A MODEL OF REGIONAL EQUALISATION TRANSFERS UNDER ASYMMETRIC INFORMATION WITH REFERENCE TO THE SPANISH REGIONAL FINANCING SYSTEM*

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ABSTRACT: This paper considers the design of equalisation transfers in the presence of asymmetric information with respect to the provision cost of regional public output (*Adverse selection*). To overcome this problem, the central layer of government has to design an optimal incentive-compatible direct co-ordination mechanism. This provokes a distortion in the (optimal) private decisions of the high-cost type governments in order to opt to the transfers. Moreover, both levels of government levy a tax on labour income in such a way that a *vertical tax externality* also crops out, and affects private decisions of high and low-cost type regions. The model which will infer such results is a preliminary attempt, open to future research, to approximate to the present Spanish situation, and achieve useful recommendations based on economic theory.

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1- Introduction

The establishment of transfers between layers of government is a common feature of federations. Its setting is usually conditioned both by the historical and political context in which they are conceived. In this sense, in Spain, regional transfers have played a crucial role in the process of political decentralisation started in 1978, and have been conditioned both by the fiscal disparities among communities and the historical centralist tradition of the nation. However, their design has not clearly responded to the criteria that should compose a regional equalisation system, mainly due to the cited conditions. That is why, in the present, this situation is being dealt with, and the settlement of such system is the next challenge of the Spanish regional financing system.

This paper will treat the configuration of such transfer equalisation system, namely taking into consideration the problems of asymmetric information that arise in the relation between the central and state level of government. Therefore, the interest of this study is neither capricious nor just based on theoretical grounds, but influenced by the interesting situation of the regional financing system in Spain. Even recently, a group of study has been created to work on the implementation of such equalisation transfer system, given the recent increase in fiscal responsibility for the regions, and so the more explicit need for redistributional devices[1]. The model developed in this paper aims to serve as a close approximation to the Spanish situation, and hopes to derive useful insights on it, and possibly on the theoretical literature related with the topic as well. I have to stress that the conclusions of the paper about the Spanish case are just based on the economic theory, so as I have also commented above, the consideration of other kind of factors, historical or political or social, would certainly influence them.

Hence, the model I am going to develop deals with the problem of *asymmetric information* that usually characterises the relations between the federal layer of government and the regional governments in an economic federation. In particular, I consider a model of ***adverse selection*** in which the federal tier of government does not have access to the provision cost of public output in each region, which are divided in high-cost regions and low-cost regions. This information is private for the regional governments, and the basis for the design of federal equalisation transfers to them. In order to solve this problem, *signalling* can be used by the Federal government as an appropriate mechanism to overcome it, since can help to distinguish between cost-type regions. In the model I present, this task is carried through by the regional tax rate, and so a relatively higher tax rate for high-cost regions will be the *cost of signalling*. Thus, the "optimal" contract will be composed by a pair tax level-transfer level according to the (announced) cost type by each region. In contrast with other models which consider asymmetric information, both levels of government make use of distortionary taxation, sharing the same tax base on labour income, and also the Federal government provides a public good, in such a way that vertical tax externalities will have to be considered by the Federal government when designing the "optimal" transfer system. This provokes a difference between the *marginal cost of public funds* and the *social*

[1] *Modelo para la Aplicación del Sistema de Financiación de las Comunidades Autónomas en el Quinquenio 1997-2001*, Acuerdo Sexto, sobre la Creación del Grupo de Trabajo para la instrumentación de las asignaciones de nivelación, Page 44, Consejo de Política Fiscal y Financiera. Madrid, 23rd, September, 1996.

marginal cost of public funds, given that regional governments do no take into account this vertical externality when set up their tax level.

According to the traditional theory of **Fiscal Federalism**[2], on the one hand, the relatively more accurate information the regional governments have about the preferences of the residents in their community is the cause of the decentralisation of public good provision to the regional governments from the central tier. This is the so-called *Theorem of decentralisation*. On the other hand, another argument in favour of decentralisation is that it can encourage a better public management through a more detailed and rigorous analysis of the cost of public projects by the very regional governments. Nonetheless, due to the presence of fiscal disparities among regions, there still appears to be a role for the central layer of government through the use of equalisation transfers to the regions, in such a way that "*an individual should have the assurance that wherever he should desire to reside in the nation, the over-all fiscal treatment which he receives will be approximately the same*"[3].

Under no-mobility of individuals across the federation, the equity argument quoted above is the only one which justifies the role of this kind of transfers. Otherwise, these also have an efficiency role, since they have to ensure an efficient allocation of the resources within the federation[4].This is the case because when members of a federation find in their interest to migrate they will not normally take into account the fiscal externalities their action provokes. Nevertheless, efficiency requires that social benefits (which include the effect of the externalities) rather than simply private benefits from migration should be equalised across provinces, and that is precisely the role of the intergovernmental transfers. In this paper, I will assume that households are immobile, so the transfers I consider are based just on equity issues, which arise due to the differences in the cost of provision of one unit of public *output* in each region.

Concerning the design of these transfers, most of the published papers have assumed perfect knowledge by the federal government about the parameters which compose them[5]. However, recently, there has appeared an important amount of literature explicitly varying this assumption from different perspectives. Several works by CORNES, R.C., SILVA, E.C.D. (1996) study this situation modelling different scenarios in which the federal government is not able to control regional variables affecting the cost of provision, and which distort the "optimal" allocation of transfers because of the perverse incentives created for the regional governments to set them up sub-optimally (problem of *moral hazard*), and cannot infer the cost type of each region, but only their distribution probability (problem of *adverse selection*). BORDIGNON, M., et al. (1996) also consider this question, focusing on the incentives created for the regions on tax enforcement (problem of moral hazard) and also treating the problem of adverse selection when it is the case that the Federal government cannot verify the size of regional tax bases. LEVAGGI, R. (1991) analyses the problem on the basis of different regional preferences toward the public good to be provided. BOADWAY, R., et al. (1994)'s model will be explained in some detail in the next section, since will be used as the benchmark work in this paper. Just to say now

[2] Vid. OATES, W.E. (1972).
[3] BUCHANAN, J. (1950), page 590.
[4] Vid., e.g., BOADWAY, R.W., HOBSON, P. (1993).
[5] Vid., e.g., BRADBURY, K.L., et al. (1984).

about it that that paper also studies both problems, moral hazard and adverse selection. In the former case, only the region's cost distribution is known by the Federal government when designing transfer packages. In the latter case, two different situations are analysed, in one, agency's effort affects probabilities of the low-cost case occurring, and in the other one, agent's effort affects provision costs. Therefore, in both cases, the case of moral hazard these authors deal with is related to provision costs. Finally, CREMER, H., et al. (1996) take into consideration the problem of asymmetric information but from a slightly different perspective, since the Federal government does not allocate a transfer but instead levies a tax on the regional governments, being limited in its ability to distinguish between regional income levels and preferences among provinces.

As a main difference with all previous related papers, my conclusions will differ due to the fact that the federal government also provides a public good, and not having access to lump-sum taxation, needs to utilise distortionary taxation. In this situation, a vertical tax externality arises. That is why, even the tax rate chosen by the low-cost regions will be distorted, in contrast with the model by BORDIGNON, M., et al. (1996), where the choice of the regions at the top (in their case, rich regions) is not distorted at all. Nevertheless, for the high-cost regions, the distortion will certainly embody another effect, apart from the vertical tax externality, that is, the cost of signalling. Moreover, all the studies condition the amount of the transfer on one endogenous parameter to the regions, e.g., tax level or provision cost (which can be varied according to the effort made), when the Federal government has asymmetric information about tax bases or cost-type, respectively. However, I mix these two situations, and so use the tax rate as a signal when cost-type cannot be observed. Finally, I have to say that the transfers I pretend to model have to be considered as *general* equalisation transfers, and so I do not take into account differences in preferences among regions as, for instance, LEVAGGI, R. (1991)'s model does. This assumption is also explicitly made by BORDIGNON, M., et al. (1996, page 3).

Another strand of the economic literature that concerns this paper is the one that treats the presence of tax externalities in an economic federation, which appearance in our model has already been mentioned above. DAHLBY, B. (1996) describes in depth all the kind of potential tax and expenditure externalities which can arise in it, and the formula of the appropriate corrective transfers. Other two papers, BOADWAY, R., KEEN, M. (1996), and SATO, M. (1997) model the decisions of both levels of government, what is not usually done in this literature, and also get the presence of the vertical tax externality. The divergence with my model is certainly the presence of incomplete information. As we will see, this does not make any difference, since still **both** types of regions are affected downwards in their tax level, though to a different extent. The signalling cost will mitigate the internalisation of this tax externality for both type of regions, namely, for high-cost regions, can even suppose to set up their tax level above the one that would have been "optimally" chosen by the regional government itself. The presence of the externalitiy implies the main result found by BOADWAY, R., KEEN, M. (1996) about the negativity of the federal tax rate, what at the same time provokes the ambiguity of the sign of the intergovernmental transfer. This result will be dealt in the present paper as well, and we will see that the sign of the federal tax rate remains ambiguous.

The structure of the paper is as follows. In the next section, I review the literature

dealing with the problems of asymmetric information in the design on intergovernmental transfers, and about other models treating economic intergovernmental relations as well. Afterwards, I develop my model, emphasising the main divergences with other models also tackling asymmetric information. Finally, I show the conclusions of the model on the Spanish's system and on the theoretical literature, and terminate with a list of references.

