Industrial policy - centralization or decentralization?

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Angaben zur Veröffentlichung / Publication details:

Morasch, Karl. 1997. “Industrial policy - centralization or decentralization?” Augsburg: Volkswirtschaftliches Institut, Universität Augsburg.

INSTITUT FÜR VOLKSWIRTSCHAFTSLEHRE

der

UNIVERSITÄT AUGSBURG

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Beitrag Nr. 157 Februar 1997

Volkswirtschaftliche Diskussionsreihe

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Abstract

This paper deals with the question whether industrial policy is better performed by the central government or by regional governments. The advantage of the decentral solution is better information about the regional industry: Only the regional government knows the costs of the firm in its region. On the other hand, the central government internalizes the negative spillovers of strategic industrial policy. In an integrated Cournot duopoly market with domestic and third country consumption it is shown that the decentral solution will be preferred if only a small fraction of the good is exported and if there does exist some degree of uncertainty with respect to the costs of the duopolists.

JEL–classification: D43, H70, L52

Key words: Industrial policy; (De)centralization

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1 Introduction

In most countries decentralization of public decision making is quite common: Some tasks are performed by the central government and others by regional governments. Whether the given distribution of powers is in the interest of the whole country depends on the particular situation: The central government may be able to internalize spillover–effects while the local governments may have superior information about local aspects.

The present paper tries to analyze this tradeoff in the context of industrial policy in an oligopoly model. It brings together two strands of literature: The so called "strategic trade policy" literature and the literature on the (de)centralization of government based on information economics. My paper is closely related to some recent papers on strategic trade policy under imperfect information (*Collie/Hviid, 1993*, *Qiu, 1994* and *Brainard/Martimort, 1996*). However, in contrast to these papers I am not interested in signalling aspects of strategic trade policy or the effects of asymmetric information on the commitment ability of the government. The most closely related paper about the appropriate degree of decentralization of government is *Caillaud et. al. (1996a)* where the interaction of central and regional industrial policy is discussed in a moral hazard context. In a survey article *Caillaud et. al. (1996b)* argue that according to the "revelation principle" a central mechanism is weakly preferred to decentralization as long as communication costs are negligible. I will assume that communication costs make it unattractive or impossible for the central government to attain the same amount of local information than a regional government.[1]

The paper is both relevant for the analysis of strategic trade policy and for the analysis of the internal structure of government:

- Assume that the regions are sovereign nations. Would it be preferable to delegate the decision about industrial policy to some central institution (e. g.

[1]It would be preferable to endogenize communication costs. But I am not aware of a model specification which allows a sound analysis of the relative impact of communication costs vs. advantages of centralization. While the present paper thus gives an unfair advantage to decentralization, at least a limited result may be obtained: If centralization is preferable without communication then the performance will be even better if communication allows the central government to obtain additional information.

on the world level to the WTO or in an european context to the European Community)?

- Under what circumstances should a central government delegate the power over industrial policy to regional governments (e. g. in Germany to the federal states)?

The remainder of the paper is organized as follows: In section 2 I analyze a Cournot duopoly model with general demand and cost conditions. I show that under some specific circumstances central and decentral policy lead to the same result an. In section 3 I use a linear model to derive explicit results about the relative performance of the two policy options for different shares of domestic consumption and different degrees of uncertainty about the costs of the firms.

2 General Model

The model structure is based on the strategic trade policy model in *Brander/Spencer (1985)*. The domestic country consists of two regions with one Cournot firm in each region. These firms produce a homogenous good for an integrated market comprising the two regions of the domestic market and a third country which is solely a importer of the good (if the firms would only produce for the third country market this would be perfectly equivalent to the standard formulation in *Brander/Spencer, 1985*). Demand is given by $p(X)$, where p is price, $X = x_1 + x_2$ is industry output, and $p'(X) < 0$. In order to assure stability of the Cournot equilibrium it is assumed that each firms reaction curve slopes downward [i. e. $p'(X) + x_i p''(X) < 0$] and that each firms residual demand curve intersects its marginal cost curve from above [i. e. $c''(x_i) > p'(X)$]. Industrial policy is modelled as an output subsidy (or tax if applicable): Either the central government pays a per unit subsidy s to each firm or each regional government pays s_i to the firm which is producing in its region. These subsidies are credibly set in advance of the quantity decisions of the firms.

