic firm and the consumers' surplus. Following this definition, welfare reads $\Omega_I = \Pi_I + \Lambda_I + \Lambda_{IA}$, where Π_I is the profit of the firm, Λ_I is the consumers' surplus in the market area of the domestic firm and Λ_{IA} symbolizes the consumers' surplus in the domestic market area of the foreign firm. If the foreign firm spends the profit it attains in the home country, Π_A, either for consumption or reinvestment purposes, this amount has to be added to the

welfare function. Also, if the tariff revenue, T, leads to reductions of taxes or government expenditures of the same amount in the domestic country, the tariff revenue has to be added as well. The welfare maximizing tariff thus depends on the employed concept of welfare. While Hass [1996], [1997/8] used the definition $\Omega_I = \Pi_I + \Pi_A + \Lambda_I + \Lambda_{IA}$, Schöler [1997] employed the approach $\Omega_I = \Pi_I + \Lambda_I + \Lambda_{IA} + T$, which is applied in the discussion of the model with linear demand curves in the appendix, too.

Consumers' surplus at point r within the market area of the domestic firm is

$$\lambda(r) = \int_{p_I(r)}^{\phi^{-1}(0)} \phi(m_I + r)dp, \tag{23}$$

where $\phi^{-1}(0)$ is the prohibitive price and $p_I(r) = m_I + r$ symbolizes the local price at point r. The total consumers' surplus in this market area is

$$\Lambda_I = \int_0^{R_C} \int_{p_I(r)}^{\phi^{-1}(0)} \phi(m_I + r)dpdr. \tag{24}$$

In the same manner, consumers' surplus at a point within the domestic part of the foreign firm can be calculated as

$$\lambda(r) = \int_{p_A(r,t)}^{\phi^{-1}(0)} \phi(m_A + D + r, t)dp, \tag{25}$$

where $\phi^{-1}(0)$ is the prohibitive price and $p_A(r,t)$ stands for the price at point r. The total domestic consumers' surplus in the market area of the foreign firm thus reads

$$\Lambda_{IA} = \int_0^{R_G - R_C} \int_{p_A(r)}^{\phi^{-1}(0)} \phi(m_A + D + r, t)dpdr. \tag{26}$$

Under consideration of R_C^* and equations (17) and (18), welfare effects, however they are composed, are a function of the distance between the locations of the firms and the border between the countries:

$$\Omega_I = \Omega_I(R_G, D, t). \tag{27}$$

If it is assumed that this welfare function is twice differentiable, its maximum with respect to the tariff rate can be calculated. In accordance with the theory of international trade, the welfare maximizing tariff is referred to as the 'optimal tariff'.

$$t_\Omega^* = t_\Omega^*(R_G, D), \tag{28}$$

which, just as the other endogenously determined tariff rates, depends on the distance between the firms and the border between the two countries. The results for the optimal tariff and welfare depend, however, on the chosen definition of welfare which is determined by the political and economical environment.

4. Non-tariff barriers to trade in a spatial market

Apart from tariffs, non-tariff restrictions to trade, such as import quota and export subsidies, are more and more common interventions in international trade. In the former case, the government only allows for a given quantity of imports per unit of time. In a spatial model, this means the limitation of the domestic market area being supplied by the foreign firm (see Hass [1996]). With regard to allocation, an import quota has the same effects as an import tariff or, put differently, for any tariff rate, there exists an import quota having the same spatial and economical effects. There are, however, differences with regard to distribution. More specifically, the government has no revenue if the import quota is not attached to firms by auctions or sales of licences. In the latter case, goods crossing the border become cheaper, which causes the market area of the exporter to be larger (see Hass/Schöler [1999]).

Import quota: If it is assumed that trade policy does not aim at autarky, the import quota Q is strictly positive. It can be expressed in terms of demand:

$$Q = \int_0^{R_G - R_C} \phi(m_{A,Q} + D + r) dr. \tag{29}$$

If an import quota is effective, the amount of the imports has to be smaller than with free trade. Consequently, the mill price from equation (29) must be higher than under free trade:

$$m_{A,Q} = g(Q, D, R_G - R_C) > m_A^*. \tag{30}$$

The amount of the import quota enters into the equilibrium condition

$$g(Q, D, R_G - R_C) + D + R_G - R_C = \psi_I(R_C) + R_C \tag{31}$$

and, by applying the endogenously derived border between the market areas (see equation (31)) $R_C^* = R_C^*(R_G, D, Q)$, into the price of the domestic firm:

$$m_I^* = \psi_I(R_C^*(R_G, D, Q)). \tag{32}$$

Is there – in analogy to an optimal tariff – an optimal import quota? If licences for imports are not sold, the objective of earning a maximum revenue does not apply to this case. Also, if maximum protection is the aim of the government, the optimal import quota amounts to zero. Only the welfare maximizing import quota is a political option. Assuming that the welfare function, being composed of the elements $\Omega_I = \Pi_I + \Lambda_I + \Lambda_{IA}$ and reading

$$\Omega_I = \Omega_I(R_G, D, Q), \tag{33}$$

is twice differentiable, its maximum can be calculated with respect to the import quota. The welfare maximizing quota equals:

$$Q_\Omega^* = Q_\Omega^*(R_G, D). \tag{34}$$

Just as the endogenously derived tariff rates, it depends on the distance between the locations of the firms and the border between the two countries. The amount of the welfare maximizing quota and the welfare maximum are determined by the composition of the welfare effects.

