Beitrag 193, Volkswirtschaftliche Diskussionsreihe, Universität Augsburg

Decentralization of Industrial Policy as Strategic Delegation

Karl Morasch
University of Augsburg*

February 2000

Abstract

What is the appropriate degree of centralization in the context of industrial policy? The basic advantage of centralization results from internalization of external effects. While most of the literature stresses the superior information of regional authorities as a countervailing force, the present paper discusses another argument in favor of decentralization: Delegation of authority to regional governments will improve the position of the home country in the policy game with a foreign government. In a linear Cournot oligopoly with two domestic regions delegation is shown to be profitable if the domestic industry comprises at least twice as many firms as the foreign industry.

JEL–classification: D43, F13, L13, L52

Key words: Decentralization; Strategic delegation; Industrial policy; Oligopoly

*Address: Dr. Karl Morasch, Wirtschafts- und Sozialwissenschaftliche Fakultät, Universität Augsburg, D–86135 Augsburg, Germany, Tel. ++49–821–5984196, Fax ++49–0821–5984230, e-mail: Karl.Morasch@WiSo.Uni-Augsburg.DE

1 Introduction

Until the beginning of the 90th industrial policy in the European Union has been mainly performed by national governments. However, in the last years industrial policy actions on the community level have become more important and the European Commission made an effort to reduce the leeway of national policies:

- Improving the competiveness of the european industry is explicitly mentioned as a community task in article 3 of the Treaty of Maastricht. In addition Title XIII: Industry has been added to the initial treaty of the European Community (Art. 130 of the EC–treaty).
- There has been a notable change in the application of the state aid rules of the European Community (Art. 92 of the EC–treaty): The Commision is now much more reluctant to allow state aid (subsidies) of community members to their domestic industries and single firms.

However, this trend towards centralization of industrial policy has not been unchallenged. While part of the crititcism stems from the fact that national authorities do not want to give up their power and national interest groups fear to loose rents, there are also some sound economic arguments against industrial policy on the community level. The present paper attempts to shed some light on this issue.

The economic literature dealing with centralization of economic policy usually focuses on the trade off between internalizing spillover effects and better information of regional authorities (see e. g. *Gilbert/Picard, 1996*). In this context *Morasch (1997)* explicitly analyzes the incentives to decentralize *industrial* policy: It is shown that the information advantage may outweigh the negative effects of decentralization if the good is mainly consumed within the producing regions. An additional aspect considered in the literature are political economy considerations, i. e. whether central or decentral agencies are more prone to capture by interest groups (see e. g. *Laffont/Martimort, 1998*). While for most policy fields the decentralization problem may be adequately described by these factors, in the case of industrial policy the interaction with foreign governments seems to be too important to be ignored. The present paper will discuss incentives for decentralization of industrial policy which are based on this policy interaction: Decentralization may be used as a mean of strategic delegation.

The underlying concept of strategic delegation is commonly applied in the game theoretic literature of industrial organization (see e. g. *Vickers, 1985*, *Fershtman/Judd, 1987* and *Welzel, 1995*). In a situation with strategic interaction it may be profitable to delegate the decision about a strategic variable to another player with

different preferences. How can this idea be applied to the problem of decentralization? Consider the policy game between the domestic central government (e. g. the European Commission) and a foreign government (e. g. the US government). If the two governments simultaneously set their industrial policies, the resulting equilibrium is usually not optimal from the point of view of the domestic government. In this setting I will analyze the question whether delegating the power over industrial policy to regional authorities (the member states in our example) may improve welfare of the domestic country (the European Union).

There already exist some papers which are dealing with similar questions in the context of (strategic) trade policy and of industrial policy. To show how my analysis departs from this work, I will now try to point out the central assumptions and the basic results of this literature.

- *Gatsios/Karp (1991, 1995)* analyze delegation incentives in a tariff union. They assume that countries outside the union behave strategically and that member countries have different objective functions. Under these assumptions delegating the decision about the common external tariff to the country which behaves more aggressively is shown to be profitable as long as tariffs are strategic substitutes.

- While the delegation decision of the tariff union reduces welfare of the other countries, *Collie (1997b)* analyzes a case where delegation may yield an pareto improvement. He considers the interaction of tariff policy by the domestic country and export subsidies by the foreign country. If the domestic country delegates the decision to a policy maker which attaches less weight to the profits of the domestic firm than a welfare maximizing government, domestic trade policy is less aggressive which increases both domestic and foreign welfare.

- *Collie (1997a)* considers the formation of trade blocs in a multi–country–version of the export subsidy game of *Brander/Spencer (1985)*. Here an exogenous enlargement of symmetric trade blocs yields higher welfare for all producing countries.

- Finally, *Collie (1999)* shows in a symmetric Cournot model that prohibiting state aid in an integrated market may be preferable if subsidies are financed by distortionary taxation.

How are these models related to my analysis?

- The present paper is in some sense complementary to *Collie (1997a)*: Delegation of industrial policy to regional authorities may be interpreted as an asymmetric reduction of the size of trade blocs. While total welfare of the

producing countries is reduced by this step, welfare of the domestic country may increase because the reduction is asymmetric and thus raises the domestic share of industry profits.

- Because delegation to regional authorities always results in more aggressive behavior, as shown by *Gatsios/Karp (1995)* regional policy may only yield higher welfare if reaction curves in the policy stage have a negative slope (strategic substitutes).

- As in *Collie (1999)* I consider an integrated market and do not restrict attention to the case where the product is solely exported to a third country. However, contrary to his analysis the good is not *exclusively* consumed in the producing countries and the good is also produced outside the home country. In this respect my work is a generalization of *Collie (1999)*.

The remainder of the paper is organized as follows: In section 2 the delegation incentives of the domestic government are discussed in a linear Cournot oligopoly. It is assumed that the home country comprises only two regions and that the good is completely exported to a third country. In the section 3 I will test the robustness of the results: The model is generalized to cases with three and more domestic regions, the impact of consumption within the producing countries is analyzed, and, finally, price and quantity competition in a market with differentiated product are considerd. Section 4 summarizes and discusses policy implications.