2- Literature Review.

As I have previously said in the Introduction, lately there have appeared many papers dealing with the problem of asymmetric information in the design of intergovernmental transfers. This section aims to provide a brief review of this literature, and the table in the next page is an attempt to outline part of this recent literature.

As I have also commented before, the paper I am going to follow most closely is BOADWAY, R., et al. (1994), and so try to give answer to the interrogation they left in their Conclusion, when they wondered about the findings they got, and "*how robust they are as different assumptions about the economy are adopted"* (page 19). That is why, I think will be useful to explain more carefully this paper, namely the ***signalling problem*** they treat, and refer the other papers to the table presented below, since all the results are very similar.

In that paper, on the one hand, the local government is considered as a local agency which maximises its profits, defined as the transfer received from the federal government minus regional public *expenditure*. These are classified according to their cost of provision, as high-cost and low-cost type agencies. On the other hand, having as decision variables the level of public *service* and the level of transfer, the federal government (or principal) maximises the sum of expected (because just knows the distribution of types) indirect utility functions of the regions, so we are in the presence of a problem of adverse selection. In consequence, the federal government's problem might be incentive-incompatible, since the low-cost regions may find advantageous to report a high cost, and so get the transfer originally designed for the high-cost regions. That is why, the problem of maximisation of the federal government has to embody *incentive compatibility* (or truth-telling or self-selection) constraints, in such a way that each region finds optimal to report its state truthfully.

When a *Single-Crossing Property* holds[6], the solution of the Federal government's problem entails the cost of signalling, through the distortion upwards of the marginal cost of public funds for the high-cost type regions, though not applying this distortion for the low-cost regions. This will suppose that, on the one hand, the level of public services for high-cost regions will be lower under asymmetric information, and also will be the transfer they receive. On the other hand, the transfer received by low-cost regions will be bigger, and the level of public services could be either higher or lower, depending on the slope of the indifference curves. Similar results, in other contexts,

[6] Vid., e.g., MYLES.G..D. (1995), Chapter 5. As we will later see, this property implies that the indifference of both cost types will only cross once, and it is a necessary for the solution of the incentive-compatible maximisation problem.

Table: *Outline of the economic literature dealing with asymmetric information in the design of equalisation transfers*

PAPER PROBLEM TO STUDY MAIN RESULTS BOA R., et al. (1994)* • Regional governments do not have tax power, simply choose a combination of subsidy/public services offered by the Federal government (FG).
• The FG does not observe region's provision costs • *Marginal cost of Public Funds* (MCPF) for low-cost region is not distorted.
• MCPF for high-cost regions is distorted upwards.
BORDIGNON, M, et al. (199 * The FG observes the local (or regional) ta rates, but not the size of the local tax bases nor their elasticity. • Tax rate for high-cost regions is distorted upwards.
• Tax rate for low-cost regions remains undistorted. CORNES, R.C, SILVA, E.C.D. (1996,a)* * The provision cost of provinces (or regions) embodies a non observable exogenous component (*adverse selection* problem) and an endogenous one, effort *(moral hazard* problem). Only unitary **total** cost can be observed by the FG. As in previous cases, there also appears to be *informational rents* (though they also point out Pareto improvement Reforms with negligible second order effects), since low-cost regions are better-off in the full information setting CORNES, R.C, SILVA, E.C.D. (1996,b)* * As a main difference with (a) paper's authors, this one allows th level of public good to be continuously variable. Same results with respect to the transfer allocation than in (a), and in relation to the level of public good provision, this will be lower for the low-cost regions than for the high-cost regions when trying the former to pose as the latter. CORNES, R.C, SILVA, E.C.D. (1996,c) Output levels are not observable, only **total** cost of provision (so on what the transfer has to be conditioned on). Different results according to the elasticity of demand of the provided public good , and *informational rents* are derived from distortions in output public provision by the low-cost region.

* In relation to these two studies, I only report the problem of adverse selection they analyse.

** These authors describe several possible regimes. However, I focus the attention on the so-called *Regime B,* the most relevant according to them, and the closest to ours. In that regime, an *incentive compatibility* constraint binds, and *feasibility* ones (similar to participation constraints in other contexts) do not.

have been obtained by BORDIGNON, M, et al**.** (1996)[7], or the several papers by CORNES,R.C, SILVA, E.C.D.(1996).

They also consider the case when the regional governments differ only in fixed costs. Then, the Single-Crossing Property does no longer hold, and the optimal policy will be a *pooling equilibrium*. In that circumstance, under asymmetric information, there are also informational rents for the low-cost agency.

In any case, the interesting results to be considered are the ones in which the Single-Crossing Property holds in the signalling problem, in the same way that the situation of the model we will present in this paper. In this sense, as we will be later able to check,

[7] These authors also obtain the result of "non-distortion at the top" (in their case, the top corresponds to the "rich" regions) and compare this result to the classical one obtained by MIRLEES, J. (1971) in optimal income taxation. Vid. also about this general result, MACHO-STADLER, I., PEREZ-CASTRILLO, D. (1997), page 113.

the results we get are certainly very close to the ones got by BOADWAY, R., et al. (1994).

Finally, it is worthwhile to comment the paper by BOADWAY, R., KEEN, M. (1996), whose main objective is to infer the optimal direction of the Federal-state transfers through the modelling of both maximisation behaviours. The transfers they consider are just based on efficiency matters. These authors find that the direction of these transfers might be just the reverse of what is commonly thought, and so they may have to be made from the regional governments to the Federal government instead. The reason of this fact is precisely the presence of a ***vertical tax externality***, since regions will typically neglect the impact of their tax decisions on the federal budget. Thus, the Federal government should ensure that the regions internalise this effect by means of subsidising labour, on which the regions also have tax power. This will provoke the need of transfers from the states (regions) to the central level of government if the federal rents are low enough relative to the subsidy to the regions and the federal expenditure needs itself. SATO, M. (1997) carries on with a very similar study, but introducing both imperfect mobility of the individuals and heterogeneous regions.

3- The Model.

In this section, I show the model which tries to reflect as close as possible the present Spanish situation through the variables that compose the model itself, tough it could be perfectly applied to any other federation with the same or similar characteristics. In particular, incomplete information about regional provision costs by the Federal government, and the fact that both levels of government share the same tax base are the two main features of the Spanish system that concern my model. This is at its early stages of development, and the author hopes to continue researching on it in the near future.

The model will describe the maximisation behaviours within an *economic* federation of the layers which compose it. Firstly, I will do so with the household sector, later with the regional or state government, and finally with the Federal government. The regional governments are classified as high-cost or low-cost type, depending on their provision costs of regional public *output*, which are not directly observed by the Federal government (problem of *adverse selection*).

The analytical methodology I will use to solve the model will be based on MYERSON (1982)´s paper, in such a way that the federal governments' problem of designing an incentive-compatible contract (the optimal in the class of all co-ordination mechanisms)[8], which will give the highest possible expected utility to it, will be derived from the combination of two variables embodied in the contract: cost type (reported information), and regional tax level (observed variable).

Household's behaviour

The additively separable utility function of the representative individual in region *i* is

[8] Vid. MYERSON, R.B. (1982), Proposition 2.

$$U^i = x + J^i(L) + H^i(g) + B^i(G) \qquad (1)$$

from now on, I will suppose that preferences do not vary across regions. The description of each variable is as follows: x is private consumption, having been its price normalised to one; L is leisure, and l is labour supply ($L = 1 - l$); g is regional public *output*; G, is the federal public *good*; and c_i is the provision cost of one unit of regional public *output*, c_H (for low-cost regions) and c_L (for high-cost regions). The functions *H(g), J(L)* and *B(G)* are concave.

The household in region i will maximise her utility function choosing private consumption, x, and labour supply, l, taking the rest of variables as given, subject to her budget constraint,

$$\begin{aligned} &Max \quad x + J(L) + H(g) + B(G) \\ &\{x,l\} \\ &\quad s.t. \quad x = \left(1 - t_i - t_F\right) w^i l^i \quad , \end{aligned}$$

being t_i and t_F, the regional and federal tax on labour income, respectively, where w is the *gross* wage rate, so both levels of government share the same tax base. I only consider the wage rates as *potentially* different between cost-type regions. Additionally, I define the *net* wage rate in region i as

$$w_N^i = \left(1 - t_i - t_F\right) w^i \qquad (2)$$

The First Order Conditions (FOC's) of the previous problem are the following,

$$\begin{aligned} &x: \quad 1 - l = 0 \\ &l: \quad J_l + l\, w_N = 0 \end{aligned}$$

so $J_l = -w_N$ or $J_L = w_N$, i.e., the marginal utility of one unit of leisure should be equalised to its opportunity cost, the net wage, where l is the Lagrange multiplier of the budget constraint. Therefore, from the household maximisation behaviour, I get the labour supply for the representative household in region i,

$$l^i = l^i(w_N^i) \qquad (3)$$

Regional government's problem

The regional government i maximises the indirect utility function of the representative agent of its region, not taking care of other region households' welfare, and taking G as given. From the household's problem, I get the indirect utility function, which already takes into account the maximising behaviour of the household,