Export subsidies: Throughout this paper, it has been assumed that the domestic country is larger than the market area of the domestic firm $(R_G > R_C)$, the remaining area being supplied by the foreign firm. In this setting, trade can have only one direction. Within this subsection, the inverse shall be assumed $(A1.2)$. Accordingly, the domestic firm not only supplies the entire domestic market, but also a part of the foreign market area $(R_G < R_C)$. Furthermore, it shall be assumed that exports are subsidized by the amount of s per unit because the government aims – for what reason ever – at increasing the exports (see Hass/Schöler [1999]). The profit function of the domestic firm becomes

$$\Pi_I = m_{I1} \int_0^{R_G} \phi(m_{I1} + r)dr + (m_{I2} + s) \int_{R_G}^{R_C} \phi(m_{I2} + r)dr - K_f, \tag{35}$$

where $S = s \int_{R_G}^{R_C} \phi(m_{I2} + r)dr$ signifies the sum of export subsidies which is paid to the domestic firm. Allowing only for a non-discriminatory pricing policy, there is only one mill price $m_{I1} = m_{I2} = m_I$, depending on the amount of export subsidies:

$$m_I^* = \psi_I(R_G, R_C, s). \tag{36}$$

With export subsidies, too, the equilibrium condition

$$\psi_I(R_G, R_C, s) + R_C = \psi_A(R - R_C) + R - R_C \tag{37}$$

causes both mill prices to depend on the amount of subsidies:

$$m_I^* = \psi_I(R_G, s, R_C^*(R, R_G, s)) \tag{38}$$

and

$$m_A^* = \psi_A(R - R_C^*(R, R_G, s)). \tag{39}$$

Provided that the welfare function, being composed of the elements $\Omega_I = \Pi_I + \Lambda_I + \Lambda_{IA} - S$ and reading

$$\Omega_I = \Omega_I(R_G, R, s), \tag{40}$$

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is twice differentiable, its maximum can be calculated with respect to the amount of export subsidies. The welfare maximizing rate of subsidy is

$$s_\Omega^* = s_\Omega^*(R_G, R),$$ (41)

with $R = R_G + D$. By now, we discussed trade policies under the precondition that firms are not able to apply discriminatory pricing techniques. If each exporting firm is setting different prices in home country and in the foreign country, respectively, thus applying spatial price discrimination, we shall yield other results.

5. Conclusion

The variations of a spatial border-crossing dyopoly as shown above correspond to the ideas proposed by Lösch within his critique of the traditional international trade theory: International trade arises if a border divides a market area. It can be shown that trade-political parameters of optimal welfare (tariffs, import quotas and export subsidies) for given locations can be explained by spatial variables and thus be endogenized. As described in other articles (see Schöler [1997], Hass/Schöler [1999]), under certain conditions within the framework of such models it is possible to practise a trade policy which leads to a higher level of welfare than free trade. Those results support our findings on strategic trade policy, which are derived from models of non-spatial markets (see also Brander/Spencer [1981]). However, it has to be considered that only partial analytical solutions referring to only one market are being found whereas the traditional international trade theory, besides partial analytical results, also offers total analytical results. Furthermore, in deriving the optimal trade policy, especially the parameters t_Ω^*, Q_Ω^* or s_Ω^* for maximum welfare, it has to be taken into account that different solutions may arise depending on the distance variables R_G, D and R, respectively, and/or the assumed type of the demand function of individual consumption $\phi(m + r)$: (a) For all admissible distances, an internal solution might arise (e.g. for $q = 1 - m - r$ and t_f^*, see Schöler [1997]). (b) There may be an internal solution for restricted combinations of distances (e.g. for t_Ω^*, see Schöler[1997]). (c) Non-internal solutions may arise (e.g. for non-price discrimination and export subsidies (see Hass/Schöler [1999])). (d) It is possible that there is no valid solution (e.g. only a complex one).

Despite these difficulties it should be noted that with each trade-political activity the design of an optimal trade policy depends on the distances between the producers' locations and the national border. Finally, the results of our model vary with the conjectural

variations of the firms (Löschian competition or any other type of competition), their pricing strategy (price discrimination or fob pricing) and the number of participants (two or more). This leads to a higher number of possible solutions of the model which correspond more appropriately to the concrete questions.