2 Delegation incentives in the base model

Throughout this paper industrial policy is analyzed in a strategic trade policy model in the spirit of *Brander/Spencer (1985)*: In the first stage domestic and foreign authorities simultaneously determine output subsidies. In the second stage domestic and foreign firms compete in an integrated world market.[1]

Because delegation to regional authorities is a discrete step, explicit solutions of the two stage games are necessary to compare the situations with central and regional policy, respectively. Therefore a model with a general cost and demand specification is not suitable. Instead a Cournot oligopoly with linear demand $p(X) = 1 - X$ and constant variable costs $c = 0$ for all firms will be analyzed.[2] To check the robustness of the results obtained in this specific setting, price and quantity competition in a market with differentiated products will be considered in 3.3.

[1] See *Dixit* (1984) for an analysis of strategic trade policy in a setting with segmented markets.

[2] Because delegation incentives only depend on relative welfare, the results also hold for demand $p(X) = a - bX$ and constant variable costs $0 < c < a$.

In this section it will be assumed that there are only two domestic regions labeled h_1 and h_2 which comprise n_{h_1} and n_{h_2} firms, respectively. With n_f describing the number of firms in the foreign country, the total number of oligopolists is thus given by $n = n_{h_1} + n_{h_2} + n_f$. Each government attempts to maximize the welfare of its regional entity. Welfare coincides with the sum of net profits (i. e. profits minus subsidies) of the firms belonging to this regional entity if total production is exported to a third country. Under centralization subsidies per unit of output are given by s_f and s_h, under decentralization by s_f, s_{h1} and s_{h2}.

To determine whether strategic delegation of industrial policy is preferable from the point of view of the domestic government, the following two games are compared:

- In the game under central policy the domestic and the foreign government simultaneously determine the subsidy levels, taking into account the behavior of firms in the subsequent output game.
- In the case of decentralization the same kind of game is now played between the regional authorities of the domestic country and the foreign government.

To analyze these games we must first consider the output stage for given subsidies. The profits of a firm i which belongs to country or region j are given by

$$\pi_i^j = (1 - X)x_i^j + s_j x_i^j. \tag{1}$$

This yields first order conditions

$$\frac{\partial \pi_i^j}{\partial x_i^j} = 1 - X_{-i} - 2x_i^j + s_j = 0. \tag{2}$$

Under centralization the equilibrium at the output stage is determined by simultaneously solving the n_h equations (2) with $j = h$ and the n_f equations with $j = f$. Accordingly the n_{h_1} first order conditions with $j = h_1$, the n_{h_2} with $j = h_2$ and the n_f with $j = f$ must be fulfilled in the case of strategic delegation. For a given number of firms in each region and each country, respectively, output levels in equilibrium may be written as a function of subsidy levels:

$$x_i^j(s_h, s_f) = \frac{1 + (n+1)s_j - n_h s_h - n_f s_f}{n+1} \quad \text{with} \quad j \in \{h, f\} \tag{3}$$

$$x_i^j(s_{h_1}, s_{h_2}, s_f) = \frac{1 + (n+1)s_j - n_{h_1} s_{h_1} - n_{h2} s_{h2} - n_f s_f}{n+1} \quad \text{with} \quad j \in \{h_1, h_2, f\} \tag{4}$$

Inserting the x_i^j into the profit function (1), profits may be determined as a function of the subsidy structure. Because total production is assumed to be exported to

a third country, governments only consider the effect on firm profits. Objective functions for the policy stage under central policy are thus given by

$$\begin{aligned} W_j(s_h, s_f) &= n_j \pi_i^j(s_h, s_f) \\ &= n_j \frac{(1 - n_h s_h - n_f s_f)[1 + (n+1)s_j - n_h s_h - n_f s_f]}{(n+1)^2}. \end{aligned} \tag{5}$$

Accordingly the following welfare functions result in the case of delegation to regional authorities:

$$\begin{aligned} &W_j(s_{h_1}, s_{h_2}, s_f) = n_j \pi_i^j(s_{h_1}, s_{h_2}, s_f) = \\ &\quad n_j \frac{(1 - n_{h_1} s_{h_1} - n_{h_2} s_{h_2} - n_f s_f)[1 + (n+1)s_j - n_{h_1} s_{h_1} - n_{h_2} s_{h_2} - n_f s_f]}{(n+1)^2} \end{aligned} \tag{6}$$

By simultaneously solving the first order conditions resulting from these objective functions, the subgame perfect equilibria of the two policy games may be determined. We obtain the following subsidy levels:

$$(s_h^*, s_f^*) = \left(\frac{n + 1 - 2n_h}{n_h(n+3)}, \frac{n + 1 - 2n_f}{n_f(n+3)} \right) \tag{7}$$

$$(s_{h_1}^*, s_{h_2}^*, s_f^*) = \left(\frac{n + 1 - 2n_{h_1}}{n_{h_1}(2n+4)}, \frac{n + 1 - 2n_{h_2}}{n_{h_2}(2n+4)}, \frac{n + 1 - 2n_f}{n_f(2n+4)} \right) \tag{8}$$

Assuming symmetric regions, i.e. $n_{h_1} = n_{h_2}$, the basic effect of regionalization is already visible by comparing (7) and (8). Regional authorities choose higher subsidies than a central government. As a reaction, the foreign government reduces its subsidy level. Delegation thus yields a strategic advantage for the home country. However, because average subsidies rise, total welfare of the producing countries is declining. What can be said about the net effect for domestic welfare? Inserting equilibrium subsidies into the objecitve function of the domestic government, the following results are obtained for welfare under centralization (W_h^C) and under decentralization (W_h^D):

$$W_h^C = \frac{n + 1 - n_h}{(n+3)^2} \tag{9}$$

$$W_h^D = \frac{2 + 2n - (n_{h_1} + n_{h_2})}{(2n+4)^2} \tag{10}$$

Note that welfare in the case of regional policy only depends on the total number of domestic firms: In the numerator of (10) $n_{h_1} + n_{h_2}$ may be substituted by n_h. Whether the decentral solution is preferable thus only depends on the number of home firms relative to the number of foreign firms. Based on (9) and (10) we are able to prove the following statement:

Proposition *Assume that firms from two countries compete in a linear Cournot oligopoly on a third country market and that the domestic country comprises two*

regions. Given this, delegating the power over industrial policy to the regional authorities improves domestic welfare if the number of domestic firms is at least twice as large as the number of foreign firms, i. e. $n_h \geq 2n_f$.