$$V^i\left(t_i, g\right) = \left(1 - t_i - t_F\right) w_i l^i\left(w_N^i\right) + J\left(1 - l^i\left(w_N^i\right)\right) + H\left(g\right) + B(G) \ , \qquad (4)$$

and the *i's* region budget constraint is

$$t_i w_i l^i\left(w_N^i\right) + T_i = c_i g_i, \tag{5}$$

where T_i is the transfer received from the Federal government, and which will be later carefully treated, while now I consider it as given. Analytically, the problem of the regional government is the following

$$\begin{aligned} \underset{\{t_i, g_i\}}{Max} \quad & \left(1\text{-}t_i\text{-}t_F\right) w_i l^i\left(w_N^i\right) + J\left(1 - l^i\left(w_N^i\right)\right) + H(g) + B(G) \\ s.t. \quad & t_i w_i l^i\left(w_N^i\right) + T_i = c_i g_i \end{aligned}$$

so maximises the indirect utility of the representative household in the region, (4), subject to the regional budget constraint, (5). The FOC's are

$$\begin{aligned} t_i: \quad & -w_i l_i + J\left[w_i l_i + t_i w_i \frac{\partial l_i}{\partial w_N}\frac{\partial w_N}{\partial t_i}\right] = 0 \\ g_i: \quad & H(g) - J c_i = 0 \end{aligned}$$

where J is the Lagrange multiplier of the regional budget constraint. From these conditions, I get the next relation

$$\frac{H_g^i}{c_i} = \frac{1}{1 - q_i e_i}, \tag{6}$$

where I have used the concept of the elasticity of labour supply with respect to the gross wage rate, $e_{i_{l,w}} = \frac{\partial l}{\partial w}\frac{w_i}{l_i}$, the relation $\frac{\partial l}{\partial w} = \frac{\partial l}{\partial w_N}\left(1 - t_i - t_F\right)$, defined the regional *regional "ad valorem" tax rate* on labour income as $q_i = \frac{t_i}{1 - t_i - t_F}$, and H_g^i is the marginal utility of one unit of regional public *output*. Given that I am making use of distortionary taxation, we also define the *marginal cost of public funds* (MCPF),

$$MCPF_i = \frac{1}{1 - q_i e_i} \geq 1, \tag{7}$$

as the cost to taxpayers in region *i* of raising one additional unit of public revenue. Hence, the condition I have got from maximisation, (6), states that the regional government provides public output in terms of cost up to the point where it equalises the MCPF[9], which is the traditional Samuelson condition of public goods allocation

[9] Note that when taxation is not distortionary, $e_i = 0$, MCPF=1, and so there is not deadweight loss, condition (6) simply becomes $H_g^i = c_i$, i.e., regional public output is provided until marginal benefits,

rectified by the presence of distortionary taxation. From this condition, it is obvious that, facing the same tax level, provinces with different provision costs, and without equalisation transfers, will not have access to the same level of public services if their regional governments behave optimally as I have supposed. This situation breaks down the equalisation of the fiscal balance among the regions in a federation proposed by BUCHANAN (1950).

Let suppose the Federal government wanted to compensate such kind of imbalances. We represent Buchanan's equalisation concept in a such a way that consider a situation in which any region is able to enjoy the same marginal level of public output, $H_g^i = H_g^j$, $\forall i, j, i \neq j$, irrespective of their fiscal conditions, or their level of provision cost. Hence, depending on their preferences the level of public output will differ, and would only be the same if both regions had the same preferences. Analytically, from (6),

$$\frac{c_i}{1 - q_i e_i} = \frac{\bar{c}(1-a)}{1 - \bar{q}\bar{e}} \tag{8}$$

where $\bar{c}, \bar{q}, \bar{e}$ are average parameters, and consider to be exogenous to region *i*, Clearing a , we get the following cost matching grant formulae

$$T_i = \bar{g} c_i \left[1 - \frac{\bar{c}}{c_i} \frac{\overline{MCPF}}{MCPF_i} \right] \tag{9}$$

so if the *MCPF* of region *i* rectified by its provision cost is greater than average values, region *i* will receive a positive transfer, and so its final level of public provision would be $\left\{ c_i g_i + c_i \bar{g} \left[1 - \frac{\bar{c}}{c_i} \frac{\overline{MCPF}}{MCPF_i} \right] \right\}$. In this situation, having made endogenous such transfer pattern, the regional government will have two perverse incentives:

- In the presence of asymmetric information, having it more precise knowledge about its cost structure, will try to pose as a high-cost region $c_i \geq \bar{c}$, in order to increase the transfer to receive. The presence of better informed regional governments does not mean that they have complete information, but just better that the federal layer of government.

- Will also try to exploit its tax base, and so increase its *MCPF*, and also the transfer to receive. This situation has been stressed by a recent paper done by SMART, M., BIRD, R. (1996) dealing with the design of revenue equalisation transfers[10]. These

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H_g^i, equal marginal cost, c_i.

[10] In our setting, the establishment of a revenue equalisation transfer would produce the following regional optimal allocation, $\frac{g}{c_i} = \frac{}{1 \quad {}_i \left\lfloor \frac{\bar{t} -}{1 - t_i} \right\rfloor}$ incentive to set its level of taxation $t \geq \bar{t}$, in such a way that its $MCPF_i$ decreases.

authors infer an interesting result, "*equalization diminishes welfare of the representative citizen, relative to the equivalent lump-sum grant, due to the additional deadweight loss associated with the higher provincial tax rate"* (page 8-9).

Therefore, these two conditions should be taken into account by the Federal government in the resolution of an allocation problem in a general equilibrium context. By considering intergovernmental lump-sum transfers, and so leaving momentarily aside the consideration of the latter incentive[11], the next section describes this process.

Federal government's problem

The Federal government will attempt to compensate the *potential* fiscal disparities by means of equalisation transfers to the regional governments. These will be conditioned on the type-cost *reported* by each regional government, since this cost is not directly observable by the Federal government, and the tax level, which is certainly observed. Consequently, the Federal government has to rely on region's information, since simply knows the number of regions attached to each cost type, high and low.

However, this setting might make it attractive for the low-cost regions to pose as high-cost, and so get the transfer primarily designed for the latter, or, conceivable, could just happen the reverse. In order to avoid this tendency, the Federal government has to set up an *incentive-compatible* device, in such a way that low-cost regions do not find worth to pose as high-cost ones. In this sense, the introduction of the tax level into the transfer contract will act as a signal for high-cost regions, demanding a higher tax effort for these regions. Formally, the process is the following[12] [vid. Figure 2]:

1. The Federal government announces the transfer rule, based on a contract which specifies the level of transfer and the required tax level according to type-costs, high or low.
2. The type-cost of each region, c_i, is exogenously determined to the regions, and its realisation is only observable by them.
3. The regions are asked to report their cost, such reported cost, $\hat{c}_i$, will enter as an argument in the transfer rule set up at stage 1.

[11] In any case, it does not mean that the equalisation objective is not achieved. The different amount of each region's transfer could make possible such objective.

[12] The description of this process closely follows BORDIGNON, M, et al. (1996)'s, page 11. For a more general treatment of this kind of games, vid. MYERSON, R.B. (1982), MAS-COLELL, et al. (1995), Chapter 13, or MACHO-STADLER, I., PEREZ-CASTRILLO, D. (1997), Section 5C.3.

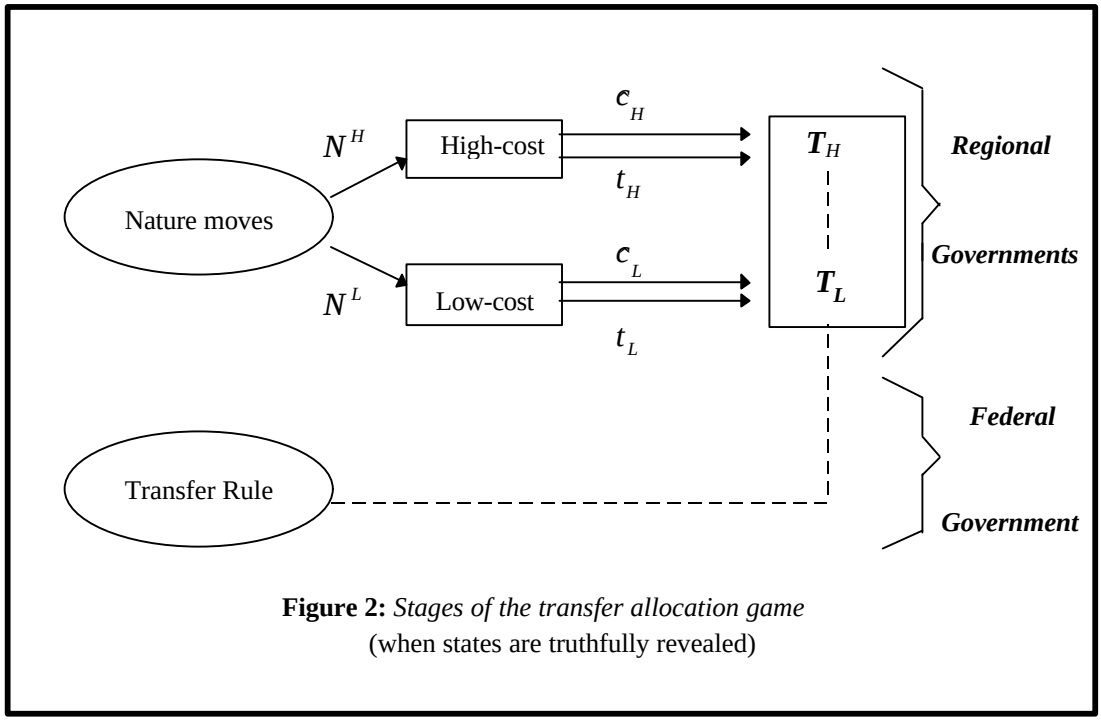

Figure 2: *Stages of the transfer allocation game*
(when states are truthfully revealed)