For the case of perfect information and without domestic consumption *Brander/Spencer (1985)* obtain the following results: With unilateral policy a positive subsidy will raise regional welfare but reduce total domestic welfare. When both regional governments use strategic trade policy, the equilibrium of the two–stage game is given

by positive subsidies and lower welfare for both regions than in the situation without policy. A central government would internalize this external effect of regional policies and impose a tax in order to induce the domestic firms to behave together like a monopoly.

Introducing informative advantages of regional governments in this setting would not change the qualitative results: Even if the central government does not have exact knowledge about the cost structure of the firms, it will still impose a tax which is preferable to the subsidies imposed by the regional governments. However, things will change if we introduce domestic consumption. Here even a central government might use a subsidy in order to correct for the domestic distortion which is caused by the underproduction in the Cournot equilibrium. With symmetric firms and without exports to a third country it can be shown that the equilibrium subsidies in the policy game between the regional government and the optimal subsidies coincide.

Proposition 1 *If the good is only consumed by the two producing countries, there does exist a Nash-equilibrium in the subsidy game where joint welfare, $W^1 + W^2$, of the two producing nations is maximized: The equilibrium subsidies induce output levels which lead to $p = c'$ for all firms.*

Proof: Total consumer surplus is given by $CS = \int_0^X p(y)\,dy - p(X)X$ and by symmetry $CS_i = CS/2$. Suppose that both regions initially use subsidies s_i^* which induce $p = c'(x_i)$. Let the government of the first region marginally change s_1^*, which in turn induces a marginal change of the output of firm 1. It can be shown that this will not change W_1 and thus there is no incentive to deviate from s_1^*. Let us first consider the direct effect on profits and consumer surplus: $\partial\pi_1/\partial x_1 = p'(X)x_1 + p(X) - c'(x_1) = p'(X)x_1$ because $p(X) - c'(x_1) = 0$ and $\partial CS/\partial x_1 = p(X) - p'(X)X - p(X) = -p'(X)X$. The two effects cancel out because in a symmetric equilibrium $x_1 = X/2$ and $dCS_1 = 1/2\,dCS$. Note, however, that the change of the subsidy level by the government of region 1 would also induce a reaction by firms in the other region. dx_2 has the following effects on π^1 and CS: $\partial\pi_1/\partial x_2 = p'(X)x_1$ and $\partial CS/\partial x_2 = -p'(X)X$. Again the two effects on W_1 cancel out.

To sum up: If the product is only exported to the third country, central industrial policy will be preferred irrespective of information problems as long as both firms have identical costs. However, if the product is not exported to the third country,

decentral policy leads to the same result than central policy for symmetric information and thus dominates central policy for asymmetric information. However, the general formulation does not allow to determine which policy option is superior if part of the production is exported to the third country or if firms could have different costs. To analyze these questions, a linear specification will be used.

3 Linear Model

In the following a simple linear duopoly model will be analyzed which allows a parametrization of the share of domestic consumption and the "degree" of uncertainty. I will assume linear demand $p(X) = 1 - X$ and constant variable costs c_i. The consumption pattern of the two producing regions is assumed to be identical. Thus the share of total production which is consumed in a given region may be described by $\gamma = \gamma_1 = \gamma_2 \in [0, 0.5]$ — in case of $\gamma = 0$ all output is exported to the third country while $\gamma = 0.5$ indicates that everything is consumed within the producing country (because markets are integrated, it is irrelevant whether the goods consumed in region i are produced in this region or in region j).

The welfare W_i of region i may be derived by summing up the profits of the regional firm and the consumer surplus in this region:

$$W_i(x_1, x_2) = [1 - c_i - (x_1 + x_2)]x_i + \gamma\frac{(x_1 + x_2)^2}{2} \tag{1}$$

The regional government i tries to maximize this function while the central government is concerned with $W = W_1 + W_2$.

In order to determine the equilibrium subsidies, we first have to solve the game in the output stage for given subsidies. The oligopolistic interaction between the two firms leads to the following result:

$$x_i^*(s_1, s_2) = 1/3(1 - 2c_i + c_j + 2s_i - s_j) \tag{2}$$

For a given cost structure the welfare can now be written as a function of the subsidies. The equilibrium between the regional governments and the subsidy imposed by a welfare maximizing central government may thus be derived as a solution of this reduced form of the game.