Proof: To prove this proposition we must determine the difference between W_h^D from (10) and W_h^C from (9). Rearranging terms appropriately we get the following expression:

$$W_h^D - W_h^C = \frac{(n+1)[(n+2)(n_h - 2n_f) + (n+2-n_f)]}{(2n+4)^2(n+3)^2} \tag{11}$$

Because the denominator in (11) is positive, decentral policy yields higher welfare if the numerator exceeds zero. The numerator monotonously declines with rising n_f. Inserting $n_h = 2n_f$ into the numerator we get $(n+1)(2n_f+2) > 0$ while $n_h = 2n_f - 1$ results in $-n_f(n+1) < 0$. ■

What are the basic forces that determine the strength of the delegation incentive in this simple setting without domestic consumption?

- The advantage of delegation stems from the more aggressive behavior of regional authorities, which do not take into account the impact of their policy on domestic firms in other regions. The relative position of the domestic country in the subsidy game with the foreign government is improved by this move: Domestic firms get a larger share of total industry profit.
- However, there is also a cost of delegation: Average subsidies rise relative to the central solution. This yields higher total output and thus declining industry profits.

If the number of domestic firms is relatively large compared to the number of their foreign competitors, central policy leads to an equilibrium were foreign firms are subsidized while domestic firms are taxed. As has been shown, under these circumstances the positive effect of delegation (larger share of industry profits) is likely to dominate the negative effect (reduced industry profits).

3 Delegation under alternative specifications

The results in section 2 have been derived in a quite specific model. To check the robustness of these results, the model will now be generalized in two respects and alternative specifications of demand and firm behavior will be considered:

- In 3.1 the analysis will be extended to cases where the domestic country comprises more than two (producing) regions. This generalization is important insofar as the number of regions in most countries or groups of countries (like the European Union) exceeds two. While the introduction of an intermediate level of hierachy for pursuing industrial policy is a theoretical possibility, it seems to be of little practical relevance.

- The impact of introducing consumption within the producing countries into the model will be analyzed in 3.2. Because export shares of almost one hundred percent are quite uncommon, dropping this assumption seems to be necessary if the model ought to be applied to real world situations.

- Finally price and quantity competition in a market with differentiated products will be discussed in section 3.3. Here the degree of product differentiation may be interpreted as a market structure parameter which serves as a proxy for the demand driven intensity of competition. On the other hand differences in firm conduct are analyzed by considering quantity and price competition: How will the way of strategic interaction (strategic substitutes vs. strategic complements) affect the results?

3.1 More than two domestic regions

If the number of producing regions in the domestic country exceeds two, delegation to regional authorities yields a more pronounced rise of "aggressivity", i. e. higher subsidies result in equilibrium. As will be shown, this is not in the interest of the domestic country: In a country comprising three or more regions delegation of industrial policy yields lower domestic welfare than in the case with two regions. To prove this statement, we need to determine the behavior of profits as a function of the number and size of regions. Based on the first order conditions in the output stage, quantities can be written as a function of subsidy levels in z regions or countries with active industrial policy:

$$x_i^j(s_1,\ldots,s_z) \;=\; \frac{1+ns_j-\sum_{k=1}^{z} n_k s_k}{n+1} \quad \text{with} \quad j\in\{h_1,\ldots,h_{z-1},f\} \tag{12}$$

Inserting these quantities into profit function (1) und mulitplying by n_j yields welfare $W_j(s_1,\ldots,s_z)$ in country or region j. Simultaneously solving the n first order conditions of these welfare functions, we obtain equilibrium subsidies

$$s_j^* = \frac{(n+1-2n_j)}{n_j[(z-1)(n+1)+2]}. \tag{13}$$

Based on (13) welfare $W_j(s_1,\ldots,s_z)$ may be written as function of the n_j and z:

$$W_j(n_1,\ldots,n_z,z) = \frac{(n+1-n_j)}{n_j[(z+1)(n+1)-2\sum_{k=1}^{C} n_k]^2} \tag{14}$$

Because $\sum n_k = n$ welfare of a country or region j only depends on n_j, the number of firms in j, on the total number of firms n and on z, the number of countries or regions with active industrial policy. Domestic welfare W_h may thus be written as a function of n, n_f and of $z_h^R \equiv z - 1$, the number of regions in the home country:

$$W_j(n, n_f, z_h^R) = \frac{z_h^R(n+1) - (n - n_f)}{(n - n_f)[z_h^R(n+1) + 2]^2} \tag{15}$$

Based on (15) it can be shown that for $z_h^R \geq 2$ domestic welfare will be reduced if the number of regions rises. The derivative of $W_j(n, n_f, z_h^R)$ with respect to z_h^R is given by

$$\frac{\partial W_j}{\partial z_h^R} = \frac{(1+n)[(2 - z_h^R)(n+1) - 2n_f]}{(n - n_f)[z_h^R(n+1) + 2]^3}. \tag{16}$$

For $z_h^R \geq 2$ expression (16) is negative. What does that mean for the proposition proved in section 2? With more than two regions $n_h \geq 2n_f$ is no longer a sufficient but only a necessary condition for delegation to raise domestic welfare: While it remains valid that the central solution is preferable for $n_h < 2n_f$, it depends on the exact values of n_h, n_f and z_h^R whether regional policy is the better option for $n_h \geq 2n_f$.

To complete the analysis, we will now determine the combinations of n_h, n_f and z_h^R which ensure the profitability of delegation. $W_h(n, n_f, z_h^R) - W_h(n, n_f, 1) = 0$ implicitly defines the limiting values $\hat{n}_h$, $\hat{n}_f$ and $\hat{z}_h^R$. Solving $W_h(n, n_f, z_h^R) - W_h(n, n_f, 1) = 0$ with respect to z_h^R yields combinations of n_h and n_f where the domestic government is indifferent between central policy and delegation to z_h^R regions. For higher n_h or lower n_f delegation will be actually preferred. We obtain the following formula for $\hat{z}_h^R$:

$$\hat{z}^R = \frac{4 + 5n_h + n_h n_f + n_h^2}{1 + 2n_f + n_f^2 + n_h + n_f n_h} \tag{17}$$

To visualize the impact of an increasing number of domestic regions on the delegation incentive, the borderlines for $z_h^R = \{2, 3, 4, 5, 6\}$ are displayed in figure 1. All possible combinations of n_h and n_f have been marked in this diagram so that it can be easily checked whether delegation to z_h^R regions is actually preferable for some combination of n_h and n_f.

