# The impact of economic openness on the vertical structure of the public sector

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**Abstract**

The aim of this paper is to investigate the relationship between the degree of economic openness of a country and the vertical structure of its public sector. To tackle this issue we set up a simple theoretical model of fiscal federalism, where central and local public expenditures are characterized by some exogenous degree of substitution, reflecting their intrinsic characteristics. Central Government (CG) and Local Governments (LG) independently maximize different objective functions. CG decides the level of public expenditures and the level of transfers to LG subject to a revenue constraint that becomes tighter the higher the degree of economic openness, assumed to erode central tax revenues. On the other hand, LG decides the level of autonomous public expenditures that are financed by both central government transfers and a local lump-sum tax. The main findings are that for a large subset of the parameters feasible set an increase in economic openness leads to: a) a lower level of central government expenditures, b) a higher degree of public sector decentralization, c) a higher level of local taxation, d) a lower level of general government expenditures.

**Keywords**: openness, decentralization, fiscal federalism, public sector, government size.
**JEL Classification**: H77, H50, H11.

## 1. Introduction

A consolidated strand of the economic literature on the relationships between the openness of the economy and government size usually disregard the vertical distribution of taxes and expenditures across government levels, by focusing on either the public sector as a whole or on the size of central governments. This is the case, for example, in Cameron (1978) and Rodrik (1998) – two of the most popular contributions on this topic – but also in a series of recent papers discussing how trade – and to a less extent financial – openness may provide either a boost or a constraint to the development of large public sectors.[1]

On the other hand, there is a massive literature on how decentralization may impact on the total size of the public sector, yet almost totally disregarding the possibility that economic openness, as an external factor, may alter this relationship.[2]

Much less investigation has been carried out, until now, on how, and whether, economic openness may directly impact on the vertical distribution of public expenditures across government levels and, through this way, on the size of the general government and on the degree of decentralization in any given country.

This interest is partly motivated by the literature on globalization and tax competition, whose main message is that public sectors may be somewhat constrained in the use of both taxes and public expenditures when there is a high degree of economic integration. That literature suggests that tax revenues may decrease (or increase slowly), the tax burden may reallocate from more mobile to less mobile tax bases, that large redistributive programs are less easily implemented and that large welfare states are increasingly difficult to maintain.

The point of departure of our paper is that it is unlikely that these "big" changes that economic integration is alleged to generate may leave the vertical structure of public sectors unaffected. In order to tackle this issue, we set up a simple theoretical model, where central and local public expenditures are characterized by some "subjective" degree of substitution, reflecting central and local government preferences. In this sense, our framework is enough general to encompass, as special cases, both self-interested (Niskanen-type) governments, and welfare-maximizer governments.[3]

The Central Government (CG) decides the level of central public expenditures and the level of transfers to LGs subject to a revenue constraint that becomes tighter the higher the degree of economic openness, assumed to erode central tax revenues. On the other hand, Local Governments (LGs) set the level of autonomous public spending, financing it by central grants and local lump-sum taxes.

The main findings are that – in the case of fully self-interested CG and for a significant subset of the parameters feasible set – an increase in economic openness leads to: a) a lower level of central government expenditures; b), a higher level of local

[1] For an extensive review, see Schulze and Ursprung (1999). See, among many, Garrett (1996, 1998a, 1998b and 1999), Quinn (1997), Rodrik (1997), Swank (1998), Hallerberg and Basinger (1998), Iversen and Cusack (2000), Grubert (2001), Bretschger and Hettich (2002), Swank (2002), Sanz and Velázquez (2003), Dreher (2003), Slemrod (2004), Garen and Trask (2005), Liberati (2007).

[2] See, for example, Brennan and Buchanan (1980), the empirical evidence provided by Oates (1985) for the Leviathan hypothesis, the recent empirical evidence provided by Stein (1999) and the survey of the literature in Rodden (2003).

[3] Given the purpose of the paper, the federalist structure of the public sector is taken as given, without pursuing its microfoundation.

taxation; c) a lower level of general government expenditures; d) a higher degree of public sector decentralization.

## 2. The relation between openness and government size

Even though the relationship between economic openness and decentralisation is relatively unexplored in the prevailing literature, there are some useful insights that can be learned from different strands of theoretical and empirical studies that have investigated those topics either jointly or in isolation. In what follows, we propose both a classification of these studies and their implications for the vertical structure of public sectors.

### *2.1. The extension of the compensation hypothesis*

A possible nexus between openness and fiscal federalism arises from by a straightforward extension to local governments of the hypothesis suggested by Rodrik (1998). He argued that increasing external economy's exposure may lead to more demand for public expenditures to compensate for increasing external risk (macroeconomic volatility, asymmetric shocks), a process that has become popular as the *compensation hypothesis* (e.g., Swank, 2002).[4] Since the insurance function is thought to be best served by centralised fiscal arrangements (e.g. Oates, 1972), the consequential outcome is that globalisation should increase the size of central governments and relatively reduce that of local ones, especially if regions are specialised in production.[5] On the other hand, economic integration may increase the cost of stabilisation policies – i.e. the cost associated to counter-cyclical policies – as part of the intended effects can be vanished by factor mobility.

### *2.2. The emphasis on the costs of secession*

The second explanation stems from a strand of research suggesting that economic integration may reduce the cost of secession by part of small regions and provide for less benefits to larger countries (e.g. Alesina and Spolaore, 1997; Alesina and Wacziarg, 1998). According to this view, "political separatism should be associated with increasing economic integration" (Alesina and Spolaore, 1997, p.1041). In other terms, exit threats might become more credible (and cheaper) in an integrated world than in an autarchic world.

Now, if fiscal decentralisation is interpreted as a backstop to secession (for example to avoid inefficiency costs associated to secession – Bolton and Roland, 1997) more economic integration should lead to more decentralised countries. The reason is that central governments will be willing to "pay" more to local governments to avoid secession – for example, by increasing transfers or by devolving expenditure and taxation power to them. However, as Garrett and Rodden (2003) pointed out, central governments may try to "buy" loyalty of voters – especially in would-be breakaway regions – by direct

[4] The role of asymmetric shocks in increasing regional demand for insurance was already pointed out in Persson and Tabellini, 1996a and 1996b).
[5] See also Garrett and Rodden (2003).

spending rather than by transfers, by this way recovering the possibility that economic integration would increase (more) the size of central governments.