4. Both regions simultaneously choose their optimal tax levels according to (6).
5. The Federal government allocates the transfer according to the information reported at stage 3 and 4. That is,

$$\begin{Bmatrix} \hat{c}_L \times t_L \rightarrow T_L \\ \hat{c}_H \times t_H \rightarrow T_H \end{Bmatrix}$$

The problem of the Federal government is to maximise the utility as the summation of indirect utility functions of each cost-types, subject to its budget constraint, and the incentive-compatibility constraints, which will be later commented. Given that the Federal government's problem is an *optimal incentive-compatible* ***direct co-ordination mechanism***[13], will induce the regions to behave truthfully. Then, as also BORDIGNON, M., et al. (1996) do, I will let the Federal government directly choose the tax level and transfer level for each state of nature. As possibly the main difference with other similar models, it is important to bear in mind that the Federal government also carries through with the provision of federal public goods, *G*. Analytically,

$$\begin{aligned} &Max && N^L V^L + N^H V^H \\ &\{t_H, t_L, t_F, T_H, T_L\} && \\ &s.t. && t_F\left[N^H w^H l^H\left(w_N^H\right) + N^L w^L l^L\left(w_N^L\right)\right] - G - N_H T_H - N_L T_L = 0 \\ & && V^H\left(t_H, t_F, T_H, c_H, \hat{c}_H, G\right) \geq \hat{V}^H\left(t_L, t_F, T_L, c_H, \hat{c}_L, G\right) \ \ (\mathrm{N_H} - rest.) \\ & && V^L\left(t_L, t_F, T_L, c_L, \hat{c}_L, G\right) \geq \hat{V}^L\left(t_H, t_F, T_H, c_L, \hat{c}_H, G\right) \ \ (\mathrm{N_L} - rest.) \end{aligned}$$

The description of the variables is as follows, N^i is the number of each cost-type, and

[13] Vid. MYERSON, R.B. (1982), page 73.

the only information the Federal government has about cost-type distribution; V^i is the indirect utility function for each cost-type as has been previously shown in (4), and once the regional budget restriction, (5), has been introduced into it, that is

$$V^i(\bullet) = w^i l^i\left(w_N^i\right)\left(1-t_i-t_F\right) + J\left(1-l^i\left(w_N^i\right)\right) + H\left(\frac{t_i w^i l^i\left(w_N^i\right)+T_i}{c_i}\right) + B(G) \qquad (10)$$

Thus, the first restriction is the Federal budget constraint, and the second and third one are the *self-selection* constraints for high-cost type regions and low-cost type regions, respectively. At this point, I assume that the population in both type of regions is equal, so the Federal budget constraint can be considered in per capita terms[14]. I also note that the Federal government chooses the level of both transfers, both region's tax level, and the federal tax rate, so the federal public good (recall, in per capita terms, like the federal transfers), *G*, is residually determined from the budget constraint.

Both self-selection constraints have the same interpretation, so I will focus on the low-cost one to explain them. I rewrite it

$$V^L\left(t_L,t_F,T_L,c_L,G\right) \geq \hat{V}^L\left(t_H,t_F,T_H,c_L,G\right), \qquad (11)$$

it means that low-cost regions should at least get the same utility behaving as such as behaving as high-cost regions, that is, mimicking the other type of regions, in such a way that these regions do not have incentive to cheat when revealing their cost type. Implicit in expression (11), there is the vertical tax externality that will be later dealt with, since low-cost regions do not take into account the effect of their tax decision on the level of federal public good provided, *G*. The variable c_L is region's real cost, while $\hat{c}_L$ or $\hat{c}_H$ are the announced cost, in the second case, the real state would be mimicked. From now on, $\hat{V}^L$ will be the indirect utility function of low-cost regions when try to mimic high-cost regions, and so get the transfer T_H primarily designed for high-cost regions, establishing a tax rate t_H. In contrast with expression (10), $\hat{V}^L$ is

$$\hat{V}^L(\bullet) = \hat{w}^L\hat{l}^L\left(\hat{w}_N^L\right)\left(1-t_H-t_F\right) + J\left(1-l^L\left(\hat{w}_N^L\right)\right) + H\left(\frac{t_H\hat{w}^L\hat{l}^L\left(\hat{w}_N^L\right)+T_H}{c_L}\right) + B(G) \qquad (12)$$

The necessary condition for being binding the incentive compatibility constraint of the low-cost regions is that $S_H \geq S_L$. Being this the case, as we will see, the tax rate will act as a signal, and will leave indifferent the mimickers between cheating or not,

[14] This assumption is also realised by CORNES, R.C., SILVA, E.C.D. (1996,b), in order to isolate the problem of asymmetric information, while BORDIGNON, M, et al. (1996) normalise the population to one, and BOADWAY, R., et al. (1994) reduce the problem to the representative consumer in each region, with no need to make further assumptions for the Federal budget constraint, since the transfer pairs are already previously determined, and it is only its allocation what really matters.

$$w^L l^L\left(1-t_L-t_F\right)+J\left(1-l^L\right)+H\left[\frac{t_L w^L l^L+S_L}{c_L}\right]=$$
$$=\ \hat{w}^L\hat{l}^L\left(1-t_H-t_F\right)+J\left(1-\hat{l}^L\right)+H\left[\frac{t_H\hat{w}^L\hat{l}^L+S_H}{c_L}\right] \tag{13}$$

since the negative effects of raising taxes over t_L will fully compensate the benefits from receiving a greater transfer.

The FOC's of the federal problem are the following,

$$t_F:\quad N^H\frac{\P V^H}{\P t_F}+N^L\frac{\P V^L}{\P t_F}+m\left[N^H l^H+N^L l^L+t_F\left(N^H\frac{\P l^H}{\P w_N}\frac{\P w_N^H}{\P t_F}+N^L\frac{\P l^L}{\P w_N}\frac{\P w_N^L}{\P t_F}\right)\right]+$$
$$+b_H\left[\frac{\P V^H}{\P t_F}-\frac{\P\hat{V}^H}{\P t_F}\right]+b_L\left[\frac{\P V^L}{\P t_F}-\frac{\P\hat{V}^L}{\P t_F}\right]=0 \tag{14}$$

$$T_H:\quad N^H\frac{\P V^H}{\P T_H}-mN_H+b_H\frac{\P V^H}{\P T_H}-b_L\frac{\P\hat{V}^L}{\P T_H}=0 \tag{15}$$

$$T_L:\quad N^L\frac{\P V^L}{\P T_L}-mN_L+b_L\frac{\P V^L}{\P T_L}-b_H\frac{\P\hat{V}^H}{\P T_L}=0 \tag{16}$$

$$t_H:\quad N^H\frac{\P V^H}{\P t_H}+m\left[t_F N_H\frac{\P l^H}{\P w_N}\frac{\P w_N^H}{\P t_H}\right]+b_H\frac{\P V^H}{\P t_H}-b_L\frac{\P\hat{V}^L}{\P t_H}=0 \tag{17}$$

$$t_L:\quad N^L\frac{\P V^L}{\P t_L}+m\left[t_F N_L\frac{\P l^L}{\P w_N}\frac{\P w_N^L}{\P t_L}\right]+b_L\frac{\P V^L}{\P t_L}-b_H\frac{\P\hat{V}^H}{\P t_L}=0 \tag{18}$$

where m is the Lagrange multiplier of the Federal budget constraint, and b_L, b_H are the multipliers for the incentive-compatibility restrictions of low-cost and high-cost type regions, respectively.