As can be seen in figure 1, delegation incentives diminish considerably with an increasing number of domestic regions. A close inspection of (17) shows that the number of domestic firms must be at least three times the number of foreign firms to ensure profitability of delegation in the case of $z_h^R = 3$. For $z_h^R = 4$ the respective relation is given by $n_h \geq 5n_f$ and for $z_h^R = 5$ by $n_h \geq 7n_f$. We can thus draw the following conclusions: While delegation of industrial policy on *two* domestic regions

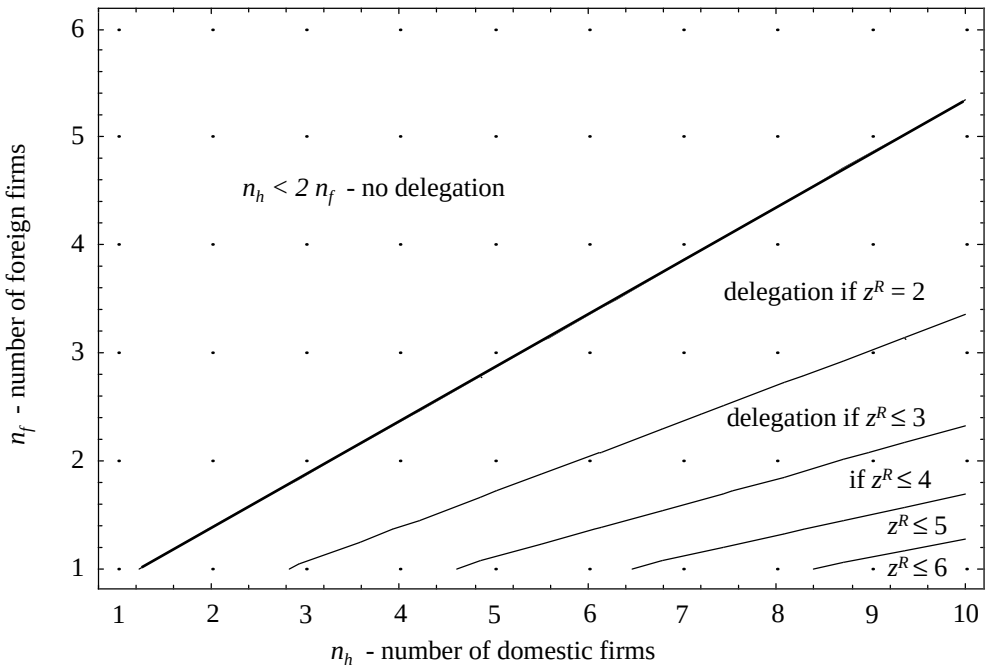

Figure 1: Impact of the number of domestic regions on delegation incentives

will be preferable if the domestic market share is relatively large, it is not in the interest of the domestic country to further splitting the competences. If there exist more than two regions, delegation may be only profitable if the market share of the domestic firms is quite large.

3.2 Consumption within the producing countries

Having analyzed the case with more than two regions in the last section, we will now consider the possibility of consumption within the producing countries. To concentrate on this aspect attention will be restricted to the case with only two domestic regions. In addition it will be assumed that these regions are symmetric, i. e. that the number of firms and the consumption shares are identical. What additional effects have to be considered if the good is consumed within the producing regions?

- There is another incentive to subsidize because output under oligopoly is below the first best value obtained under perfect competition. While the central government considers the impact on total domestic consumption, regional authorities are only concerned with regional consumption. An increasing share

of domestic consumption should thus yield a more pronounced increase in subsidy levels if policy is performed by the central government.

- A higher consumption share in the foreign producing country will yield higher subsidies in this country. The relative impact on the equilibriy under central and regional policy, respectively, crucially depends on the slope of the reaction functions.

- If the good is consumed domestically, not only equilibrium subsidies change but also the welfare function which is used to compare the results: Contrary to the situation without domestic consumption, increasing total output may even raise welfare if the consumption share is substantial.

The relative impact of these factors will now be analyzed by varying the total share of consumption in the producing countries, γ^P, and the foreign share of this consumption within the producing countries, ϕ^A. For the consumption share of a domestic region we get $\gamma^P(1-\phi^A)/2$ while the share of the foreign country equals $\gamma^P\phi^A$.

Total consumer surplus in a Cournot oligopoly with linear demand $p(X) = 1 - X$ is given by $X^2/2$. Based on (12) consumer surplus may thus be written as a function of the number of firms in each domestic region and the foreign country and of the subsidies which are given to these firms:

$$KR = \frac{1}{2}\left(\frac{n + n_{h_1}s_{h_1} + n_{h_2}s_{h_2} + n_f s_f}{n+1}\right)^2 \tag{18}$$

To derive the objective functions of the governments, we must applying the consumption shares to (18). For central policy this is done by taking (5), the formula for the welfare functions without consumption, and adding the appropriate shares of consumer surplus:

$$W_h(s_h, s_f) = n_h\pi_i^h(s_h, s_f) + (1-\phi^A)\gamma^P KR \tag{19}$$

$$W_f(s_h, s_f) = n_f\pi_i^f(s_h, s_f) + \phi^A\gamma^P KR \tag{20}$$

For welfare under decentralization the same procedure must be applied to the respective expression (6):

$$W_{h_j}(s_{h_1}, s_{h_2}, s_f) = n_{h_j}\pi_i^{h_j}(s_{h_1}, s_{h_2}, s_f) + (1-\phi^A)\gamma^P/2KR \tag{21}$$

$$W_f(s_{h_1}, s_{h_2}, s_f) = n_f\pi_i^{h_j}(s_{h_1}, s_{h_2}, s_f) + \phi^A\gamma^P KR \tag{22}$$

