Rethinking the Decentralization of Transportation Policy

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Abstract

Inter-regional spillovers of local public goods is the main reason of decentralization failure. Under the assumption that the quality of transportation policy affects the strength of inter-regional spillovers, we compares a static decentralization institutional design, where all policies are chosen simultaneously, with a dynamic decentralization institutional design, where the transportation infrastructure is a priority in the political agenda. We find that the decentralization failure is partially solved in the dynamic decentralization institutional design. In particular, when the transportation infrastructure becomes a priority, citizens obtain the same level of public good benefit of a static decentralization policy but with lower taxes. Finally, dynamic decentralized system yields to a lower quality of transportation infrastructure and a higher intensity of local public goods.

JEL classification: H70, H41, R42, R48, D62.

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1 Introduction

Regional economic literature has amply discussed the link between the quality of transportation infrastructure and welfare (Krugman, 1991; Fujita et al., 1999). With different shades of opinion, scholars have theoretically and empirically demonstrated that the quality of transportation infrastructure has a positive impact on both inter-regional trade and regional growth (Martin and Rogers, 1995; Martin and Ottaviano, 1999). Less attention has been posed on the impact of transportation infrastructure on inter-regional spillovers, especially with reference to the spillovers coming from the provision of local public goods.

Since the intensity of local public goods and the quality of transportation infrastructure are affected by government decisions, it seems us relevant to study both policies in the same framework and within the current debate on decentralization. A milestone of literature on public economics is that the decentralization policy is optimal only in the absence of inter-regional spillovers (Oates, 1972; Besley and Coate, 2003). The reason of this decentralization failure is that regional governments consider only the local effects of a policy internal at their own region. Therefore, the size of the decentralization failure could be affected from the institutional design (Alderighi and Feder, 2014; Brueckner, 2009; De Borger and Proost, 2015). In this paper, we principally compare two designs of institutional scheduling: the static decentralization and the dynamic decentralization. The former is a one-step decisional design where both the quality of transportation infrastructure and the intensity of the local public goods are chosen simultaneously. The latter is a two-step decisional design where in the first step the quality of transportation infrastructure is chosen and in the second step the intensity of the local public good is chosen.

The main result of this paper is that when there are positive spillovers the dynamic decentralization solves partially the decentralization failure. In the static decentralization, a more efficient transport infrastructure yields larger costs but it favors citizens to access local public goods on the other region. In addition to this, in the dynamic decentralization, a more efficient transport infrastructure also reduces the negative effects due to the decentralization failure. Thus, the regional governments choose a more efficient quality of transportation infrastructure if the transportation policy becomes a priority in the political agenda. However, this is a second-best solution because the governments do not internalize the inter-regional spillovers.

We find that with a two-step decisional design, citizens obtain the same level of public good benefit of a one-step decisional design, i.e. the public component of welfare is unchanged, but with lower taxes, i.e. the private component of welfare is higher. Furthermore, also if the regional governments do not internalize the positive spillovers could be happen that there is an overproduction (and not an underproduction) of local public goods. Actually, for a given strength of inter-regional spillovers, a positive externality ensures the underproduction of local public goods; and a lower strength of inter-regional spillovers increases the production of local public goods. Since the strength of inter-regional spillovers is affected from the institutional design. It may occur that in the decentralization institutional design the government reduces the strength of inter-regional spillovers and that this increases the production of local public goods more than in the first-best case.

This paper adds to the branch of literature on transportation infrastructure and decentralization (for a survey of the literature, see De Borger and Proost, 2012a; 2012b). However, scholars focus on the transportation infrastructure particularly because it has some specific features and, among others, it has some kinds of spillovers (e.g. traffic congestion and smog) that are different in nature from each other good (Bjørner, 1996; Brueckner, 2013; Van Der Loo and Proost, 2013; Russo, 2013; Ferguson, 2015; De Borger and Proost, 2016).[1] In this paper, we go a step further by the transportation infrastructure has not only some inter-regional spillovers, exactly like each public good, but that it could affect the inter-regional spillovers of the other public

[1] Other papers analyze the relationship between transportation and private goods and, in particular, for the trade of goods between regions (Bond, 2006; Mun and Nakagawa, 2010) or for the tourism (Levinson, 2000).

goods. In other words, while in this literature the transportation policies affect their spillovers, in this paper the transportation policies affect other spillovers.