In the analysis of signalling models, or more generally in the ones which deal with problems of asymmetric information, the ***Spence-Mirrlees condition*** (or *single-crossing property* because of the single cross between both type's indifference curves***)***[15] is crucial to ensure that second order conditions of the maximisation problem hold. Before going on explaining this property, I will derive the indifference curve between the transfer and the tax level for each type of region. I get it from the total differentiation of (10),

$$\left.\frac{dT}{dt}\right|_{dV=0}^{i}=-\left[\frac{\P V/\P t}{\P V/\P T}\right]=w^i l^i\left[\frac{c_i}{H_g^i}-\left(1-q_i e_i\right)\right] \tag{19}$$

and from it, we can easily get the following relation, which is assumed to be positive (cost of signalling increases with region's type),

[15] Vid. e.g., MYLES, G.D. (1995), Chapter 5.

$$\frac{d}{dc}\left(\frac{dT}{dt}\right)=\frac{w^i l^i}{H_g^i}\left[1-\frac{P^i}{c_i}\right], \tag{20}$$

where I have defined P^i as *i's degree of preference towards the regional public output*,

$$P^i \equiv -\frac{H_{gg}^i}{H_g^i}\geq 0, \tag{21}$$

so from (20), we see that the indifference curve will be steeper for high-cost regions[16]. This supposes that for the same marginal increase in the tax level, high-cost regions should be compensated with a greater transfer to keep utility constant. This is the case because to enjoy the same level of public services, they have to set up a higher level of taxation, so marginal increases in the tax level will be relatively more harmful for the high-cost regions. Moreover, I postulate that the indifference curves are convex,

$$\frac{d}{dt}\left(\frac{dT}{dt}\right)=\frac{w^i l^i e^i}{\left(1-t_i-t_F\right)}\left[\left(1-q_i e_i\right)-\frac{c_i}{H_g^i}\right]+w^i l^i\left[\frac{-H_{gg}^i w^i l^i\left(1-q_i e_i\right)}{\left(H_g^i\right)^2}+q_i\frac{w_i}{l_i}\left\{l_{wt}+e_i\frac{\P l^i}{\P w_N}\right\}+e_i\left\{\frac{1-t_F}{\left(1-t_i-t_F\right)^2}\right\}\right] \tag{22}$$

and so this expression will be assumed to be greater than zero, the necessary condition for convexity. All the terms are positive, except the first one, which will be so on the zone where the slope of the indifference curve is negative [see (19)], $\frac{H_g^i}{c_i}\geq\frac{1}{1-q_i e_i}$, i.e., the marginal benefit of one additional unit of public service (in cost terms) is greater than the marginal cost of raising one more unit of public funds (MCPF), and $l_{wt}=\frac{\P}{\P t}\left(\frac{\P l}{\P w}\right)\geq 0$, that is, the income effect is greater than the substitution effect[17]. Otherwise, if these terms were not positive, would still I assume that the whole expression is positive, and so the indifference curve is convex. Being the indifference curve convex, this has an U-shape, since for low levels of *t*, it will certainly be the case that $\frac{H_g^i}{c_i}\geq\frac{1}{1-q_i e_i}$ as (19) requires for the slope to be negative, until its minimum at the optimisation point I have calculated in the region's problem (at that point, the required transfer to maintain utility constant is the smallest), given by expression (6). From that point on, the slope of the indifference curve is positive, then increases in the tax rate will require increases in the level of equalisation transfers to keep utility

[16] Expression (17) is the **agent monotonicity** property, which supposes that the marginal relation of substitution between the federal transfer and the tax level is a monotone function of the type, and implies the *single-crossing* property.

[17] In particular, we have $l_{wt}=-w_N\frac{\P^2 l}{\P {w_N}^2}-\frac{\P l}{\P w_N}$, where the first effect is the *income effect* which is positive if we consider $l\left(w_N\right)$ as concave, and the second one is the *substitution effect* which is negative. Therefore, the sign of the whole expression is ambiguous, and will depend on the net result of these two contrary effects.

constant.

As we can check in Figure 3, the single-crossing property implies that indifference curves cross only once, and that they cross from below. The locus $\left\{T_i^*, t_i^*\right\}$ is the optimal location from the region's point of view, according to (6), where the slope of the indifference curve is zero. If we consider that utility increases when the indifference curves move upwards, can see that the situation drawn in Figure 3 is incentive-compatible, since none of both type regions has the incentive to pose as others' type.

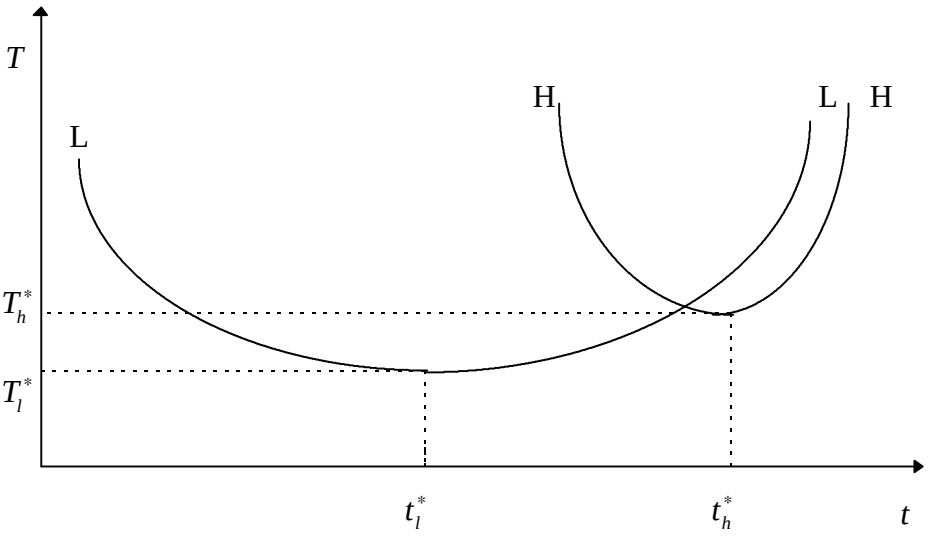

Figure 3: *Single-crossing property*
(Incentive-compatible situation)

Once I have explained how the single-crossing property holds in our model, can go further in the analysis of the FOC's we got from the Federal government problem. As in the classical problems of asymmetric information which entail redistribution, the most interesting case to study is the one in which the self-selection constraint for the high-cost region is not binding, $b_H = 0$, i.e., the high-cost region does not have an incentive to pose as a low-cost region (vid. Appendix). Taking this into account, from (16) and (18), we get the following expression for the low-cost region,

$$\frac{H_g^L}{c_L} = \frac{1}{1 - q_L e_L - q_L^F e_L} \tag{23}$$

where we define the *i's federal "ad valorem" tax rate* on labour income as $q_i^F = \frac{t_F}{1 - t_i - t_F}$, and the *total* or *social marginal cost of public funds* (SMCPF)[18]

[18] According to DAHLBY, B. (1996), the SMCPF *"takes into account the effect of a tax change on all taxpayers and on all governments' budget constraints"*, page 398.

$$SMCPF^{L} \equiv \frac{1}{1 - q_L e_L - q_L^F e_L} \ , \qquad (24)$$

to differentiate from (7), the MCPF. Hence, from expression (23), we get two main conclusions for low-cost regions:

1.1) The MCPF, expression (7), is lower than $SMCPF^{L}$. This is so because the regional government when maximises does not take into account the vertical tax externality generated on the federal tax base, underestimates the social marginal cost of raising revenue, and so establishes a labour tax too high from a social point of view[19]. This result has already been noted by BOADWAY, R., KEEN, M. (1996), DAHLBY, B. (1996), or more recently, by SATO, M. (1997). In Figure 4, we can see the effect of the externality *Tax Base Overlap*[20]. In the vertical axis, both tax rates are represented, while in the horizontal one, labour income is, keeping the wage rate constant[21]. Originally, the Federal government sets up a tax rate, t_F, and the regional government, t_i^0, the labour supply is l^0, and their tax revenues are the areas (A+B) and (C+D), respectively. If the latter decides to raise its tax rate, to t_i^1, its tax revenues *might* increase by the area (E-D), but federal tax revenues will certainly decline by B (dark zone), having the labour supply shrunk to l^1. Thus, an increase in the regional tax rate will (likely) reduce federal tax revenues, depending on labour elasticity (e_i) and the tax level itself (q_i^F).

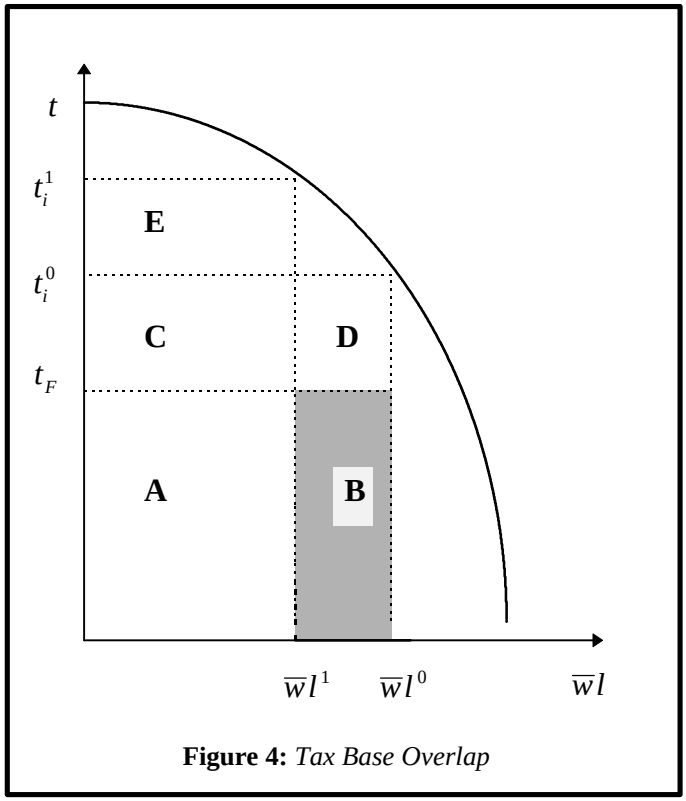

Figure 4: *Tax Base Overlap*

In Figure 5, the internalisation of this vertical tax externality on regional taxes is

[19] In DAHLBY, B. (1996)'s terminology, this concrete externality is labelled as *Tax Base Overlap*.