Equilibrium subsidies may then be derived by simultaneously solving the resulting first order conditions. Because it is assumed that regions are symmetric, i.e. $n_{h_i} = n_h/2$, both equilibria can be written as functions of four parameters: n_h, n_f, γ^P and

ϕ^A.

$$(s_h^*, s_f^*) = \left(\frac{(1-\gamma^P)(n+1-2n_h) + (1-\phi^A)\gamma^P(n+2)}{n_h(n+3-\gamma^P)}, \frac{(1-\gamma^P)(n+1-2n_f) + \phi^A\gamma^P(n+2)}{n_f(n+3-\gamma^P)} \right) \tag{23}$$

$$(s_{h_1}^*, s_{h_2}^*, s_f^*) = \left(\frac{(1-\gamma^P)(n+1-n_h) + (1-\phi^A)\gamma^P(2n+3)}{n_h/2(2n+4)-\gamma^P)}, \frac{(1-\gamma^P)(n+1-n_h) + (1-\phi^A)\gamma^P(2n+3)}{n_h/2(2n+4)-\gamma^P)}, \frac{(1-\gamma^P)(n+1-2n_f) + (1-\phi^A)\gamma^P(2n+3)}{n_f(2n+4)-\gamma^P)} \right) \tag{24}$$

To analyze the impact of a change in consumption shares on domestic subsidies under central and decentral policy, respectively, we have to determine the derivatives of s_h and s_{h_i} with respect to γ^P:

$$\frac{\partial s_h}{\partial \gamma^P} = \frac{(n+2)[(2n_h+2) - \phi^A(n+3)]}{n_h(n+3-\gamma^P)^2} \tag{25}$$

$$\frac{\partial s_{h_i}}{\partial \gamma^P} = \frac{(2n+3)[(2n_h+2) - \phi^A(2n+4)]}{n_h(2n+4-\gamma^P)^2} \tag{26}$$

Setting ϕ^A equal to zero allows us to consider in isolation the direct effect caused by a rise in domestic consumption. As suspected, in both cases equilibrium subsidies increase. By substracting (26) from (25), it can be shown that this increase is higher under central policy:

$$\frac{\partial s_h}{\partial \gamma^P} - \frac{\partial s_{h_i}}{\partial \gamma^P} = \frac{(2n_h+2)(n+1)[(n+1)(2n+5) + \gamma^P(2-\gamma^P)]}{n_h(n+3-\gamma^P)^2(2n+4-\gamma^P)^2} \tag{27}$$

The indirect effect caused by the change of the foreign subsidies can be seen if the same analysis is performed for $\phi^A = 1$. While the denominator of (25) and (26), respectively, remains unaffected, the sign of the numerator may now differ between central and decentral policy: Under decentral policy we get $-(2n+3)(n_f+1)$, i. e. subsidies are reduced by the regional governments. With central policy the numerator is given by $(n+2)(n+1-2n_h)$ which is positive for $n_h > (n+1)/2$.

Because the limiting value for delegation to be preferable in the case without domestic consumption is given by $n_h = 2n/3 > (n+1)/2$, both the indirect and the direct effect reduce the difference between subsidies under centralization and decentralization. It will now be analyzed under what circumstances this impact of consumption is big enough to change the result obtained in section 2. To do this we insert equilibrium subsidies from (23) and (24), respectively, into the expressions for domestic welfare given by (19) and (21). Rearranging terms appropriately, the

difference between welfare under central and under decentral policy may be written in a way that allows to isolate the effect without domestic consumption ($\phi^A = 1$) from the effect without foreign consumption ($\phi^A = 0$):

$$W_h^D - W_h^C = \frac{(1-\gamma^P)^2(n+1)}{(2n+4)^2(n+3)^2} \{ 2[(n+2)(n_h - 2n_f) + (n+2-n_f)] - \gamma^P(1+n_h-3n_f) - \gamma^P\phi^A(3n+7-2\gamma^P) \} \quad (28)$$

In a first step it will be shown that the limiting value $n_h \geq 2n_f$ remains unaffected by γ^P if the good is not consumed in the foreign producing country ($\phi^A = 0$). Here the impact of the share of consumption on the decision about delegation is solely given by $-\gamma^P(1+n_h-3n_f)$, the second term between the braces in (28). Because all factors in the denominator and the numerator of the fraction in (28) are positive, only the sign of the expression between the braces is relevant. In the interesting parameter range arround $n_h = 2n_f$ the effect of a rise in γ^P is positive for $n_f > 1$. However, the impact of domestic consumption is not big enough to change the limiting value for the delegation decision, $n_h \geq 2n_f$: At $n_h = 2n_f - 1$, the highest value of n_h where decentralization is not preferable in the case without domestic consumption, the total effect in the braces is given by $-2n_f + \gamma^P n_f < 0$.

While the share of domestic consumption does not affect the decision about delegation, this may happen if the consumption share of the foreign country is big enough. For $n_h > (n+1)/2$ reaction curves of the domestic central government in the policy game are upward sloping. Therefore an increase of the subsidy by the foreign country yields a rise in domestic subsidies under centralization while the subsidies are reduced under regional policy. The net effect on delegation incentives is ambiguos: Suppose that the good is consumed in the foreign producing country but not in the home country. Starting from a situation where subsidies are to low under central policy and too high under regional policy,[3] both policy options are closer to the first best after a marginal increase of the foreign subsidy.

A detailed analysis shows, that the net effect of consumption in the foreing producing country is to make delegation less attractive. Assuming that the good is not consumed domestically, i.e. $\phi^A = 1$, this can be directly seen in (28): After substituting n_f by $n - n_h$ we get $-\gamma^P(4n_h + 8 - 2\gamma^P)$. For $n_h = 2n_f$ decentral policy yields lower welfare than central policy if $2n_h + 4 < \gamma^P(4n_h + 8 - 2\gamma^P)$ — for $\gamma^P = 1/2$ decentral policy is still preferable while central policy is better for $4n_h + 8 + 2n_f > \gamma^P(4n_h + 8 - 2\gamma^P)$. It should be noted that an effect on delegation incentives only results for $n_h = 2n_f$ and a change of the delegation decision only happens if the consumption share of the foreign producing country is quite high.