The authors, however, seem to disregard the possibility that "local voters" might be more effectively bought by increasing either the size of – possibly unconditional – transfers or the amount of taxes devolved to local territories (at least if one assumes that local citizens are better informed about what happens at local rather than at central level or that less rents are dissipated at local level).[6]

A notable contribution on this issue is by Stegarescu (2004), who argues that economic integration may have triggered the recent process of fiscal decentralisation in OECD and EU countries. The theoretical model contains several interesting points, the most relevant for our analysis being the dependence of both preferences for national public goods and per capita regional output on the degree of economic integration. He shows that complementarities between local and national public goods leads to an increase of the total supply of public goods (central + local) when economic integration increases. At the same time, the theoretical effect on the optimal degree of decentralisation would be ambiguous, yet a positive relationship between openness and decentralisation finds some support on the empirical side.[7]

### *2.3. Openness as a fiscal discipline device*

A third explanation tend to highlight the role of globalisation as a fiscal discipline device. In particular, as suggested by de Mello (2005), globalisation can impose harder budget constraints on decentralised governments. By this way, it would reduce the "deficit bias" empirically observed in more decentralised countries – originated by either implicit or explicit bail-out guarantees from the central governments[8] – and favour the implementation of a market-preserving federalism (e.g. Qian and Roland, 1998; Qian and Weingast, 1997).

There are two debatable points in this interpretation. The first is directly related to the model developed by de Mello (2005), in which globalisation has a direct impact on local budgets, but only a mediate effect on the budget of the central government, a feature which remains rather unexplained. The second is that some theories of fiscal federalism suggest that decentralisation may be a discipline device by itself, through an increase of both horizontal and vertical competition among government levels.[9] Arguing that more decentralised countries tend to have a "deficit bias" – and that economic integration may remedy it – is a direct challenge to the benefits of decentralisation highlighted by the theories of competitive federalism.

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[6] On this latter point, see Ferejohn (1999).

[7] See also Verdier and Breen (2001) and van Houten (2003), the first showing that fiscal centralisation is positively related to financial openness; the second showing that economic integration has not a clear effect on decentralisation.

[8] See, for example, Alesina and Perotti (1998).

[9] In particular those theories evoking some kind of competitive federalism. See, for all, Buchanan and Brennan (1980) and Salmon (1987). But see Oates (1985) and Ferejohn (1999) pointing to the fact that local voters may ask for more spending rather than less, to the extent that they perceive that less public money is dissipated in rents by local governments. More recently, Wilson and Janeba (2005) show how local governments may play a role in reducing the harmful effects of externalities in a tax competition setting.

In another contribution, Jin and Zou (2002) suggest that vertical imbalances (i.e. the excess of expenditure responsibilities over tax powers at local level) may lead to higher subnational, national and aggregate governments, presumably because central governments pay transfers to localities.[10] In this context, however, there is no analysis of whether economic integration may discipline this inefficiency.

But perhaps the most compelling case for this point of view indirectly arises from a comment to Buchanan (1995). While describing the main features of competitive federalism, it is argued that "the monopoly power of unitary governments, as well as the common pool problem of federalist politics, can be alleviated to the extent that free movements of resources allows resource owners to move away from excessive taxes and regulations". It is indeed a common point of all theories of competitive federalism, that the institution of "federalism" may facilitate the exit option by part of individuals and firms dissatisfied with tax and expenditure policies, compared with the monolithic central government. In the same vein, increased economic integration may play the same role at a supranational level, strengthening fiscal discipline.

### *2.4. The role of opportunistic behaviour*

A fourth explanation is based on the existence of opportunistic behaviour by part of either of the government levels involved in the process. In particular, the existing literature has focused on the case where central governments may offload some fraction of total public expenditures to local governments.

Economic integration, for example, may increase the marginal efficiency cost for central governments of pursuing redistributive aims (through an increased elasticity of tax bases). To some extent, the reason is the same as that predicted by the Tiebout (1956) model when perfect mobility is assumed. In this latter case, redistribution is a hardly tenable function for local governments and unstable equilibria may originate.

In the same vein, in more open countries, central governments are likely to face high mobile tax bases and additional distortions in taxing less mobile tax factors. This would point to redistributive expenditures (but also to redistributive taxes) as the most at risk at high levels of economic integration.[11]

However, since cutting redistributive expenditures is a politically costly activity for central governments, one possible strategy would be to decentralise. Economic integration may therefore push towards more decentralisation on a political ground, something that can be referred to here as the *shifting hypothesis*.[12] Sáez (2001) has indeed pointed out that central governments may try to offload public expenditures to local governments without a commensurate increase in tax revenue (i.e. central governments shift budget deficits), which is likely to lead to smaller aggregate government size.

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[10] See Rodden (2003) who argue that when local expenditures are financed with local own taxes the size of welfare spending is lower. Hicks and Swank (1992), Schmidt (1996), Castles (1998) and Swank (2002) also provide empirical evidence of a negative relation between fiscal federalism and the size of welfare spending.

[11] Note that this argument may be interpreted as the counterpart of the compensation hypothesis. This latter predicts that there is a larger demand of public expenditures, but this does not necessarily entail that this demand can be satisfied by a larger supply if there are constraints on the use of public finance variables.

[12] The relevance of this *shifting hypothesis* is not new in the economic literature. Its origin can be traced back to the literature on regulation authorities. See, for example, Mitnick (1980).

Garrett and Rodden (2000) argue that strategic behaviour may be followed by central governments facing increasing pressures to maintain fiscal balance, by attempting to cut expenditures by offloading expenditures and deficits to local governments.

Two things are worth noting. First, the previous arguments by de Mello (2005) seem to be turned on their head. In this latter case, openness could remedy to the fact that more decentralised countries have higher budget deficits. In Garrett and Rodden (2000), openness may induce central governments to shift budget deficits to local governments.

Second, if one is ready to assume that the most powerful pressure to maintain fiscal balance comes from capital markets[13], the argument by Garrett and Rodden (2000) that fiscal balance pressures give incentives to central governments to offload public expenditures to local governments ends up to be the argument advanced in this paper that more economic integration (at least some types of economic integration) may lead to larger local governments.[14]

## 3. The model

The following model will set up a simple theoretical framework to show one basic point and some by-products. The basic point is that higher economic openness may lead in most cases to higher degrees of decentralisation. The by-product, as we will see, is that this may occur combining various cases of the underlying behaviour of both central and local governments.

### 3.1. *The Local Government decision problem*

Consider a simplified structure of territorial organization in which there are a Central Government (CG) and two Regions. The central government spends an amount $g$ for overall purposes, while each local government spends an amount of $g_i$ for local purposes.