[20] Vid. the similarities with DAHLBY, B. (1996)'s Figure 1, where instead both level of government share a consumption tax.

[21] The shape of the function has been derived from the following relations, $\frac{dl}{dt} = -w\frac{\partial l}{\partial w_N} \le 0$, and $\frac{d^2 l}{dt^2} = \frac{\partial^2 l}{\partial w_N^2} w^2 \le 0$, because of the assumed concavity of $l(w_N)$ [vid. footnote (17)], so the slope is negative and decreasing.

represented, so the regional tax rate, $\tilde{t}_l^*$, has to be set up below the point that would be optimal from the region's point of view, t_l^*, but socially non-optimal. Because of the internalisation of the distortion, the federal transfer to the region has to be bigger.

1.2) The second result is that the SMCPF for the low-cost region is not affected by the problem of asymmetric information, since does not embody any term picking up this kind of influences. If we did not consider the effect reported in 1.1), we would have got the same result that BORDIGNON, M, et al. (1996) found of "non-distortion at the top" [vid. footnote (7)] when also dealt with problems of asymmetric information, namely, adverse selection with respect to regional tax bases.

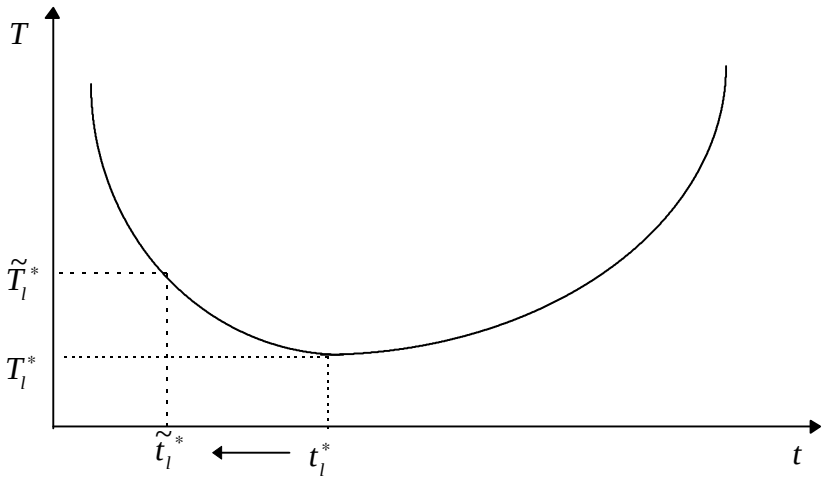

Figure 5: Internalisation of the *Vertical tax externality on regional tax rate*

With respect to high-cost regions, from (15) and (17), we get the following relation,

$$\frac{H_g^H}{c_H} = \frac{1+\dfrac{b_L N^L w^L l^L}{N^H w^H l^H}\left[1-\dfrac{\hat{H}_g^L}{c_L}\left(1-q_H\hat{e}_L-q_H^F e_H\dfrac{w^H l^H}{w^L l^L}\right)\right]}{1-q_H e_H-q_H^F e_H} \tag{25}$$

From (25), we also have the SMCPF for the high cost regions,

$$SMCPF^H = \frac{1+\dfrac{b_L N_L w^L l^L}{N^H w^H l^H}\left[1-\dfrac{\hat{H}_g^L}{c_L}\left(1-q_H\hat{e}_L-q_H^F e_H\dfrac{w^H l^H}{w^L l^L}\right)\right]}{1-q_H e_H-q_H^F e_H} \tag{26}$$

From this expression, we can derive useful insights on the factors on which the federal distortion to the regions , created by the presence of asymmetric information, depends, in a very similar way to the ones obtained by STIGLITZ, J.E. (1987), pages 1007-8. Thus, the distortion will be lower

(a) the (relatively) greater the number of high-cost regions, N^H, since the Federal

government (Social Planner) will not want to impose high distortions there where there are more regions (people) concentrated;

(b) the greater the tax base of the high-cost region, $w^H l^H$, in comparison with low-cost region's one is, $w^L l^L$, since then the loss in output because of *signalling* would be more important; and

(c) the lower is b_L, the shadow price of the self-selection constraint for low-cost regions [vid. explanation in STIGLITZ, J.E., op cit., point (2)].

For high-cost regions, we also obtain two main results which can directly be compared with the ones obtained for low-cost regions. The MCPF, expression (7), for the high cost regions can either be greater or lower than the SMCPF for these regions, expression (26). This is so because this latter expression embodies two contradictory effects, which are now explained.

2.1) On the one hand, and in the same way than low-cost regions, the SMCPF for high-cost regions entails a part related with the vertical tax externality, which makes this bigger than the MCPF, and so supposes to lower the tax rate for this kind of regions. However, we expect this externality to be bigger for these regions, since they impose a higher fiscal pressure in relation to low-cost regions, given that e_H and q_H^F will have a greater value.

2.2) On the other hand, in the numerator, there appears a bit reflecting the problems of asymmetric information. This will decrease the SMCPF for these regions if the following expression holds

$$\frac{1}{1 - q_H \hat{e}_L - q_H^F e_H \dfrac{w^H l^H}{w^L l^L}} \leq \frac{\hat{H}_g^L}{c_L} \qquad , \qquad (27)$$

so this is a contrary effect to the one provoked by the vertical tax externality, 2.1), since the former forces regional taxes to raise (as a signal effect of high cost of provision) while the externality forces them to decrease. This is so because the tax rate acts as a signal for high-cost regions when mimicking is attractive for low-cost regions as expression (27) reflects. Hence, signalling embodies a social cost through more fiscal pressure for high-cost regions[22], and at the same time, slacks the correction of the tax externality. This cost has to be balanced with the more efficient allocation of the transfers, so social's welfare is most likely to be reduced specially if the cost of signalling is very high.

On the whole, we do not know which effect will be bigger, and so if the tax rate for the high-cost regions will be higher or lower than the level that would have been optimally set up by the regions themselves, though will certainly be higher than in the original situation when just the vertical externality is taken into account by the Federal government. From the development of (17), we can more clearly see this uncertain balance

[22] BORDIGNON, M., et al. (1996) define **fiscal effort** by a region as "*the distortion that the poor region suffers in order to receive a transfer…*" (page 17, footnote 17).

$$1-\frac{H_g^H}{c_H}\left(1-q_H e_H\right)=\left\{-mq_L^F e_L-\frac{b_L N_L w^L l^L}{N_H w^H l^H}\left(1-\frac{\hat{H}_g^L}{c_L}\left(1-q_H \hat{e}_L\right)\right)\right\}\leq \quad \geq 0\,, \qquad (28)$$

if the right-hand side is lower than zero, the vertical tax externality dominates, and the reverse happens if (28) is greater than zero. In any case, the distortion due to asymmetric information is lower, and so the tax rate is closer to the one optimally from a social point of view, the greater is the number of low-cost type regions, N_H, and the lower b_L is, as we have already commented above. At the same time, it is remarkable that the tax rate for high-cost regions will tend to be higher, the higher their tax base, $w^H l^H$, is in comparison to the others cost-type region's tax base, $w^L l^L$, though the marginal tax rate would tend to be lower as we have also remarked before.

On the other hand, for the low-cost regions, once having expanded (18), we get

$$1-\frac{H_g^L}{c_L}\left(1-q_L e_L\right)=-\frac{m\, q_L^F e_L}{1+b_L}\leq 0 \qquad (29)$$

so asymmetric information, through b_L, makes t_L to increase, though (29) is undoubtedly still negative, so it lies on the zone where the slope of the indifference curve is negative.

From (15) and (16), we can also know the effects of asymmetric information on the transfer levels; using (16), we get for low-cost regions,

$$\frac{\P V^L}{\P T_L}=\frac{m}{1+b_L} \qquad (30)$$

so due to the problems of asymmetric information, the transfer to the low-cost regions increases, since the presence of b_L in the denominator diminishes the marginal indirect utility of one more unit of transfer, and the relation $V^L(T)$ is concave, since

$$\frac{\P V^L}{\P T_L}=\frac{H_g^L}{c_L}\geq 0, \text{ and } \frac{\P}{\P T_L}\left(\frac{\P V^L}{\P T_L}\right)=\frac{H_{gg}^L}{c_L^{\,2}}\leq 0$$

being $H_{gg}^L\leq 0$ because of the assumed concavity of *H(g)*. Following the same procedure, and now employing (15), for high-cost regions, we have

$$\frac{\P V^H}{\P T_H}=m+b_L\frac{N^L}{N^H}\frac{\P \hat{V}^L}{\P\, T_H} \qquad (31)$$

so in this case, the presence of asymmetric information increases the marginal indirect utility of one more unit of federal transfer, and again because of concavity properties of $V^L(T)$, the federal transfers to the high-cost regions shrink[23].