We will now derive the combinations of ϕ^A and γ^P where the domestic government is just indifferent between central and decentral policy in the case of $n_h = 2n_f$.

[3] This is exactly the case at the point where the domestic government is just indifferent between central and decentral policy.

This is done by substituting n_h by $2n_f$ and n by $3n_f$, which allows us to write the expression between the braces in (28) as a function of ϕ^A, γ^P and n_f. Equating the result $4n_f + 4 - \gamma^P(1 - n_f) - \gamma^P\phi^A(9n_f + 7 - 2\gamma^P)$ to zero and solving for ϕ^A we obtain

$$\phi^A = \frac{4(n_f + 1) + \gamma^P(n_f - 1)}{\gamma^P(7 - 2\gamma^P + 9n_f)}. \tag{29}$$

Based on this expression the borderlines for $n_f = 1$ and $n_f \to \infty$ have been computed. They are displayed in figure 2 where γ^P is measured at the horizontal axis and ϕ^A at the vertical axis. As can be seen in the diagram, the borderlines are only marginally different for $n_f = 1$ and $n_f \to \infty$: In both cases the foreign country which comprises only half as many firms as the domestic country must consume at least 50% of total production.

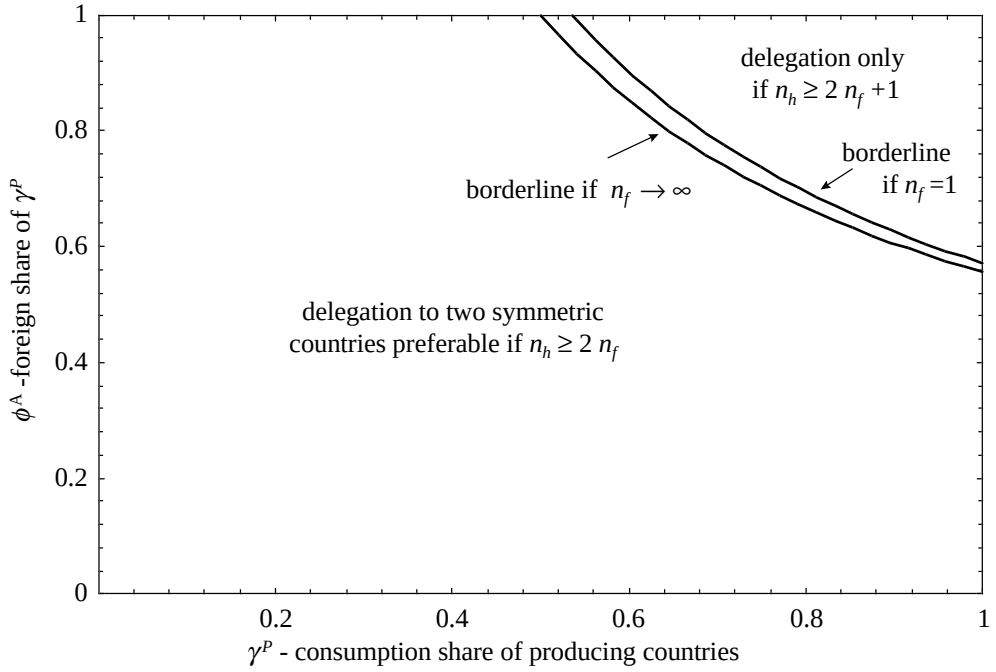

Figure 2: Consumption shares and delegation incentives

3.3 Price and quantity competition with heterogenous goods

The results up to now have been derived in a homogenous good quantity setting oligopoly. As is well known from the literature, policy recommendations for oligopolistic markets are often rather sensitive to assumptions about market demand

and firm conduct. To check the robustness of the results with respect to changes in these assumptions, price and quantity competition in a market with differentiated products are now examined.

Concerning price competition, a formal analysis is not necessary. Here all governments will tax the firms in any equilibrium. More aggressive behavior is not favorable unter these circumstances (see *Bulow et al., 1985*): Higher domestic profits may only be achieved by a policy which increases the price of the domestic firms. Regional policy always yields lower taxes than central policy because regional authorities do not consider the positive effect of higher taxes on firms in the other domestic regions. Thus delegation could never be profitable in the case of price competition.

In the rest of the section we will therefore concentrate on a quantity setting oligopoly in a market with differentiated products. Each firm is assumed to produce a symmetrically differentiated product, x_i, which is sold at a price p_i. Demand is represented by a continuum of consumers with utility function

$$U(x_1, \ldots, x_n; x_0) = \alpha \sum_{i=1}^{n} x_i - 1/2 \left(\sum_{i=1}^{n} x_i^2 + 2\beta \sum_{i=1}^{n} \sum_{j>i} x_i x_j \right) + x_0 \qquad (30)$$

where $\alpha > 0$ is a measure of market size, $\beta \in [0, 1]$ is an indicator of the degree of substitutability, and x_0 is a numeraire good.[4] If $\beta = 1$ the goods are perfect substitutes, for $\beta = 0$ they are independent. The consumer maximization problem yields linear inverse demand functions $p_i = \alpha - x_i - \beta \sum_{j \neq i} x_j$.

The first order conditions of the welfare maximization problem are too complicated to allow a determination of the equilibria as a function of β and the number of firms. Instead the welfare difference between central and decentral policy is derived for explicit values of n_f as a function of β and n_h. Based on this, the combinations of β and n_h where delegation is preferable can be determined for specific values of n_f. As will be seen, a delegation incentive may only result in markets with close substitutes.

The equilibria may be determined by the same procedure as in the Cournot model. However, due to the additional parameter β the expressions become much more complicated. This will be illustrated by determining the welfare as a function of the subsidy structure under central policy. Note that the resulting welfare function is only the starting point for the much more involved derivation of the equilibrium at the policy stage.

We start with profits written as a function of own quantity, x_i, quantities of the competitors, X_{-i}, and subsidies in country or region j, s_j:

$$\pi_i^j = (1 - x_i - \beta X_{-i}) x_i^j + s_j x_i^j. \qquad (31)$$

[4]The numeraire good is assumed to be produced in another sector of the economy and has been added linearly to ensure that the marginal utility of income is equal to one.