Each region $i$ $(i = 1,2)$ maximizes the following objective function with respect to local public expenditure $g_i$:

$$W_i = \alpha \ln(g_i + \beta g) + (1-\alpha)\ln(y_i - T - t_i) \tag{1}$$

subject to the budget constraint $g_i = t_i + b$, where $t_i$ is a local lump-sum tax (assumed differentiated among regions), $b$ is a lump-sum transfer from the central government and $y_i$ is the (differentiated) regional income.[15] Population in each region is fixed and no migration is allowed between the two regions.

[13] This hypothesis is known as the *domestic balance* hypothesis. See Swank (2002).

[14] Note that the reduction of welfare spending, for example, may also be the outcome of a process in which expenditures are first delegated without corresponding tax powers and then reduced if central governments are not available to fully finance them with transfers and local governments have insufficient resources to afford them.

[15] In this version, the transfer from the central government is assumed uniform among regions. A natural extension would be to assume a regionally differentiated transfer, such as an equalisation transfer to compensate differences of potential tax revenues.

$0 \le \beta \le 1$ is a parameter measuring the attitude of the local politician towards central public expenditures. In a welfare-maximising perspective, there is no difference with regard to the level of government actually providing public expenditures. In other words, if the local politician is a welfare maximiser, she/he evaluates central spending on a given public good in the same way as local spending on that same good. In this case, $\beta = 1$, i.e. central and local expenditures are perfect substitutes.

On the other hand, local politicians may be self-interested, in particular they may give more weight to local expenditures than to central ones. One reason is that they try to maximize their own budget (a local government of Niskanen-type); another reason is that local voters better evaluates the performance of local politicians for what they directly spend and not for what is spent by central governments on their account.[16] In all these cases, local politicians may be tempted to understate the utility of central public expenditures for local citizens. At the extreme, central spending may not enter the objective function of the local government, which implies $\beta = 0$. In other words, central spending cannot replace local spending.

Finally, $\alpha$ is a parameter of preference; $\alpha$=0 means that local governments do not assign any weight to public expenditures; at the same time private income $y_i$, net of the central revenue $T$ and of the local tax burden $t_i$, is all that matters.

In this framework the amount of transfer $b$ is taken as given by local governments, which means that the decisional process on the appropriate amount of grants is concentrated in the hands of the central government. It follows that local taxation fills the gap between local spending and grants, i.e. $t_i = g_i - b$.

The decision problem (1) is therefore equivalent to maximize the following:

$$W_i = \alpha \ln(g_i + \beta g) + (1-\alpha)\ln(y_i - T + b - g_i) \qquad (1a)$$

Note that the objective function of each local government $i$ is increasing in local public expenditure $g_i$ if the latter is below a threshold $f(y_i - T, b, g,)$.[17] Such threshold is increasing in net income (considering only central government taxes) and in central government transfers $b$, while it is decreasing in central government expenditures $g$.

### 3.2. *The Central Government decision problem*

Consider now the problem faced by the Central Government. The central government has two choice variables, central public expenditures $g$ and grants $b$ to local governments. The objective function is assumed to mirror that of local governments:[18]

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[16] This argument is consistent with Brennan and Buchanan (1980), once their statement on the tax policy perspective is transposed to one of public spending policy.

[17] In particular, $f(y_i - T, b, g) = \alpha \cdot (y_i - T + b) - (1-\alpha) \cdot \beta \cdot g$.

[18] In our model the objective function of central policy maker does not depend at all on local governments decisions. This implies that strategic interactions between central and local governments are absent. This point must not necessarily be interpreted as a weakness, however, as we will show that, also in this context, the best response to economic openness is to increase the degree of decentralisation.

$$\max_{g,\,b} W = \gamma \ln(g + \theta g_i) + (1-\gamma)\ln(y - 2T - t_L) \tag{2}$$

where $y = y_1 + y_2$, $t_L = t_1 + t_2$ is the total local taxation and $\gamma$ is a parameter describing central government's preferences. As in the case of the local governments' objective function, the central government may behave as a welfare-maximiser – and in this case would be $\theta = 1$ – or as a self-interested central government that does not care for what happens at local level – and in this case $\theta = 0$. The reasons underlying this behaviour are basically the same as those discussed in the case of local governments.

The central government has the following budget constraint:

$$g + 2b = 2T - \omega \tag{3}$$

where $T$ is exogenous CG tax revenue and in which, by assumption, $\omega < 2T$. The peculiarity of the budget constraint (3) is that central tax revenue, for a *given level of tax rates*, is *assumed to be negatively affected* by the degree of economic openness ω. In other words, a given level of tax rates is assumed to yield more tax revenue in a closed economy than in an open one.

It is worth noting that the effect of economic openness is here introduced in a very general way as a factor of *erosion* of central government tax revenue that is out of control of central political authorities.

On the one hand, this is a simplified way of dealing with economic openness, one that does not require to model economic interrelations between countries, as it focus on the internal consequences of the action of external factors.[19] On the other hand, this modelling can accommodate the action of every "eroding factor", of which openness is thought to be one of the most prominent examples.

There are a number of arguments supporting this latter assumption. The assumption that increasing economic openness may shrink tax bases (and tax revenues for the same level of tax rates) is in fact the "fiscal termites" argument by Tanzi (1995 and 2002). One of the possible consequences is a relatively more heavily taxation of less mobile tax bases.[20]

On the empirical side, however, the issue is rather controversial. Measuring the impact of either trade openness or capital openness (or both) on the level and composition of tax revenues gives very controversial results.[21] In what follows, we maintain the assumption of a negative impact of openness. In our context, the simplest interpretation is that total tax revenue in an open economy is likely to be lower than it would be with the same tax rates were the economy perfectly closed, which is in fact a mild assumption.

By analogy, the openness of the economy is here assumed to affect total tax revenue in the same way as the openness of the economy affects the level of national income by allowing some consumption to "fly away" towards imported goods in the standard Keynesian multiplier. For the sake of clarity, therefore, we will not discuss *whether* the openness of the economy causes a reduction of total tax revenue in general terms; we

[19] To some extent, it amounts to assume that every country is *openness-taker*, i.e. it is too small to affect the degree of economic integration by acting in isolation.

[20] Whether increased trade openness may have the same effect is less clear-cut. Trade openness has been the source of considerable tax revenues for long time, before the liberalisation process.