3.1 Perfect Information

Let us first consider the benchmark case with perfect information: The costs of both firms are assumed to be common knowledge. If the regional governments decide about industrial policy, the equilibrium may then be determined by partially differentiating the $W_i(s_1, s_2)$ and solving the resulting first–order–conditions with respect to (s_1, s_2). The following subsidies result in equilibrium:

$$s_i^* = \frac{(1+2\gamma) - 3c_i + 2(1-\gamma)c_j}{5-2\gamma} \tag{3}$$

For identical costs each regional government will impose positive subsidies. The subsidies will rise if domestic consumption rises. Negative values of s_i^* could only result in the economically irrelevant situation of negative values of x_i.

If the firms have different costs, the central government will impose a tax–subsidy structure which induces exit of the inefficient firm and ensures welfare maximizing behavior of the remaining monopolist. With identical costs $c = c_1 = c_2$ the following subsidy level results from the maximization of W:

$$s^* = \frac{(4\gamma - 1)(1-c)}{4(1-\gamma)} \tag{4}$$

The central government taxes the firms if at least 50% of the production is exported. Otherwise positive subsidies will be used, however, these subsidies are lower than the subsidies in the equilibrium between the regional governments. Central industrial policy leads to higher welfare because the regional governments do not consider the negative impact of the subsidies to their regional firm on the profits of the firm in the other region.

Why should these results change if asymmetric information is introduced? Two effects of the information asymmetry between the central government and the regional governments may be distinguished: (i) If both firms have identical costs ($c_1 = c_2$), the central government is unable to determine the appropriate subsidy level. (ii) If the firms have different costs and the central government has perfect information, it would be optimal to induce the exit of the inefficient firm by an appropriate tax–subsidy structure. With imperfect information, however, the central government could only impose an identical tax or subsidy for both firms. I will first discuss the case with identical costs. In a second step, the possiblity of different costs will be considered. Based on this, the relative impact of the two effects may be determined.

3.2 Asymmetric information but identical costs

Now asymmetric information will be introduced into the model. It is assumed to be common knowledge that the costs of both firms are identical and that these costs are either c^L or c^H with $\text{Prob}(c = c^L) = P$. Each firm and the corresponding regional government observe the true costs before deciding about production and subsidy levels. Because it is common knowledge that the costs are identical, each regional government will have perfect information about the costs of both firms: Knowing the costs of the own firm does automatically result in knowing the costs of the firm in the other region. The subsidy levels will therefore be determined according to equation (3).

The central government cannot observe the realization of the costs but it does know that the costs of both firms are identical. It will therefore implement a subsidy which maximizes the expected welfare $P\,W(c^L) + (1-P)\,W(c^H)$.:

$$s^* = \frac{(4\gamma - 1)[1 - (P\,c^L + (1-P)\,c^H)]}{4(1-\gamma)} \tag{5}$$

Given this the welfare with regional and central industrial policy may be compared. However, it is not possible to obtain a general statement — the result crucially depends on the exact values of P, c^L, c^H and γ.

In order to allow a meaningful economic interpretation of the parameter dependend results, a one dimensional measure for the "degree" of cost uncertainty would be helpful. In the present context the following symmetric specification seems to be appropriate: Both values of c are assumed to be equally likely ($P = 1/2$). Thus the two possible realizations may be expressed as $c^L = E(c) - d$ and $c^H = E(c) + d$ with $E(c)$ being the expected value of c and d a measure of the "degree" of uncertainty. In a model with linear demand $p(X) = 1 - X$ the costs c could take values between zero and one; therefore I assume $E(c) = 1/2$ and thus d can take values in the interval $[0, 0.5[$. A low value of d indicates that the central government knows the c_i almost exactly while higher values represent higher degrees of uncertainty.

Now it is possible to analyze how the share of domestic consumption γ and the degree of uncertainty d affect the relative performance of central and decentral industrial policy:

$$W(s^*) - W(s_1^*, s_2^*) = \frac{81(1-2\gamma)^2 + 32d^2(7 - 13\gamma - 30\gamma^2 + 44\gamma^3 - 8\gamma^4)}{144(1-\gamma)(5-2\gamma)^2} \tag{6}$$

Without neither uncertainty nor domestic consumption ($\gamma = d = 0$) the central solution leads to higher welfare. Partially differentiating (6) with respect to γ and d shows that (i) the advantage of the central solution diminishes with rising γ and (ii) more uncertainty (rising d) makes regional industrial policy relatively more attractive if the share of domestic consumption γ exceeds $(5-3\sqrt{2})/2) \simeq 0.379$ [the decentral solution thus can not be preferable for lower values of γ].