Moreover, this paper has also some implications on the centralization and decentralization debate. Indeed, we show that an important decentralization failure (the local public good externality) is considerably decreased if the transportation infrastructure becomes a priority in the political agenda. However, this reduce but not delete the centralization advantages. Indeed, there are a lot of papers that completely solve this decentralization failure or using a bargaining process (Ostrom, 1990; Westin et al., 2012) or for some sets of public goods (Ogawa and Wildasin, 2009; Brueckner, 2013; Feder and Kataishi, 2015).

The plan of the paper is as follows. Section 2 develops the model and derives the public-sector decisions for different decentralized institutional designs. Section 3 shows the main efficiency results and offers an example of policy mix. Section 4 concludes.

2 The model

We consider a country formed by two identical regions, $i = 1,2$, where regional governments define both the intensity of the local public goods (one in each region) and the quality of transportation infrastructure (between the regions). Let $g_i > 0$ be the intensity of the local public good in region i; $t_i > 0$ be the quality of inter-regional transportation infrastructure in region i; and $S \in (0,1)$ be the strength of a positive inter-regional spillovers of the local public good.[2]

We assume that a local public good in i has two sets of potential users: the citizens that live in region i, that get a full benefit of the local public good in i, g_i; and the citizens that live in region j, where $j \neq i$, that get a partial benefit of the local public good in i, Sg_i. The amount of this partial benefit is measured with the strength of inter-regional spillovers and depends positively on the quality of transportation infrastructure, but in a decreasing way, i.e. $S(T)$ and $S'(T) > 0 > S''(T)$ where $T = t_1 + t_2$. Indeed, if there is a higher (lower) quality of transportation infrastructure, then the citizens in j obtain easily (hardly) the benefit of the local public good in i.

In each region, there is a continuum of citizens with total mass equal to 1. The utility function of the representative citizen in i is:

(1) $U_i(g,t) = u\big(g_i + S(T)g_j\big) + x_i,$

where $u(g,t) > 0$ is the utility of the representative citizen in i receives from the consumption of the public goods, $u'(g,t) > 0 > u''(g,t)$; and $x_i > 0$ is the utility of the representative citizen in i receives from the consumption of a bundle of private goods. Since the mass of citizens in i is 1, then (1) is also the welfare function i.

The public budget-balancing condition holds in both regions, and transfers between regions are not permitted:

$$\tau_i(g,t) = ag_i + bt_i,$$

where a and b are, respectively, the marginal cost of the local public good and of the transportation infrastructure. The citizen budget constraint i is:

$$x_i(g,t) = y - \tau_i(g,t),$$

[2] The results with a negative spillovers assumption straightforward. In particular, the decentralization failure disappears when the transportation policy becomes a priority.

where $\tau_i > 0$ is the non-distortionary regional tax; and $y > \tau_i$ is the regional income. For focusing on a new transportation trade-off, in this model the transportation cost of citizens is only in the taxation.

Finally, we assume that the governments are involved in the decisions concerning the provision of public goods, (g, t), to maximize the welfare. For simplicity, we assume that there are not self-interested governments. If during the decisional process, governments internalize the spillovers then there is the first-best policy mix, (g^B, t^B). However, typically the governments maximize only the welfare of the own regions (Oates, 1972; Besley and Coate, 2003; Lipscomb and Mobarak, 2016). We assume that there are two scheduling of the institutional designs: the one-step system, called static decentralization, where the government chooses simultaneously the policy mix, (g^S, t^S); and the two-step system, called dynamic decentralization, where in the first step the government decides the transportation infrastructure policy and then the local public good policy, (g^D, t^D).