[21] Among the main contributions to this topic, see Garrett (1995), Garrett and Mitchell (2001), Quinn (1997), Swank (1998 and 2002), Bretschger and Hettich (2002), Adam and Kammas (2007), Dreher (2005), Swank and Steinmo (2002), Winner (2005), Krogstrup (2003). A detailed survey of these studies is available in Gastaldi and Liberati (2008).

simply assume that – for a *given level of tax rates* – the openness of the economy will tend to reduce the amount of resources available to central government. This also provides some justification to our assumption that central tax revenue is left exogenous.[22]

Note further that the central government makes decision about the level of public expenditures by considering the aggregate disposable income (net of central and local taxes) in each local government. This latter factor introduces in (2) a simplified way of how the central government "care" for local governments' well-being, in the sense that even in the self-interested scenario ($\theta = 0$), net incomes of citizens represents an implicit limit to the expansion of the central public sector. Nevertheless, when $\gamma = 1$, the central government maximises the objective function by considering only central variables.

In what follows, we will concentrate on the case in which CG is completely self-interested with reference to public expenditure, while local governments maintain a certain degree of welfarist behaviour. In terms of our model this amounts to assume $\theta = 0$ and positive $\beta$. This assumption is particularly useful in the presence of an external constraint (as economic openness), as it introduces a sort of conflict between central and local governments in the presence of an exogenous element of public budget discipline. This case, while somewhat extreme, may nevertheless give useful insights on the behaviour of the central government. As we will see, the best response for a self-interested central government will be, in many cases, to shift public spending to local governments. Moreover, the assumption that LGs are more welfarist than CG reflects the observed stronger difficulty for local governments to be autonomous on the spending side. Some insights on the extension of this setting will be however provided in Appendix.

### 3.3. *Federalist equilibrium*

#### 3.3.1. *The optimum solutions for local governments*

Both regions and the central government maximize their own objective function with respect to their own policy instruments, taking as given the decisions of the other government level.

Consider first the *local government*. The optimal level of local public expenditures can be determined by solving $\frac{\partial W_i}{\partial g_i} = 0$, from which:

$$\hat{g}_i = \alpha\left[y_i - T + b\right] - (1-\alpha)\beta g \qquad i=1,2 \qquad (4)$$

$$\hat{t}_i = \hat{g}_i - b = \alpha\left[y_i - T\right] - (1-\alpha)(\beta g + b) \qquad (5)$$

Equation (4) gives the optimal level of local public expenditures for given levels of central government transfers and public expenditures. Note that the presence of central public expenditures reduces the optimum level of local ones. The "substitution" between central and local public expenditures becomes therefore crucial. If $\beta = 0$, the optimum level of local expenditures will be achieved by using only local resources and grants,

[22] As already observed in the previous paragraph, support to this idea also comes from theories of competitive federalism. See Buchanan (1995).

while the optimum level of local expenditures will be lower when $\beta > 0$, as in this case central government expenditures "serve" also local government purposes that are "recognised" by the objective function of local politicians.

Equation (5) gives instead the optimal level of local taxes. The interpretation is straightforward: local taxes fund the fraction of public expenditures that is not financed by central grants. It is just the case to say that debt issue is not allowed to local governments.

3.3.2. *The optimum solutions for central government*

Consider now the *central government*. The optimal level of central public expenditures can be obtained by using the Lagrangian function of the maximization problem:

$$L(\lambda, g, b) = W + \lambda(2T - \omega - g - 2b)$$

The first order conditions (FOCs) of the problem are given by:

$$\frac{\partial L}{\partial g} = 0 \Leftrightarrow \frac{\gamma}{g} = \lambda$$

$$\frac{\partial L}{\partial b} = 0 \Leftrightarrow \frac{(1-\gamma)}{y - 2T - g_L + 2b} = \lambda$$

$$\frac{\partial L}{\partial \lambda} = 0 \Leftrightarrow g + 2b = 2T - \omega$$

Where $g_L = g_1 + g_2$ is the aggregate local spending. Taking the ratio between the first two FOCs and solving for *g* yields:

$$g = \frac{\gamma}{1-\gamma}(y - 2T - g_L + 2b) \tag{8}$$

Substituting equation (8) into the central government budget constraint (3) and solving for *b* yields the optimal level of transfers:

$$\hat{b} = \frac{1}{2}\left[2T - (1-\gamma)\omega - \gamma(y - g_L)\right] \tag{9}$$

Finally, substituting (9) into (8) gives the optimal level of central public expenditures:

$$\hat{g} = \gamma\left[(y - g_L) - \omega\right] \tag{10}$$

Note that the openness of the economy plays a direct role in shaping both the optimal levels of central expenditures and transfers. Both also depends on the optimal level of local public expenditures $g_i$. Equation (9) and (10) can therefore be interpreted as reaction functions of central government to local government decisions. In the same vein, equation (4) can be interpreted as the reaction function of local government to central

government decisions. Solving the system of equations (4), (9) and (10), gives the equilibrium of the model for central and local government expenditures:

$$\begin{aligned} g^* &= \frac{1}{\Omega}\left[(1-\alpha)\gamma(y-\omega)\right] \\ b^* &= \frac{1}{2}\left[2T-(1-\gamma)\omega-\gamma\left(y-g_L^*\right)\right] \\ g_i^* &= \alpha\left[y_i-T+b^*\right]-(1-\alpha)\beta g^* \end{aligned} \tag{11}$$

where $\Omega = 1-\alpha\gamma-2(1-\alpha)\beta\gamma$. Note that optimal local government expenditures now depends on all local variables as well as on economic openness through the dependence on it of both central expenditures and transfers.

## 4. Comparative Statics

Comparative statics may help disentangle the impact of economic openness on public finance variables and on their distribution among government levels. A convenient starting point is the straightforward calculation of the impact of openness on the variables analysed, which are given by:

$$\frac{\partial g^*}{\partial \omega} = -\frac{(1-\alpha)\gamma}{\Omega} \tag{12}$$

$$\frac{\partial g_i^*}{\partial \omega} = \frac{2(1-\alpha)\beta\gamma-\alpha(1-\gamma)}{2\Omega} \tag{13}$$

$$\frac{\partial b^*}{\partial \omega} = \frac{2(1-\alpha)\beta\gamma-(1-\gamma)}{2\Omega} \tag{14}$$

Note that, from (13) and (14), the following result will prove useful in the discussion of our findings, i.e. the difference between changes in local spending and changes in grants after a change in economic openness:

$$\frac{\partial g_i^*}{\partial \omega}-\frac{\partial b^*}{\partial \omega} = \frac{(1-\alpha)(1-\gamma)}{2\Omega} \tag{15}$$

In order to interpret these results, use will be made of the two following thresholds:

$$\alpha_\Omega = \frac{1-2\beta\gamma}{\gamma(1-2\beta)} \tag{16}$$

$$\alpha_b = 1-\frac{1-\gamma}{2\beta\gamma} \tag{17}$$

4.1. *The effects of economic openness on central government expenditures*

Consider first how economic openness impacts on central government expenditures. Define the following Lemma:

**Lemma 1**.

a) If $\beta > 1/2$, then $\Omega > 0 \Leftrightarrow \alpha > \alpha_\Omega$ (and $\Omega < 0 \Leftrightarrow \alpha < \alpha_\Omega$);
b) If $\beta < 1/2$, then $\Omega > 0 \Leftrightarrow \alpha < \alpha_\Omega$ (and $\Omega < 0 \Leftrightarrow \alpha > \alpha_\Omega$);
c) $\beta < 1/2 \Rightarrow \alpha_\Omega > 1 \Rightarrow \Omega > 0$.