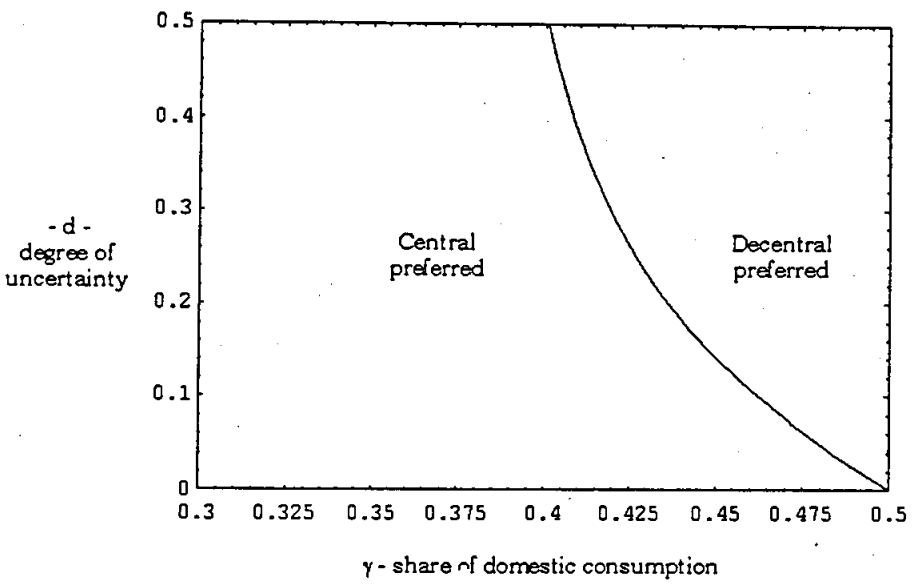

Figure 1: Optimal policy for identical costs

Figure 1 shows which policy is preferable for different combination of γ and d. The decentral solution may only lead to higher welfare if the export share is quite low and the degree of uncertainty is substantial. Thus for identical costs being common knowledge central industrial policy seems to be the more sensible option in almost all realistic scenarios.

3.3 Different costs possible

Now the assumption of identical costs is dropped. However, I still use a model structure where signalling and screening is not relevant: The firms do know the costs of each other. Each regional government is assumed to know the costs of its "own" firm but not the costs of the firm in the other region. Like the central government it does only know that the costs of the other firm are c^L with probability P and c^H with

probability $(1-P)$. While perfect information about costs is surely a simplifying assumption, the structure of the information asymmetry should be realistic: Firms interact with each other and the regional government may have close contact to the regional firm. Thus the other firm and the regional government will have better information about costs like the central government or the government of the other region.

Because the regional governments do not have perfect information about the costs of the other firm, the standard Nash–equilibrium is no longer a suitable solution concept for the first–stage policy game. When deciding about the optimal subsidy each regional government has to build expectations about the "type" of firm which is active in the other region. As a solution concept Bayesian–Nash–equilibrium applies: We have to consider a game between the different types of regional government — regions with low cost firms and regions with high cost firms. A regional government which is of type t tries to find out the welfare maximizing subsidy to the firm in its region given its expectation about the type of the other firm and the resulting behavior of the other regional government. To determine the reaction function of a regional government with firms of type t, $P\,W_i(s_i^t, s_j^L) + (1-P)\,W_i(s_i^t, s_j^H)$ must be differentiated with respect to s_i^t. This leads to four reaction functions of the following form:[2]

$$s_i^t(s_j^L, s_j^H) = \frac{(1+2\gamma) - (2+\gamma)c_i^t + (1-\gamma)[P(c_j^T - s_j^T) + (1-P)(c_j^H - s_j^H)]}{(4-\gamma)} \tag{7}$$

Based on this system of four equations the type dependent subsidy levels can be derived.

$$\begin{aligned} s_i^{t\,*} = {} & \frac{(4-\gamma)(2\gamma+1) - (2+\gamma)(5-2\gamma)c_i^t}{(4-\gamma)(5-2\gamma)} + \\ & \frac{2(1-\gamma)[-(1-\gamma)(Pc_i^L + (1-P)c_i^H] + (4-\gamma)(Pc_j^L + (1-P)c_j^H)]}{(4-\gamma)(5-2\gamma)} \end{aligned} \tag{8}$$

The subsidy level decreases with higher actual costs c_i^t and also with higher expected costs $Pc_i^L + (1-P)c_i^H$. The second effect is due to the strategic interaction between the governments: If the expected costs in region 1 decrease, the government of the other region will increase its subsidy and thus government of region 1 will use a lower subsidy in equilibrium.