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Appendix

The trade policy which has been shown for any demand functions should be discussed for the specific consumer individual demand function $\phi(m + r) = 1 - m - r$.

Free trade: The profit function of the domestic firm is

$$\Pi_I = m_I \int_0^{R_C} (1 - m_I - r) dr - K_f \tag{A1}$$

and the profit maximizing mill price for the given market area with a boundary at R_C is

$$m^* = 0,5 - 0,25 R_C. \tag{A2}$$

The profit of the foreign firm is

$$\Pi_A = m_A \int_0^{R_G - R_C} (1 - m_A - D - r) dr - K_f \tag{A3}$$

and the profit maximizing mill price for the given market area is

$$m_A^* = 0,5 - 0,25 R_G + 0,25 R_C - 0,5 D. \tag{A4}$$

The equilibrium condition is

$$m_I^* + R_C = m_A^* + R_G - R_C + D, \tag{A5}$$

which leads to

$$R_C^* = \frac{2D + 3R_G}{6}. \tag{A6}$$

If we use (A6) in the price equations (A2) and (A4), we get:

$$m_I^* = \frac{12 - 2D - 3R_G}{24} \tag{A7}$$

and

$$m_A^* = \frac{12 - 10D - 3R_G}{24}. \tag{A8}$$

Exogenous tariffs: Under the assumption of a tariff per quantity, the profit function of the importer reads as follows:

$$\Pi_A = m_A \int_0^{R_G - R_C} (1 - m_A - D - t - r) dr - K_f, \tag{A9}$$

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and the profit maximizing mill price in the market area $R_G - R_C$ is

$$m_A^* = 0,5 - 0,25R_G + 0,25R_C - 0,5D - 0.5t. \qquad (A10)$$

The application of the equilibrium condition $m_I^* + R_C = m_A^* + R_G - R_C + D + t$ in the case of import tariffs results in a market boundary of

$$R_C^* = \frac{2D + 3R_G + 2t}{6} \qquad (A11)$$

with $\partial R/\partial t = 1/3$. Using (A11) the equilibrium mill prices are:

$$m_I^* = \frac{12 - 2D - 3R_G - 2t}{24} \qquad (A12)$$

and

$$m_A^* = \frac{12 - 10D - 3R_G - 10t}{24} \qquad (A13)$$

with the partial derivatives $\partial m_I^*/\partial t = -1/12$ and $\partial m_A^*/\partial t = -5/12$.

Endogenous tariffs: The lowest protective tariff preventing imports is due to $R_C = R_G$:

$$t_s^* = 1,5R_G - D. \qquad (A14)$$

The optimal finance tariff results from

$$\max_{t_f} T(t_f) = \int_0^{R_G - R_C^*} t_f(1 - m_A^* - D - t_f - r)dr \qquad (A15)$$

with

$$t_f^* = 2/5 + 2R_G/5 - 2D/3 - \sqrt{c_f}/30, \qquad (A16)$$

in which

$$c_f = 279R_G^2 - 12R_G(10D + 21) + 4(25D^2 - 30D + 36).$$

The partial derivatives are $\partial t_f^*/\partial D < 0$ and $\partial t_f^*/\partial R_G \lessgtr 0$. Applying the optimal finance tariff, the equilibrium mill prices are

$$m_I^* = 7/15 - 19R_G/120 - D/36 + \sqrt{c_f}/360 \qquad (A17)$$

and

$$m_A^* = 1/3 - 7R_G/24 - 5D/36 + \sqrt{c_f}/72 \qquad (A18)$$

with

$$R_C^* = 2/15 + 19R_G/30 + D/9 - \sqrt{c_f}/90.$$

The optimal tariff may be determined by using the welfare function $\Omega_I = \Pi_I + \Lambda_I + \Lambda_{IA} + T$. The equations of the consumers' surplus of the market area $\overline{0R_C^*}$ are

$$\Lambda_I = \int_0^{R_C^*} [(1 - m_I^* - r)^2 / 2] dr \qquad (A19)$$

and for the market area $R_G - R_C^*$

$$\Lambda_{IA} = \int_0^{R_G - R_C^*} [(1 - m_A^* - D - t - r)^2 / 2] dr. \qquad (A20)$$