**Proof**: See Appendix.

Lemma 1 leads to the following Proposition, in which the effects of economic openness on central government expenditures are disentangled according to the degree of consideration of central spending by part of local politicians:

**Proposition 1**

a) $\beta < 1/2 \Rightarrow \dfrac{\partial g^*}{\partial \omega} < 0$;

b) $\beta > 1/2 \Rightarrow \begin{cases} \dfrac{\partial g^*}{\partial \omega} < 0 \Leftrightarrow \alpha > \alpha_\Omega \\ \dfrac{\partial g^*}{\partial \omega} > 0 \Leftrightarrow \alpha < \alpha_\Omega \end{cases}$

**Proof**: Proposition 1 follows from equation (12), Lemma 1 and the Corollary in the Appendix.

Proposition 1 clearly highlights that when the degree of consideration of central spending $\beta$ by part of local governments is relatively low (local politicians are relatively more interested in maximising their own budget), the level of central public expenditures unambiguously decreases. Some ambiguity instead arises when $\beta$ is "relatively high". In this case, the sign of $\dfrac{\partial g^*}{\partial \omega}$ depends on the level of the threshold (16). Quite important is that it is still possible to observe a reduction of central public expenditures under certain conditions, even though local politicians take into account central spending. Furthermore, our model leaves some space to the possibility that central public expenditures may increase in response to economic openness.
In fact, generalising the model to *n* Regions makes condition b) more likely, as in this case it is required that $\beta > 1/n$. This condition is more likely verified in countries with a large number of local governments. Furthermore, the larger the number of local governments the more likely is the possibility that central expenditures would increase

(i.e. more likely is that $\alpha < \alpha_\Omega$) giving some support to the *compensation hypothesis*[23] – a larger central government in more open economies. Obviously, in a context where local governments are own-budget maximisers, $\beta = 0$ and part a) of Proposition 1 always applies. This feature of the model explains that the effect of openness on central government spending strongly depends on the institutional context in which central and local government operate in various countries. It also explains why the empirical evidence on this issue is not clear-cut in favour of either part of Proposition 1. Various levels of $\beta$ are indeed compatible with both an increase and a decrease of central spending.

4.2. *The effects of economic openness on local expenditures and transfers*

What happens at central level is only part of the whole story. Central and local governments, in our model, are linked by central transfers and local governments may provide autonomous local expenditures. In this case, things are slightly more complicated, as there are no unambiguous results. In order to analyse these features of the model, a convenient starting point is the following Lemma:

**Lemma 2**

$$num\left(\frac{\partial b^*}{\partial \omega}\right) > 0 \Leftrightarrow \alpha < \alpha_b = 1 - \frac{1-\gamma}{2 \cdot \beta \cdot \gamma}$$

**Proof**: See Appendix.

Consider Lemma 2 in the context where $\beta < 1/2$. Two straightforward conclusions are summarised by Propositions 2 and 3.

**Proposition 2**

$$\alpha < \alpha_b \Rightarrow \frac{\partial b^*}{\partial \omega} > 0 \Rightarrow \frac{\partial g_i^*}{\partial \omega} > 0$$

**Proof**: The first $\Rightarrow$ follows from Corollary to Lemma 1 and Lemma 2. The second $\Rightarrow$ follows from comparing (13) and (14).

Proposition 2 states that, under conditions, both transfers and local government expenditures increase in response to increased economic openness. Moreover, expression (15) implies that local public expenditures increases more than transfers (what is sometimes called in the literature the "bandwagon effect"), which means that local taxation must increase to preserve the budget constraint.

Combining these results with part a) of Proposition 1 leads to the conclusion that more economic integration may reshape the vertical structure of the public sector, with the central government spending less and local governments spending more also using more

[23] See Rodrik (1998) and Swank (2002).

transfers. Put in other words, the vertical structure of the public sector change and this occurs through a shifting of expenditures from central to local governments.

This finding, for example, may explain why a large number of empirical studies on the relation between economic openness and the size of the public sector show apparently contradictory results (either a positive or a negative relationship) mostly depending on which definition of public sector is used, in particular whether the size of the government is measured by considering only the central government or by including also local governments.

**Proposition 3**

$$\alpha > \alpha_b \Rightarrow \frac{\partial b^*}{\partial \omega} < 0$$

**Proof**: It follows from Corollary to Lemma 1 in Appendix and from Lemma 2.

Proposition 3 makes the point that for values of $\alpha$ above the threshold, the central government unambiguously reduces transfers. However, in this case, either $\frac{\partial g_i^*}{\partial \omega} > 0$ or $\frac{\partial g_i^*}{\partial \omega} < 0$. Given the local budget constraint, when $\frac{\partial g_i^*}{\partial \omega} > 0$, local taxation must increase, as local expenditures increase but transfers are reduced. Technically, there is no shifting of resources from central to local governments, yet the increase of the size of local governments is still an admissible outcome, which means that the vertical structure of the public sector is again changed.

In the second case, $\frac{\partial g_i^*}{\partial \omega} < 0$, from (15) we know that local public expenditures must decrease less than transfers[24], which means that local taxation again increases. Note, however, that for given $\alpha$ and $\gamma$, the higher is the consideration of central expenditures by part of local governments within the observed range (i.e. when $\beta \to \frac{1}{2}$), the more likely is that $\alpha < \alpha_b$. This is perfectly plausible, as a higher $\beta$ means that the reduction of central expenditures (which have benefits from local governments' points of view) must be compensated by additional grants and local expenditures in response to economic openness.