[2]Different costs may lead to another problem: For substantial cost differences the high–cost firm will be forced to leave the market if it faces an efficient competitor. The reaction functions are only correct if it is assured that both firms produce in equilibrium.

The central government will now maximize the following function for expected welfare:

$$E[W(c_1^t, c_2^t)] = P^2 W(c_1^L, c_2^L) + P(1-P)W(c_1^L, c_2^H) + (1-P)P\,W(c_1^H, c_2^L) + (1-P)^2 W(c_1^H, c_2^H) \qquad (9)$$

The expected welfare is maximized if

$$s^* = \frac{(4\gamma - 1)[2 - (P(c_1^L + c_2^L) + (1-P)(c_1^H + c_2^H))]}{8(1-\gamma)}. \qquad (10)$$

Comparing this with equation (5) shows that the optimal subsidy is not affected by the possibility of different costs as long as $c_i^t = c_j^t$ for each type.

As with identical costs, a meaningful comparison of welfare in the two scenarios is only possible on the basis of the one dimensional measure d for the degree of cost uncertainty. The welfare difference is then given by

$$W(s^*) - W(s_1^*, s_2^*) = \frac{(2\gamma - 1)^2}{16(1-\gamma)(5-2\gamma)^2} - 2\,d^2 \frac{(7-\gamma)(2+\gamma)^2}{9(4-\gamma)^2}. \qquad (11)$$

The first term in expression (11) is positive and the second is negative and increasing in d: A higher degree of uncertainty makes regional policy relatively more attractive. Differentiating with respect to γ leads to an expression which is always positive in the relevant range for γ and d.

If the firms have different costs it is possible that the inefficient firm will not have an incentive to produce in equilibrium. The present analysis would not be correct in these cases. I will therefore determine the parameter values where the condition $x_i^*(c_i^H, c_j^L) > 0$ is fulfilled.[3] The output of the inefficient firm, $x_i(c_i^H, c_j^L)$, will be

[3]For a general solution the Kuhn–Tucker Theorem must be applied at the production stage of the game. However, the analysis for $x_i(c_i^H, c_j^L)^* = 0$ becomes quite messy at the policy stage: The equilibrium subsidy levels which result when the governments are assuming $x_i(c_i^H, c_j^L)^* = 0$ do not guarantee for all relevant parameter values that $x_i(c_i^H, c_j^L)$ is indeed zero in the resulting equilibrium. With central policy it can be shown that in these cases a subsidy level which assures $x_i(c_i^H, c_j^L)^* = 0$ is optimal. However, for decentral policy there are cases where an equilibrium in pure strategies does no longer exist. Because it is difficult to give a sound economic interpretation of mixed strategies in the present context, I will restrict attention to cases where both firms produce in equilibrium.

greater than zero if the following conditions are fulfilled [condition (12) refers to the case without industrial policy, (13) to central policy and (14) to decentral policy]

$$d < 1/6 \tag{12}$$

$$d < \frac{1}{8(1-\gamma)} \tag{13}$$

$$d < \frac{4-\gamma}{6(5-2\gamma)} \tag{14}$$

Figure 2 shows that all three conditions are fulfilled if $d < 1/8$. Note that $d = 1/8$ would denote a cost difference of 50 % (based on the expected value $c = 1/2$) between the low cost and the high cost type. Thus even for substantial cost differences both firms will produce in equilibrium. It should also be noted that for $\gamma = 0$ the inefficient firm will leave the market in the case of central policy for a lower value of d than in the case of decentral policy.