In Figure 6, we can graphically see the design of an incentive-compatible contract under the presence of asymmetric information. In the case where no consideration is taken of the problem of adverse selection, the "optimal" locus are $\{\tilde{T}_l^*, \tilde{t}_l^*\}$ and $\{\tilde{T}_h^*, \tilde{t}_h^*\}$ for low and high-cost type regions, respectively. In that case, only the vertical tax externality is considered. Nevertheless, this situation is not incentive-compatible, since low-cost regions have an incentive to pose as high-cost, given that the indifference curve they would get in that situation is further from the origin, from (LL) to $(L^{**}L^{**})$. Consequently, the Federal government taking this into account, designs an incentive-compatible contract, $\left[\{\tilde{\tilde{T}}_l^*, \tilde{\tilde{t}}_l^*\}, \{\tilde{\tilde{T}}_h^*, \tilde{\tilde{t}}_h^*\}\right]$, where, as we have previously commented, on the one hand, the tax rate for low-cost regions is slightly higher, while the transfer they receive is greater, and so they see their utility increased;

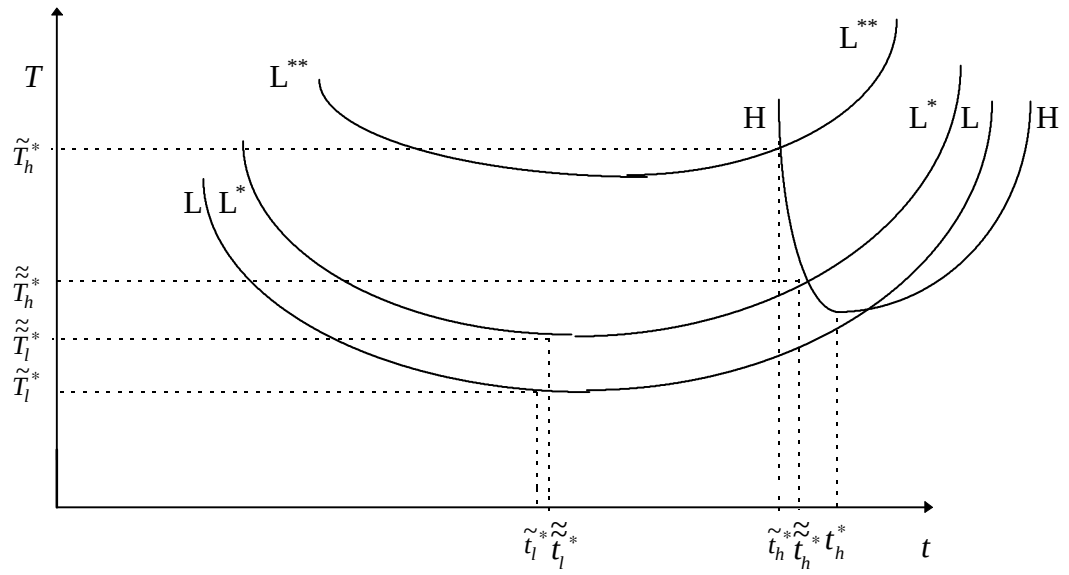

Figure 6: *Optimal contract under binding constraints*
Vertical tax externality dominates over *Signalling cost*

on the other hand, for low-cost regions, the transfer is lower, and the tax rate is higher than $\tilde{t}_h^*$, but still lower than t_h^*
according to (6). Hence, in Figure 6, the vertical tax externality dominates over the

cost regions could have lied where the slope of the indifference curve is positive.

Precisely, in Figure 7, we show another case where the signalling cost dominates over externality effect, and so the tax rate for high cost regions locates on

[23] In any case, redistribution (through a higher transfer to the high cost regions) occurs when

because both regions would establish a very similar tax rate by themselves, even if the vertical tax
government to differentiate between types, and the self-selection constraint becomes more "severe", i.e., the signalling cost is higher. This can be analytically checked in b_L (the "shadow price" of the self-selection constraint) positively affects the signalling-cost effect. At the same time, the higher value of b_L increases both the federal transfer to the low-cost regions [ ], $\tilde{\tilde{T}}_l^*$ rate as well [vid. (30)], $\tilde{\tilde{t}}_l^*$.

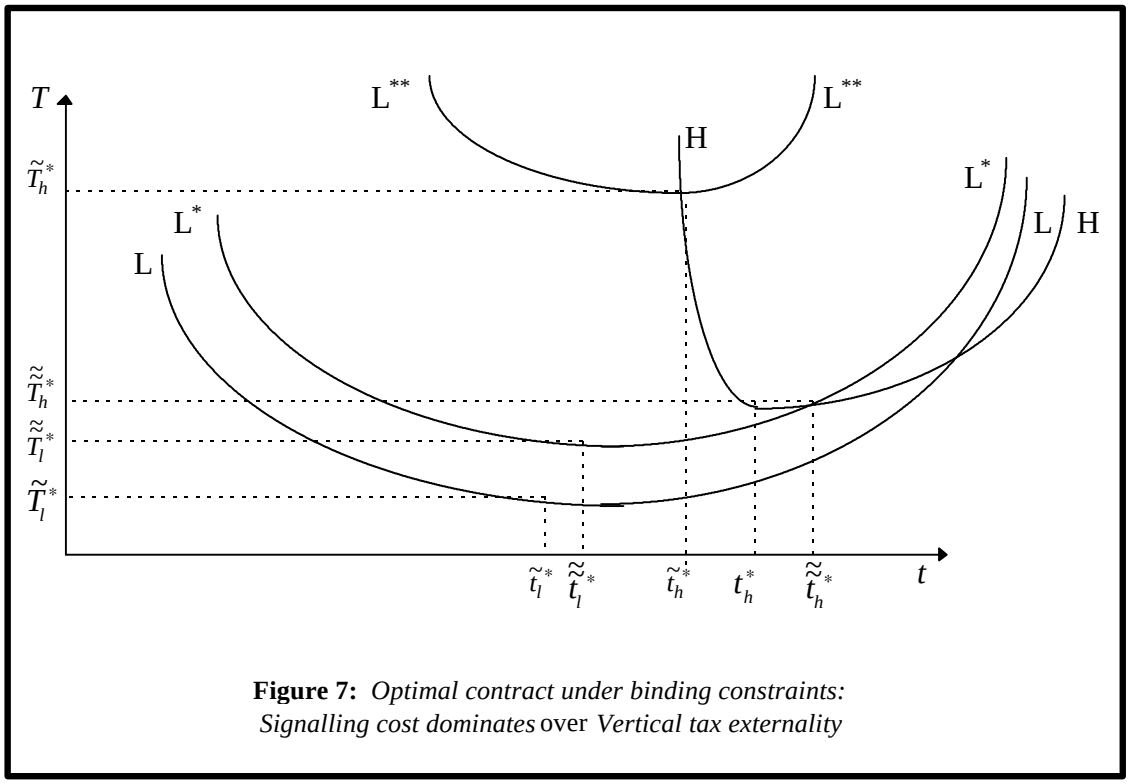

Figure 7: *Optimal contract under binding constraints: Signalling cost dominates* over *Vertical tax externality*

Although we have been working in discrete terms, we can linearize the transfer function in the neighbourhood of the equilibrium point in order to ascertain its properties[24]. Hence, substituting the equilibrium values in expression (19), we get

$$\frac{dT_L}{dt_L} = -q_L^F e^L w^L l^L \leq 0 \qquad (32)$$

$$\frac{dT_H}{dt_H} = \frac{w^H l^H}{SMCPF^H}\left\{1 - \frac{SMCPF^H}{MCPF^H}\right\} \geq 0 \qquad (33)$$

Therefore, from (32), we can see that, on the one hand, due to the vertical tax externality, low-cost regions are subsidised in their tax reduction, in such a way that are induced to internalise the externality; and, on the other hand, high-cost regions are obliged to make a greater fiscal effort in order to get the transfer for them designed, in

[24] This methodology follows RAFF, H., WILSON, J.D. (1997).

the case that asymmetric information effect dominates the vertical externality effect, $MCPF^H \geq SMCPF^H$.

We show now from the development of expression (14), the FOC for t_F,

$$\frac{N^H w^H l^H \left[1+\frac{H_g^H q_H e_H}{c_H}\right]+N^L w^L l^L \left[1+\frac{H_g^L q_L e_L}{c_L}\right]+\frac{b_L w^L l^L e_L}{c_L}\left[q_L H_g^L - q_H \hat{H}_g^L\right]}{N^H w^H l^H \left(1-q_H^F e_H\right)+N^L w^L l^L \left(1-q_L^F e_L\right)} = m \quad (34)$$

From (34), we can observe that, in the presence of asymmetric information, and if the self-selection constraint is binding, $b_L \neq 0$, the "shadow price" of the federal budget constraint, m, will increase if

$$\frac{q_L}{q_H} \geq \frac{\hat{H}_g^L}{H_g^L} \quad (35)$$

Considering we know that $q_H \geq q_L$, if (35) holds, implies that $H_g^L \geq \hat{H}_g^L$, i.e., the mimicker would not see compensated its mimicking action, since then would have to pay a higher tax rate, and the fact that $\hat{g}_L \geq g_L$ (because of the assumed concavity of *H(g)*), it would enjoy a greater level of regional public services as a mimicker region, is not enough compensation. In fewer words, the marginal value of public services (in regional public revenues) is relatively higher when the low-cost region does not mimic, $q_L H_g^L \geq q_H \hat{H}_g^L$. That is precisely the price of making mimicking unattractive, reflected by b_L. This effect will be larger, the larger the low-cost region's tax base, $w^L l^L$, and the labour supply elasticity, e_L,and the lower their provision cost, c_L, are.