Conclusions are less straightforward when $\beta > 1/2$. This makes $\alpha_\Omega < 1$, which in turn makes possible either of the following: $\alpha > \alpha_\Omega$ and $\alpha < \alpha_\Omega$. In this context, the former case implies $\Omega > 0$, which leads to the same conclusions as in the case of $\beta < 1/2$. Instead, when $\alpha < \alpha_\Omega$ (i.e. $\Omega < 0$), that in this case only allows $\alpha < \alpha_b$, the following Proposition holds:

[24] Recall that in the case under discussion, $\Omega > 0$.

**Proposition 4**

a) $\Omega < 0 \Rightarrow \frac{\partial b^*}{\partial \omega} < 0$;

b) $\Omega < 0 \Rightarrow \frac{\partial g_i^*}{\partial \omega} < 0$

**Proof**: See Appendix.

Again, combining Proposition 4 with Proposition 1, it is worth observing that while the *central* government size increases there is no assurance that the same outcome will hold for the size of the *general* government, as both transfers and local expenditures would decrease. When $\beta$ is large, an increase of central government "replaces" analogous efforts by part of local governments. This implies that there is less need to grant resources to local governments and less need, for local governments, to provide autonomous public spending.
This finding casts serious doubts on the theoretical power of the compensation hypothesis and open the question of what happens once the size of the *total* government is considered in our model.

4.3. *The effects of economic openness on the size of the general government*

The aim of this paragraph is to verify whether the previous results may lead to some conclusions on the size of the *general* government (central + local). To this purpose, it is worth defining $G = g + g_1 + g_2$, where *G* represents total public expenditures. The effect of the economic integration is easily calculated by:

$$\frac{\partial G}{\partial \omega} = \frac{\partial g^*}{\partial w} + \frac{\partial g_1^*}{\partial w} + \frac{\partial g_2^*}{\partial w} = \frac{(1-\alpha)\gamma(2\beta-1) - \alpha(1-\gamma)}{\Omega} \qquad (18)$$

Once again it is worth distinguishing two cases according to the level of $\beta$. When $\beta < \frac{1}{2}$, it is already known that $\Omega > 0$, as it always holds that $\alpha < \alpha_\Omega$. But it is also straightforward to see that, in this case, the numerator of (18) is negative. This unambiguously leads to $\frac{\partial G}{\partial \omega} < 0$. In other words, when the degree of substitutability between central and local expenditures (as observed by local governments) is relatively low, the aggregate size of the public sector decreases. This implies that the unambiguous reduction of central expenditures (associated to this case) always outperforms the possible increase of local expenditures, which is also a possible outcome. Under this perspective, our model predicts that when local governments "cares" more for their own public spending (a low $\beta$), the compensation hypothesis would hardly be verified at the level of *general* government.

When $\beta > \frac{1}{2}$, instead, the signs of both the numerator and the denominator of (18) are ambiguous. In particular, the sign of $\Omega$ depends on the threshold $\alpha_\Omega$. To study the sign of the numerator of (18), it is worth defining the following threshold:

$$\alpha_G = \frac{\gamma(2\beta - 1)}{1 - 2\gamma(1-\beta)} \tag{19}$$

One can show that it always holds that $\alpha_\Omega < \alpha_G$. It means that the following three cases can occur:

a) $\alpha < \alpha_\Omega < \alpha_G$. In this case, $num\left(\frac{\partial G}{\partial \omega}\right) > 0$, while $\Omega < 0$. This implies $\frac{\partial G}{\partial \omega} < 0$, as a result of $\frac{\partial g^*}{\partial \omega} > 0$ and $\frac{\partial g_i^*}{\partial \omega} < 0$. Again, an increase of central spending makes local spending less necessary, when $\beta$ is large;

b) $\alpha_\Omega < \alpha < \alpha_G$. In this case, $num\left(\frac{\partial G}{\partial \omega}\right) > 0$ and $\Omega > 0$. It implies $\frac{\partial G}{\partial \omega} > 0$. As already observed, this case directly implies $\frac{\partial g^*}{\partial \omega} < 0$. Furthermore, as in this area $\alpha < \alpha_b$, we have that $\frac{\partial g_i^*}{\partial \omega} > 0$ and $\frac{\partial b}{\partial \omega} > 0$. This is in fact the only case in which our model predicts an increase of general government expenditures;

c) $\alpha_\Omega < \alpha_G < \alpha$. This implies $num\left(\frac{\partial G}{\partial \omega}\right) < 0$ and $\Omega > 0$, which means that $\frac{\partial G}{\partial \omega} < 0$. Again, this case directly implies $\frac{\partial g^*}{\partial \omega} < 0$. But since in this case either $\alpha < \alpha_b$ or $\alpha > \alpha_b$, the effect on local expenditures is ambiguous. As a result, it may either further boost the reduction of total expenditure or mitigate it without affecting the sign of the total effect.

Note, however, that the following Lemma always holds:

**Lemma 3**

If $\beta > \frac{1}{2}$ then $\frac{\partial g_L^*}{\partial \omega} < 0 \Rightarrow \frac{\partial G^*}{\partial \omega} < 0$.

**Proof**: See Appendix.

This Lemma assures that whenever local spending decreases, aggregate expenditures would also decrease. It is again worth noting that the challenge to the *compensation hypothesis* is now even stronger than before, as the possibility that the general government expenditures increase is only a minor case in probabilistic terms. This is even more truer when the model is generalised to *n* Regions, as in this case $\beta > \frac{1}{n}$ is required

in Lemma 3, i.e. a low thresholds of $\beta$ is sufficient to guarantee a decrease in total public spending.[25] Again, it would seem that more decentralised governments would react to economic openness by reducing the *total* size of the public sector.

Note again that this result, in our model, is the outcome of introducing a cross-consideration of central and local spending by part of local and central authorities, respectively.

### 4.4. *The effects of economic openness on the degree of government decentralization*

In order to make a synthesis of the effects so far investigated, it is worth analysing the effects of economic openness on a single indicator. The most natural choice, in this context, is the degree of government decentralization – measured by the ratio between local expenditures and total expenditures (central + local). This allows to capture the basic point of our paper (whether economic openness affects the degree of decentralisation) by collapsing all previous by-products in one indicator.

To this purpose, define $D = \frac{g_L}{G}$ as the degree of decentralization. It is worth noting the difference between the information provided by *D* and that provided by the parameter $\beta$. As already observed, this latter represents the degree of substitutability between central and local expenditures from the point of view of local authorities. While $\beta$, in our interpretation, is mainly affected by institutional relationships between central and local governments, *D* can instead be affected by relatively more contingent factors, as the degree of economic openness of the economy.