This yields the following first order conditions:

$$\frac{\partial \pi_i^j}{\partial x_i^j} = 1 - \beta X_{-i} - 2x_i^j + s_j = 0 \tag{32}$$

As in section 2 the equilibrium on the output stage is determined by simultaneously solving the n_h equations (32) with $j = h$ and the n_f equations with $j = f$. We obtain the following quantities for a given subsidy structure (s_h, s_f):

$$x_i^j(s_h, s_f) = \frac{(2-\beta) + [2+\beta(n-1)]s_j - \beta n_h s_h - \beta n_f s_f}{(2-\beta)[2+\beta(n-1)]} \quad \text{with} \quad j \in \{h, f\} \tag{33}$$

Restricting attention to the case without domestic consumption, welfare in country or region j can be determined by inserting x_i^j into the profit functions (31) and multiplying by n_j:

$$\begin{aligned} W_j^C(s_h, s_f) = & \\ & n_j \frac{(2-\beta) + [2+\beta(n-1)]s_j - \beta n_h s_h - \beta n_f s_f}{(2-\beta)^2[2+\beta(n-1)]^2} \\ & \{(2-\beta) - (1-b)[2+\beta(n-1)]s_j - \beta n_h s_h - \beta n_f s_f\} \quad \text{with} \quad j \in \{h, f\} \end{aligned} \tag{34}$$

Comparing this expression with the respective formula (5) for the Cournot model, one can imagine that the determination of the equilibria in the policy stage are likely to become quite complicated for $\beta \neq 1$. Welfare in the case of decentral policy may be derived by the same procedure, however, expressions are even longer because now two domestic regions must be considered.

Based on the welfare functions the equilibrium can be computed relatively easily for explicit values of β, n_h and n_f. This shall be exemplified for the case $n_h = 2$ and $n_f = 1$. In the Cournot oligopoly with homogenous products ($\beta = 1$) delegation on two domestic regions dominated the central solution. To find out whether this result will also hold for differentiated products, we analyze how the welfare difference behaves for $\beta < 1$. Welfare functions under central policy are obtained by inserting $n_h = 2$ and $n_f = 1$ into (34). The objective function of the domestic government only differs insofar from the welfare function of the foreign government that profits are multiplied by two. Under decentral policy one firm is active in each domestic region and the foreign country. Thus we have a symmetric game on the policy stage with identical objective functions for each government:

$$\begin{aligned} W_j^D(s_{h_1}, s_{h_2}, s_f) = & \\ & \frac{(2-\beta) + 2(1+\beta)s_j - \beta s_{h_1} - \beta s_{h_2} - \beta s_f}{(2-\beta)^2(2+2\beta)^2} \\ & [(2-\beta) - (1-\beta)(2+2\beta)s_j - \beta s_{h_1} - \beta s_{h_2} - \beta s_f] \quad \text{with} \quad j \in \{h_1, h_2, f\} \end{aligned} \tag{35}$$

Based on the first order conditions under central and decentral policy, respectively, we obtain the following equilibrium subsidies:

$$(s_h^*, s_f^*) = \left(\frac{-\beta(1-\beta)(4-3\beta^2)}{2(4+6\beta-4\beta^2-4\beta^3+\beta^4)}, \frac{\beta^2(2-\beta^2)}{4+6\beta-4\beta^2-4\beta^3+\beta^4)} \right) \quad (36)$$

$$(s_{h_1}^*, s_{h_2}^*, s_f^*) = \left(\frac{\beta^2}{2+3\beta}, \frac{\beta^2}{2+3\beta}, \frac{\beta^2}{2+3\beta} \right) \quad (37)$$

Welfare under central and decentral policy may then be written as functions of β:

$$W_h^C = \frac{(1+\beta-\beta^2)^2(4-3\beta^2)^2}{2(4+6\beta-4\beta^2-4\beta^3+\beta^4)^2} \quad (38)$$

$$W_h^D = \frac{(2+\beta)(2+\beta-2\beta^2)^2}{2(2+3\beta^2)^2} \quad (39)$$

While the expressions for W_h^C and W_h^D are not very complicated, the numerator of the resulting formula for the welfare difference $W_h^D - W_h^C$ is a polynomial of degree nine:

$$W_h^D - W_h^C = \frac{-\beta^2(16+48\beta^2+8\beta^2-96\beta^2-71\beta^2+57\beta^5+59\beta^6-12\beta^7-13\beta^8-2\beta^9)}{2(2+3\beta^2)^2(4+6\beta-4\beta^2-4\beta^3+\beta^4)^2} \quad (40)$$

Because the denominator of (40) is always greater than zero, the sign of the expression only depends on the sign of the numerator. However, it is not possible to analytically determine the values of β where the numerator equals zero. So a numerical method has to be used to determine these values in the relevant interval $\beta \in (0,1]$. Hereby the limiting value $\hat{\beta} \simeq 0,957462$ is obtained: In a situation with two domestic and one foreign firm, delegation is only preferable as long as products are only slightly differentiated.

What happens for other combinations of n_h and n_f? To answer this question, the limiting values $\hat{\beta}$ where the central government is indifferent between central policy and delegation to regional authorities have been determined for $n_f = \{1,2,3,4\}$ in the parameter range $n_h \in \{2,\ldots,20\}$. Figure 3 shows the resulting borderlines in a diagram with n_h on the horizontal axis and β on the vertical axis.