The final result the paper tries to infer is whether the optimal federal tax rate is negative or zero as the paper by BOADWAY, R., KEEN, M. (1996) showed, becoming then a federal subsidy[25]. The intuition they give is that "*the federal government should arrange matters so that, at the margin, state taxes have no effect on federal revenues, ensuring that the states will fully internalize the social costs of their revenue raising"* (page 147).

In my case, such result does not automatically crop out, since the formulation of the "ad valorem" federal tax rates, q_H^F and q_L^F, becomes much more messy[26]. To demonstrate it, we explicitly show the FOC's of the federal tax rate, low-costs and high-costs regions' tax rate, respectively

[25] Vid. Formula (31), and Proposition 3, op. cit.

[26] We have to take into account that BOADWAY, R., KEEN, M. (1996)'s paper considers a symmetric equilibrium with all states pursuing the same polices (page 141), becoming then the formulation not so messy.

$$t_F: \quad -N^H w^H l^H \left[1+\frac{H_g^H q_H e_H}{c_H}\right] - N^L w^L l^L \left[1+\frac{H_g^L q_L e_L}{c_L}\right] - \frac{b_L w^L l^L e_L}{c_L}\left[H_g^L q_L - \hat{H}_g^L q_H\right] +$$
$$+ m\left[N^H w^H l^H \left(1-q_H^F e_H\right) + N^L w^L l^L \left(1-q_L^F e_L\right)\right] = 0 \qquad (36)$$

$$t_L: \quad \left[1-\frac{H_g^L}{c_L}\left(1-q_L e_L\right)\right]\left[1+\frac{b_L}{N^L}\right] + m q_L^F e_L = 0 \qquad (37)$$

$$t_H: \quad \left[1-\frac{H_g^H}{c_H}\left(1-q_H e_H\right)\right] + \frac{b_L w^L l^L}{N^H w^H l^H}\left[1-\frac{\hat{H}_g^L}{c_L}\left(1-q_H \hat{e}_L\right)\right] + m q_H^F e_H = 0 \qquad (38)$$

Then, from the substitution of (38) into (36), we get q_F^L,

$$q_F^L = \frac{1}{e_L}\left\{1+\frac{w^H N^H l^H}{w^L N^L l^L}\left[1+\frac{1-\frac{H_g^H}{c_H}\left(1-q_H e_H\right)+\frac{b_L w^L l^L}{w^H N^H l^H}\left[1-\frac{\hat{H}_g^L}{c_L}\left(1-q_H \hat{e}_L\right)\right]}{m}\right] - \frac{1}{m}\left[1+\frac{H_g^L q_L e_L}{c_L}\right] -\right.$$
$$\left. - \frac{w^H N^H l^H}{m w^L N^L l^L}\left[1+\frac{H_g^H q_H e_H}{c_H}\right] - \frac{b_L e_L}{m c_L N^L}\left[H_g^L q_L - \hat{H}_g^L q_H\right]\right\} \qquad (39)$$

and now substituting (37) into (36), we get the expression for q_F^H,

$$q_H^F = \frac{1}{e_H}\left\{1+\frac{w^L N^L l^L}{w^H N^H l^H}\left[1+\frac{\left[1-\frac{H_g^L}{c_L}\left(1-q_L e_L\right)\right]\left[1+\frac{b_L}{N^L}\right]}{m}\right] - \frac{b_L e_L w^L l^L}{m c_L w^H N^H l^H}\left[H_g^L q_L - \hat{H}_g^L q_H\right] -\right.$$
$$\left. - \frac{w^L N^L l^L}{m w^H N^H l^H}\left[1+\frac{H_g^L q_L e_L}{c_L}\right] - \frac{1}{m}\left[1+\frac{H_g^H q_H e_H}{c_H}\right]\right\} \qquad (40)$$

which has a very similar shape to (39).

As we can check, we get a sort of *inverse elasticity rule* (no cross-price effects) since both (implicit) *federal "ad valorem" tax rates* on labour income are negatively related to the elasticity of labour supply, e_L or e_H. In order to achieve the same result than BOADWAY, R., KEEN, M. (1996), all the expression in brackets, both in (39) and (40), should be negative or zero. Although there is no clear indication that this will be so, we cannot exclude that hypothesis either, independently of whether the self-selection constraint is binding or not. Note, however, the role expression (35) is playing in both federal tax rates, reducing their (implicit) level. This reduction derives the increase in the value of the "shadow" price of the federal budget constraint we have got before, (34), since forces total resources of the federation to shrink. In any case, it does not look probable that $q_i^F = 0$, though intuition about this fact is not clear.

5- Conclusions

The objective of this paper has been twofold. On the one hand, it aimed to achieve useful recommendations to the present situation of the Spanish regional financing system. On the other hand, tried to add further insights into the theoretical literature of the intergovernmental relations. In both cases, the results I conclude will need of future research since looks possible to model in more detail the great variety of aspects that concern such intergovernmental relations.

In July of this year, a conflict cropped out between the central government and the regions in Spain, in relation to the necessary amount of funds to provide education (*in conditions of quality*)[27]. The core of the conflict was the claim of more central transfers by the regions, while the central government claimed for their (extra) self-financing. In this kind of situations, when the information the federal government posses about their real needs is incomplete, it is evident that each region will try to take advantage of it, not taking into account any other region's welfare. The result is an allocative inefficiency of the transfers. This fact has been modelled by the present paper.

In the case we model, in parallel with the Spanish system, this distortion becomes even worse since mitigates the internalisation of the vertical tax externality forced by the use of the same tax base by both levels of government. The balance between these two distortions, and its whole net effect is analytically and graphically shown in the paper.

Therefore, it is clear that the main advice of political economy that this paper can offer is to show analytically the negative effects of the non-existence of a regional accounting system. Its existence would make possible to discern to what extent regional claims, as the ones previously referred, are legitimate. However, I also have to recognise that such an ideal accounting system is difficult to elaborate. But, as long as that its institution is supported by all the agents that compose the federation, its conclusions should be able to accomplish a valid role.

With respect to the conclusions that could affect the theoretical economic literature, I have to say that they tend to confirm, or at least not to contradict, previous works. In particular, with respect to the results induced by the presence of asymmetric information, these are quite similar, and the result of "non-distortion at the top" found by other authors also holds for our model. In relation to the effect provoked by the vertical tax externality, this conditions both optimal decisions of high and low-cost regions. Nevertheless, from my work, I do not get a clear result whether its internalisation forces the federal tax rate to become negative, as BOADWAY, R., KEEN, M. (1996) showed.

In any case, as I have repeatedly said before, this work, and the model which bases it is at its very early stages of development. Many new circumstances can be introduced into it. For example, the consideration of more than one principal[28], such as the

[27] Vid. *EL PAIS*, 10th and 11th , July, 1997.

[28] Vid., e.g., STOLE, L., (1992): "Mechanism Design under Common Agency", University of Chicago, mimeo, or more recently, DIXIT, A., et al. (1997), "Common Agency and Coordination: General Theory and Application to Government Policy Making", Journal of Political Economy, Vol. 104, No. 4.

European Community and central government itself, looks promising and more close to the future setting of European integration. Also the extension of the model to a continuum of cost-type regions, instead of just two[29], and as suggested by BORDIGNON, M. (1996, page 28), the consideration of other maximising behaviours that include explicitly policy factors are other analysis that remain for future research. The explicit introduction of a system of revenue-cost equalisation transfers of the form

$$T = \left(c_i - \bar{c}\right)\bar{g} + \left(\overline{wl} - w_i l\left(w_N^i\right)\right)\bar{t}$$

is also left for future research, though as have been briefly commented before [vid. footnote (10)], the equalisation objective would probably weaken the signal effect of the tax rate, and then regional tax rates for high cost regions would have to be higher.

[29] Vid. CORNES, R.C., SILVA, E.C.D. (1996,b), pages 17-22.

6- References

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APPENDIX

This Appendix shows that the self-selection constraint of the low-cost regions is not binding. To do it, we first rewrite such constraint, expression (9) in text,

$$V^L\left(t_L, t_F, S_L, c_L, G\right) \geq \hat{V}^L\left(t_H, t_F, S_H, c_L, G\right) \geq 0$$

which developed, transforms into

$$wl\left(1 - t_L - t_F\right) + J\left(1 - l\right) + H\left(\frac{t_L wl + S_L}{c_L}\right) \geq wl\left(1 - t_H - t_F\right) + J\left(1 - l\right) + H\left(\frac{t_H wl + S_H}{c_L}\right)$$

where we consider $w^L = w^H = w$, and $l^L = l^H = l$, to focus just on the effects provoked by the differences in provision cost. On the other hand, we can show that

$$\hat{V}^L\left(t_H, t_F, S_H, c_L, G\right) \rangle\, V^H\left(t_H, t_F, S_H, c_H, G\right) \geq 0,$$

since being $c_H \rangle\, c_L$, developing and simplifying such inequality, we finally get

$$H\left(\frac{t_H wl + S_H}{c_L}\right) \rangle H\left(\frac{t_H wl + S_H}{c_H}\right)$$

Therefore, assuming an interior solution, this implies that

$$V^L\left(t_H, t_F, S_H, c_L, G\right) \rangle\, 0,$$

and then $b_L = 0$ ■.