The following proposition holds.

**Proposition 5.**

The sign of $\frac{\partial D}{\partial \omega} = \frac{1}{\left(G^*\right)^2}\left(\frac{\partial g_L^*}{\partial \omega} G^* - \frac{\partial G^*}{\partial \omega} g_L^*\right)$ will be:

a) positive if:
   a1) $\beta < \frac{1}{2}$ ;
   a2) $\beta > \frac{1}{2}$ *and* $\alpha > \alpha_\Omega$.
b) negative only if $\beta > \frac{1}{2}$ *and* $\alpha < \alpha_\Omega$.

**Proof:** See the Appendix.

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[25] To get the point, just consider what happens to the threshold $\alpha_\Omega$ when $\beta = 0$. In this particular case, $\alpha_\Omega = \frac{1}{\gamma} > 1 \Rightarrow \alpha < \alpha_\Omega$ always. This also implies that case a) holds, and a reduction of aggregate expenditures would prevail.

Proposition 5 gives evidence that when an economy is characterized by a higher degree of economic openness, then its government will exhibit a higher degree of decentralization for a large subset of the parameters feasible set. Note however, that when the number of local governments is large, condition a1) is verified mostly in the case in which local governments are their own-budget maximiser. For a large range of values of $\beta$, instead, both outcomes are possible, clarifying once again that the impact of economic openness strongly depends on the institutional context in which central and local governments operate.

For example, *ceteris paribus*, a country with a large number of local governments that have strong benefits from central government spending ( $\beta \to 1$ ) would tend to reduce their degree of decentralization (case b)). This is obviously plausible, as with a large $\beta$, there is less need of local expenditures in the objective function of the local governments. The converse is true when $\beta$ is low (but still greater than $1/n$). This would make the case a2) more likely, which means that the degree of decentralization would increase.

We think that this is an important result, as it may contribute to those theories viewing fiscal federalism as a possible outcome of a given institutional framework. Our hypothesis is that once the institutional framework is perturbed by an exogenous factor (i.e. economic openness), the vertical structure of the public sector might change in favour of decentralisation if local governments are mostly interested in their own spending (recall that central government is also interested in its own public expenditures by assumption, $\theta = 0$).

## 5. Conclusions

It is now worth summarising the main insights of the paper. We could perform this task with the help of Table 1, where all possible outcomes of our model are reported. Following the line of reasoning already used in the text, Table 1 is divided in two panels. The top panel reports the outcome for $\beta < \frac{1}{2}$; while the bottom panel those for $\beta > \frac{1}{2}$. The various relationships among thresholds are also introduced.

Some "almost general" findings occur:

a) the degree of decentralisation *D* always increases but in one case (column 1). As already discussed, this exception is not very likely in the context of our parameters. The "almost" general conclusion of our paper is therefore that an increase of economic openness leads to a change of the vertical structure of the public sector in favour of more decentralisation;
b) the total amount of public expenditures *G* (central + local) always decreases but in one case (column 2). While there are no reason to consider this case as "high unlikely", again the "almost general" conclusion is that the size of the total public expenditures, as measured by public expenditures, seem to be negatively related to economic openness;
c) the level of local taxation also always increases but in the "high unlikely" case of point a) (column 3). This also supports the common observation that the role of local taxation has increased over time in many advanced and also less-advanced countries and that local governments have increasingly relied on their own resources to provide local public goods and services;
d) central public expenditures always decrease but in the "high unlikely case" of point a) (column 4). This point is rather important if assessed in view of the on-going debate on the effects of globalisation on public finance. In particular, our finding would weak the relevance of the "compensation hypothesis", at least when the validity of this compensation is measured against the level of central expenditures. In fact, our model does not leave much space to the "compensation hypothesis", if one considers the findings discussed in point b);
e) quite interestingly, these "almost general conclusions" stem from a more variable behaviour of both local expenditures and transfers (columns 5 and 6). When they both increase, a result of our paper is that local expenditures increase more than transfers (the bandwagon effect). When they both decrease, local public expenditures decrease less than transfers (which may be thought of as a bandwagon effect on the opposite side). This result gives account of the common idea that more transfers may facilitate the growth of local public expenditures, while less transfers do no act in a symmetric way, in the sense that local public expenditures reduce to a less extent.

We think that these results may open the way to further investigation of how economic integration may impact on the vertical structure of the public sectors as a whole, rather than considering either the tax side or the expenditure side in isolation.

**Table 1 – The effects of an increase in economic openness**

| | | | **1** | **2** | **3** | **4** | **5** | **6** |
|---|---|---|---|---|---|---|---|---|
| $\beta < \frac{1}{2}$ | | | $\frac{\partial D}{\partial w}$ | $\frac{\partial G}{\partial w}$ | $\frac{\partial t_i}{\partial w}$ | $\frac{\partial g}{\partial w}$ | $\frac{\partial g_i}{\partial w}$ | $\frac{\partial b}{\partial w}$ |
| $\alpha < \alpha_\Omega$ $(\Omega > 0)$ | $\alpha < \alpha_G$ | $\alpha < \alpha_b$ | + | - | + | - | + | + |
| | | $\alpha > \alpha_b$ | + | - | + | - | - | - |
| | | | + | - | + | - | + | - |

| | | | **1** | **2** | **3** | **4** | **5** | **6** |
|---|---|---|---|---|---|---|---|---|
| $\beta > \frac{1}{2}$ | | | $\frac{\partial D}{\partial w}$ | $\frac{\partial G}{\partial w}$ | $\frac{\partial t_i}{\partial w}$ | $\frac{\partial g}{\partial w}$ | $\frac{\partial g_i}{\partial w}$ | $\frac{\partial b}{\partial w}$ |
| $\alpha > \alpha_\Omega$ $(\Omega > 0)$ | $\alpha < \alpha_G$ | $\alpha < \alpha_b$ | + | + | + | - | + | + |
| | $\alpha > \alpha_G$ | $\alpha < \alpha_b$ | + | - | + | - | + | + |
| | | $\alpha > \alpha_b$ | + | - | + | - | + | - |
| | | | + | - | + | - | - | - |
| $\alpha < \alpha_\Omega$ $(\Omega < 0)$ | $\alpha < \alpha_G$ | $\alpha < \alpha_b$ | - | - | - | + | - | - |

**APPENDIX**

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**Proof of Lemma 1**

*Proof of parts a) and b):*

$\Omega > 0 \Leftrightarrow 1-\alpha\gamma > 2\cdot(1-\alpha)\cdot\beta\cdot\gamma \Leftrightarrow \alpha\cdot\gamma\cdot(1-2\cdot\beta) < 1-2\cdot\beta\cdot\gamma \Leftrightarrow \alpha > (<)\frac{1-2\cdot\beta\cdot\gamma}{\gamma\cdot(1-2\cdot\beta)}$ where the latter implication exploits the fact that $\beta > (<) 1/2 \Rightarrow (1-2\cdot\beta) < (>) 0$.