The profit of the domestic firm is

$$\Pi_I = m_I^* \int_0^{R_C^*} (1 - m_I^* - r) dr - K_f \qquad (A21)$$

and the tariff revenue is

$$T = \int_0^{R_G - R_C^*} t(1 - m_A^* - D - t - r) dr. \qquad (A22)$$

The optimal tariff results from

$$\max_{t_\Omega} \Omega(t_\Omega) = \Lambda_I(t_\Omega) + \Lambda_A(t_\Omega) + \Pi_I(t_\Omega) + T(t_\Omega) \qquad (A23)$$

with

$$t_\Omega^* = 20/49 + 16 R_G/49 - 29D/49 - \sqrt{c_\Omega}/98, \qquad (A24)$$

in which

$$c_\Omega = 1600 D^2 - 32 D(67 R_G + 47) + 1465 R_G^2 + 1384 R_G - 752.$$

For the optimal tariff $R_G \in [R_{G_1} \ \ R_{G_2})$ is valid. For $R_G < R_{G_1}$ there is no real solution, and for $R_G \geq R_{G_2}$ the non-negativity condition does not hold. The partial derivatives are $\partial t_\Omega^*/\partial D < 0$ and $\partial t_\Omega^*/\partial R_G \lessgtr 0$. By using the optimal tariffs, the equilibrium mill prices are as follows:

$$m_I^* = 137/294 - 179 R_G/1179 - 5D/147 + \sqrt{c_\Omega}/264 \qquad (A25)$$

and

$$m_A^* = 97/294 - 307 R_G/1176 - 25D/147 + 5\sqrt{c_\Omega}/1176 \qquad (A26)$$

with

$$R_C^* = 20/147 + 179 R_G/294 + 20D/147 - \sqrt{c_\Omega}/294.$$

Import quotas: For the given demand function the import quota equals

$$Q = \int_0^{R_G - R_C} (1 - m_A - D - r) dr, \qquad (A27)$$

which leads to a foreign mill price at a level of

$$m_{A,Q} = \frac{R_c^2 - 2R_C(D + R_G - 1) + 2DR_G + R_G^2 - 2R_G + 2Q}{2(R_C - R_G)}. \qquad (A28)$$

Together with the mill price of the domestic firm $m_i^* = 0, 5 - 0, 25R_C$ we can now determine the equilibrium condition $m_{A,Q} + D + R_G - R_C = m_I^* + R_C$ from which the market boundary may be derived:

$$R_C^* = 0, 1(-\sqrt{c_Q} + 7R_G + 2) \quad mit \quad c_Q = (3R_G - 2)^2 + 80Q. \qquad (A29)$$

Now the mill prices are

$$m_I^* = 0, 025(18 - 7R_G + \sqrt{c_Q}) \qquad (A30)$$

and

$$m_{A,Q} = 0, 025[-7\sqrt{c_Q} + 9R_G - 2(20D - 17)]. \qquad (A31)$$

The welfare function

$$\Omega_I = \int_0^{R_C^*} (0, 5(1 - m_I^* - r)^2 + m_I^*(1 - m_I^* - r))dr - K_f$$

$$+ \int_0^{R_G - R_C} 0, 5(1 - m_{A,Q} - D - r)^2 dr \qquad (A32)$$

serves to calculate a welfare optimal import quota at the level of

$$Q_\Omega^* = [211R_G^2 - 713R_G + 556 - \sqrt{(553R_G^2 - 1064R_G + 592)} \cdot |7R_G - 13|]/4356. \qquad (A33)$$

Export subsidies: The profit function of the domestic firm in the case of export subsidies reads:

$$\Pi_I = m_I \int_0^{R_G} (1 - m_I - r)dr + (m_I + s) \int_{R_G}^{R_C} (1 - m_I - r)dr - K_f \qquad (A34)$$

and the corresponding profit maximizing mill price is:

$$m_I^* = -\frac{R_C^2 + 2R_C(s - 1) - 2sR_G}{4R_C}. \qquad (A35)$$

Together with the mill price of the foreign firm $m_A^* = (2 + R_C - R)/4$, it is possible to determine the equilibrium condition $m_A^* + R - R_C = m_I^* + R_C$ from which the market boundary

$$R_C^* = (1/12)(\sqrt{c_s} + 3R + 2s) \quad mit \quad c_s = (3R_G - 2s)^2 - 48R_G s \qquad (A36)$$

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may be derived. The mill prices are:

$$m_I^* = -(1/48)[7\sqrt{c_s} - 15R + 2(7s - 12)] \qquad (A37)$$

and

$$m_A^* = -(1/48)(\sqrt{c_s} - 9R + 2s + 24). \qquad (A38)$$

The welfare function

$$\Omega_I = \int_0^{R_G} (0,5(1 - m_I^* - r)^2 + m_I^*(1 - m_I^* - r))dr - K_f$$

$$+(m_I^* + s)\int_{R_G}^{R_C} (1 - m_I^* - r)dr - s\int_{R_G}^{R_C} (1 - m_I^* - r)dr \qquad (A39)$$

does not lead to a general solution for the welfare optimal rate of export subsidy. If, however, we assume R_G to be $0,5$ and R to be 1, the welfare optimal rate of subsidy would be $s_\Omega^* = 0,5094$.

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