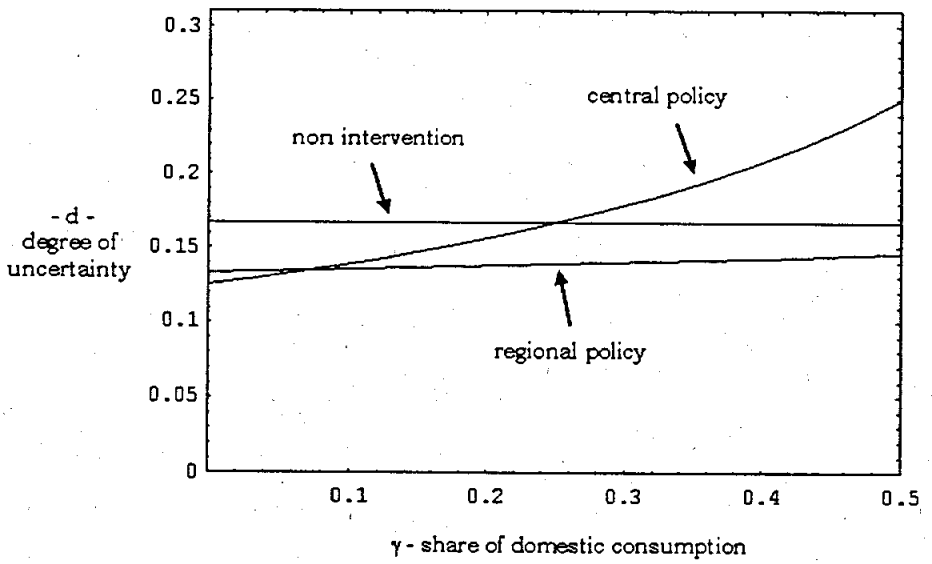

Figure 2: Inefficient firm does not produce in equilibrium

Figure 3 shows which policy is superior for different combinations of γ and d in the range of parameter values where both firms produce. If different costs are possible, regional industrial policy becomes much more attractive: Even if the degree of uncertainty is relatively low, central industrial policy is dominated for realistic shares of domestic consumption (the dotted line represents the border values for identical costs). However, if the good is only exported to the third country, central policy

will always be superior. This is assured even for the case where an inefficient firm would not produce in equilibrium: Central policy leads to such an equilibrium for lower values of d than decentral policy.

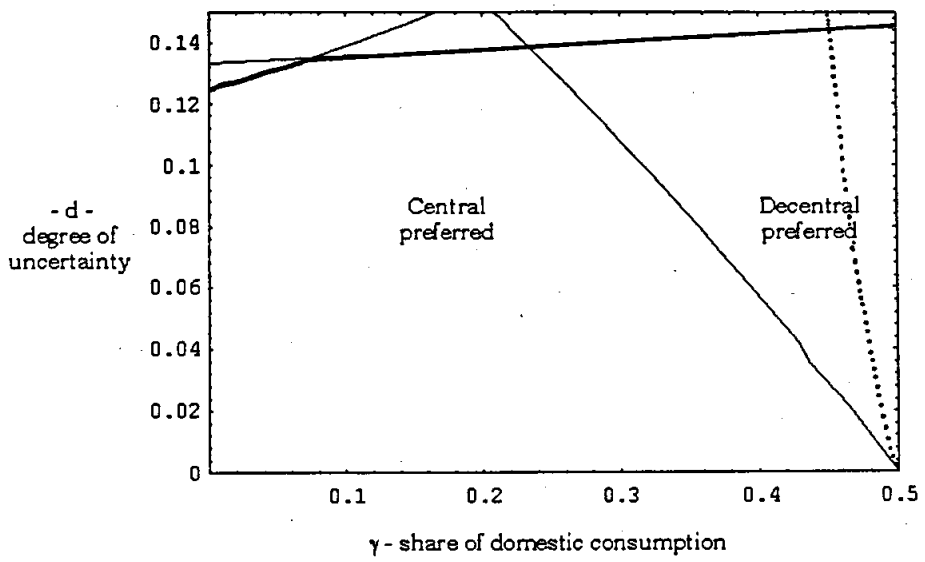

Figure 3: Optimal policy if different costs are possible

4 Conclusion

What have we learned about the attractiveness of the two policy options? As long as industrial policy is only used to gain an strategic advantage for the "home firm", the introduction of information asymmetries between central and regional governments does not change the result that the producing regions are better off if a central industrial policy is applied. However, if a big share of the good is consumed within the producing countries, the result will change: Industrial policy is now mainly used to correct the (domestic) distortion which is caused by the market power of the firms. In this context the informative advantages of the regional governments may dominate the negative effects of the strategic interaction.

It should be noted that these results have been derived in a model with special assumptions about oligopoly competition. It might be interesting to analyze how the findings are affected if one changes these assumptions. What will happen if the

firms compete in prices? In this case there will be no prisoners dilemma between the regional government (both will tax their firm in equilibrium); however, in general the optimal tax–subsidy structure which would be imposed by a central government with perfect information will not result in the regional policy equilibrium. A second modification may concern the number of firms in the industry: If more than one firm is active in each region the incentive to subsidize the home firm is reduced and thus the results with regional policy will differ less from the optimal central policy. On balance I would guess that decentralization becomes more attractive if one considers these alternative assumptions.

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