*Proof of part c):*

$\alpha_\Omega > 1 \Leftrightarrow \frac{1-2\cdot\beta\cdot\gamma}{\gamma\cdot(1-2\cdot\beta)} > 1 \underset{\beta<1/2}{\Leftrightarrow} (1-2\cdot\beta\cdot\gamma) > \gamma\cdot(1-2\cdot\beta) \Leftrightarrow 1 > \gamma.$

The latter inequality is always true by assumption.

**Corollary.**

$\beta < 1/2 \Rightarrow \Omega > 0.$

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**Proof of Lemma 2**

$2\cdot(1-\alpha)\cdot\beta\cdot\gamma - (1-\gamma) > 0 \Leftrightarrow 2\cdot\alpha\cdot\beta\cdot\gamma < 2\cdot\beta\cdot\gamma - (1-\gamma) \Leftrightarrow \alpha < 1 - \frac{1-\gamma}{2\cdot\beta\cdot\gamma} = \alpha_b.$

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**Proof of Proposition 4**

Note that it is sufficient to prove that when $\Omega < 0$ $num\left(\frac{\partial b^*}{\partial \omega}\right) > 0$ and $num\left(\frac{\partial g_i^*}{\partial \omega}\right) > 0$. Let us prove the proposition by contradiction, that is assume that $num\left(\frac{\partial b^*}{\partial \omega}\right) < 0$, $num\left(\frac{\partial g_i^*}{\partial \omega}\right) > 0$ and $\Omega < 0$.

Then, $\Omega < 0 \Rightarrow 2\cdot(1-\alpha)\cdot\beta\cdot\gamma > 1-\alpha\cdot\gamma > 1-\gamma > \alpha\cdot(1-\gamma)$.

Yet, $2\cdot(1-\alpha)\cdot\beta\cdot\gamma > 1-\gamma \Rightarrow num\left(\frac{\partial b^*}{\partial \omega}\right) > 0$ and

$$2\cdot(1-\alpha)\cdot\beta\cdot\gamma>\alpha\cdot(1-\gamma)\Rightarrow num\left(\frac{\partial g_i^*}{\partial\omega}\right)>0$$

that contradicts the initial assumption.

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**Proof of Lemma 3**

$$\frac{\partial g_L^*}{\partial\omega}=\frac{(1-\alpha)\cdot\gamma\cdot 2\cdot\beta-\alpha\cdot(1-\gamma)}{\Omega}$$
$$\frac{\partial G^*}{\partial\omega}=\frac{(1-\alpha)\cdot\gamma\cdot(2\cdot\beta-1)-\alpha\cdot(1-\gamma)}{\Omega}$$

Let us recall that $\frac{\partial g_L^*}{\partial\omega}$ is positive only if $\Omega>0$.

When $\Omega>0$, $\frac{\partial g_L^*}{\partial\omega}<0\Leftrightarrow\alpha\cdot(1-\gamma)>(1-\alpha)\cdot\gamma\cdot 2\beta>(1-\alpha)\cdot\gamma\cdot(2\beta-1)$ but $\alpha\cdot(1-\gamma)>(1-\alpha)\cdot\gamma\cdot(2\beta-1)\Rightarrow\frac{\partial G^*}{\partial\omega}<0$.

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**Proof of Proposition 5.**

a1) $\beta<\frac{1}{2}\Rightarrow\frac{\partial G^*}{\partial\omega}<0$. Here we have to distinguish the case where $\alpha<\alpha_b$ from the one where $\alpha>\alpha_b$. In the former case the proof is straightforward looking at the expression of $\frac{\partial D}{\partial\omega}$ since $\frac{\partial g_L^*}{\partial\omega}>0$. When $\alpha>\alpha_b$ the proof is in Lemma 4.

a2) Here the only controversial case is when $\alpha>\alpha_\Omega,\alpha>\alpha_b,\frac{\partial g_L^*}{\partial\omega}<0$. In this case the proof is again in Lemma 4. In the other cases $\frac{\partial G^*}{\partial\omega}$ and $\frac{\partial g_L^*}{\partial\omega}$ have opposite sign, so that the proof is straightforward looking at the expression of $\frac{\partial D}{\partial\omega}$.

b) see Lemma 5.

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**Lemma 4.**

If $\Omega > 0, \frac{\partial g_L^*}{\partial \omega} < 0$ *and* $\frac{\partial G^*}{\partial \omega} < 0$ we have that $\left|\frac{\partial g_L^*}{\partial \omega}\right| < \left|\frac{\partial G^*}{\partial \omega}\right|$, that is $\frac{\partial D^*}{\partial \omega} > 0$.

**Proof of Lemma 4.**

The denominators of $\frac{\partial g_L^*}{\partial \omega}$ *and* $\frac{\partial G^*}{\partial \omega}$ are the same. Therefore, proposition 2 holds if $\alpha \cdot (1-\gamma) - 2 \cdot (1-\alpha) \cdot \beta \cdot \gamma < \alpha \cdot (1-\gamma) - 2(1-\alpha) \cdot \gamma \cdot (2\beta - 1)$ that turns out to be $2 \cdot (1-\alpha) \cdot \gamma > 0$ that is always true by assumption.

---

**Lemma 5.**

If $\Omega < 0, \frac{\partial g_L^*}{\partial \omega} < 0$ *and* $\frac{\partial G^*}{\partial \omega} < 0$ we have that $\left|\frac{\partial g_L^*}{\partial \omega}\right| < \left|\frac{\partial G^*}{\partial \omega}\right|$, that is $\frac{\partial D^*}{\partial \omega} < 0$.

**Proof of Lemma 5.**

When $\Omega < 0$. Proposition 4 holds only if

$2(1-\alpha) \cdot \gamma \cdot (2\beta - 1) - \alpha \cdot (1-\gamma) < 2 \cdot (1-\alpha) \cdot \beta \cdot \gamma - \alpha \cdot (1-\gamma)$ that turns out to be $-(1-\alpha) \cdot \gamma < 0$. The latter expression is always true by assumption.

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