An inspection of 3 shows that the introduction of product differentiation strictly reduces the delegations incentives: As long as the number of domestic firms is smaller than $2n_f$ delegation could not be welfare enhancing and with rising β there exist more and more combinations of n_h and n_f where the central solution is preferred even for $n_h \geq 2n_f$. While the central solution always yields higher welfare in the diagram for $\beta \leq 0.9$, it can be shown that delegation may be preferable in this case

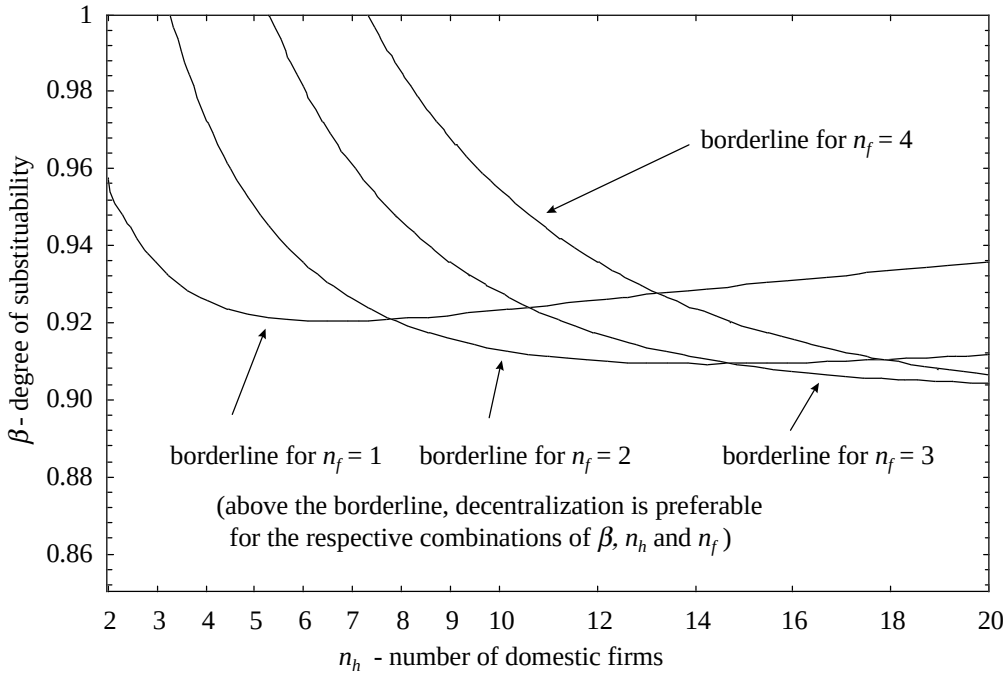

Figure 3: Delegation incentives in a market with differentiated procucts

for higher n_h: For example regional policy dominates centralization for $\beta = 0.9$ and $n_f = 4$ if n_h takes a value between 28 and 32.[5]

4 Conclusion

This paper discussed the strategic incentives for delegating the power over industrial policy to regional authorities. In a linear Cournot oligopoly with third country consumption and two domestic regions it has been shown that delegation raises domestic welfare relative to the situation under central policy if the number of domestic firms is at least twice as large as the number of their foreign competitors. This result remains largely unaffected if consumption within the producing countries is allowed. However, delegation incentives are substantially reduced if the number of domestic regions exceeds two: A welfare improvement by delegation is then only possible in cases where a market is almost completely covered by domestic firms. Finally, under modified assumption about market demand or strategic variables used

[5]In a numerical analysis smaller values of β have been considered as well. For $\beta = 0.89$ a positive effect of delegation has been found for $n_f = 51$ if n_h is approximately 400. For $\beta = 0.88$ centralization has been profitable for all values considered (however, the expressions where to complicated to actually proof this result).

by the oligopolists the delegation incentive may vanish completely: Under price competition (strategic complements) the impact of delegation on domestic welfare is always negative. The same result is obtained for heterogenous goods quantity competition whenever products are sufficiently differentiated.

What do these results imply for the policy relevance of the strategic delegation incentive? The profitability of delegation is restricted to markets which are dominated by domestic firms: Even in the Cournot model with only two regions the domestic market share must be nearly 70%. Therefore it would be not appropriate to generally delegate industrial policy to regional authorities (at least if this delegation decision is based on strategic aspects). On the other hand an abstract rule like the state aid article of EU treaty where the Commission may decide *ex post* whether national subsidies are admissible will not yield a strategic effect. Instead the decision power must be delegated in advance for a given industry. It should be noted that there are indeed some EU regulations for specific industries which may serve this purpose. However, if one considers that in most markets there are more than two producing countries within the European Union and a world market share of european firms that exceeds 70% is quite uncommon, strategic incentives for decentralization of industrial policy may not be quite important in practice.

References

Brander, J. A, Spencer, B. J. (1985), Export Subsidies and International Market Share Rivalry, Journal of International Economics 18, 83-100

Bulow, J. I., Geanakoplos, J. D., Klemperer, P. D. (1985), Multimarket Oligopoly: Strategic Substitutes and Complements, Journal of Political Economy 93, 488-511

Collie, D. R. (1997a), Bilateralism is Good: Trade Blocs and Strategic Export Subsidies, Oxford Economic Papers 49, 504-520

Collie, D. R. (1997b), Delegation and Strategic Trade Policy, International Economic Journal 11/3, 35-46

Collie, D. R. (1999), State Aid in the European Union: The Prohibition of Subsidies in an Integrated Market, erscheint in: International Journal of Industrial Organization

Dixit, A. (1984), International Trade Policy for Oligopolistic Industries, Economic Journal 94 (supplement), 1-16

Fershtman, C., Judd, K. L. (1987), Equilibrium Incentives in Oligopoly, American Economic Review 77, 927-940

Gatsios, K., Karp, L. (1991), Delegation Games in Customs Unions, Review of Economic Studies 58, 391-397

Gatsios, K., Karp, L. (1995), Delegation in a General Equilibrium Model of Customs Unions, European Economic Review 39, 319-333

Gilbert, G., Picard, P. (1996), Incentives and Optimal Size of Local Jurisdictions, European Economic Review 40, 19-41

Laffont, J.-J., Martimort, D. (1998), Transaction Costs, Institutional Design and the Separation of Powers, European Economic Review 42, 673-684

Morasch, K. (1997), Industrial Policy — Centralization or Decentralization?, Beitrag Nr. 157, Volkswirtschaftliche Diskussionsreihe, Universität Augsburg

Vickers, J. (1985), Delegation and the Theory of the Firm, Economic Journal 95, 138-147

Welzel, P. (1995), Commitment by Delegation Or: What's "Strategic" about Strategic Alliances?, in: *Van Witteloostuijn, A. (ed.)*, Studies in Industrial Organization, Dordrecht: Kluwer, 87-100