2.1 Benchmark

We begin studying what happens when in each region the government fully internalizes the spillovers in its policies.[3] In other words, the regional government in i chooses the provision of public mix, (g, t), maximizing the whole welfare in the country. Therefore, the maximization problems for the regional government i is:

$$max_{g_i,t_i} u(g_1 + S(T)g_2) + u(g_2 + S(T)g_1) + 2y - a(g_1 + g_2) - bT.$$

Consequently, the FOCs for g_i and t_i are:

$$u'(g_i + S(T)g_j) + u'(g_j + S(T)g_i)S(T) \ = \ a;$$

$$u'(g_i + S(T)g_j)S'(T)g_j + u'(g_j + S(T)g_i)S'(T)g_i \ = \ b.$$

By symmetry, both the quality of transportation infrastructure and the intensity of the local public good are the same in both regions, i.e. $g_i = g_j = g$ and $t_i = t_j = t$. Therefore, the previous FOCs become:

$$(2) \quad u'\left(g\big(1 + S(2t)\big)\right)\big(1 + S(2t)\big) = \ a;$$

$$(3) \quad 2u'\left(g\big(1 + S(2t)\big)\right)S'(2t)g \ = \ b.$$

We can rewrite (2) as:

$$(4) \quad u'\left(g\big(1 + S(2t)\big)\right) = \frac{a}{1 + S(2t)};$$

and, putting (4) in (3), we have:

$$(5) \quad g = \frac{b}{a}\frac{1 + S(2t)}{2S'(2t)}.$$

Finally, using (4) and (5), we obtain the unique policies solution that solves the response functions of government, (g^B, t^B). By construction, this institutional design solves the decentralization failure and then it is the first-best policy mix. The following Proposition summarizes the results:

[3] In the literature, it is often assumed that this happens in a centralized government.

Proposition 1 *Assume that the government internalizes spillovers. In the decentralized system the unique policies solution* (g^B, t^B) *is given by:*

$$(6) \quad \begin{cases} u'\left(\dfrac{b}{a}\dfrac{\left(1+S(2t^B)\right)^2}{2S'(2t^B)}\right) = \dfrac{a}{1+S(2t^B)} \\ g^B = \dfrac{b}{a}\dfrac{1+S(2t^B)}{2S'(2t^B)} \end{cases};$$

and it is the first-best policy mix.

Assuming homogeneity of regions, the first-best solution emerges in the centralized institutional design. Using the (g^B, t^B) solution as benchmark, in Section 3 we will better compare the next two decentralized institutional designs: the static and the dynamic ones.

2.2 Static decentralization

Unfortunately, empirical evidence shows that regional governments do not maximize the whole welfare in the country but only the welfare in the own regions (Foremny et al., 2015; Lipscomb and Mobarak, 2016). Therefore, in the rest of the paper, we assume that the regional governments take decisions without internalize the inter-regional spillovers. In this sub-section, we measure the policy mix when regional government simultaneously chooses the quality of transportation infrastructure and the intensity of the local public goods. Then the maximization problem for the government in region i is:

$$max_{g_i,t_i} u\left(g_i + S(T)g_j\right) + y - ag_i - bt_i.$$

Consequently, the FOCs for g_i and t_i are:

$$(7) \quad u'\left(g_i + S(T)g_j\right) = a;$$

$$(8) \quad u'(g_i + S(T)g_j)S'(T)g_j = b.$$

By symmetry, $g_i = g_j = g$ and $t_i = t_j = t$; then, combining (7) and (8), we obtain:

$$(9) \quad g = \frac{b}{a}\frac{1}{S'(2t)};$$

and the following Proposition:

Proposition 2 *Assume that the government does not internalize spillovers. In the one-step decentralized system, where the government chooses simultaneously the policy mix, the unique policies solution* (g^S, t^S) *is given by:*

$$(10) \quad \begin{cases} u'\left(\dfrac{b}{a}\dfrac{1+S(2t^S)}{S'(2t^S)}\right) = a \\ g^S = \dfrac{b}{a}\dfrac{1}{S'(2t^S)} \end{cases};$$

and it is an inefficient policy mix.

Indeed, comparing (6) and (10), we observe that the policy mix (g^S, t^S) is inefficient because the regional government is unable to solve the decentralization failure. In particular, the intensity of the local public good has the standard underproduction problem from externality; and the quality of transportation infrastructure does not affect in an efficient way the intensity of the local public good.

2.3 Dynamic decentralization

Now we use the scheduling instrument for affecting positively the decentralization failure. In particular, we assume a two-step system in which, governments first choose the quality of infrastructure and then the local public good intensity. From backward induction, we start solving the following maximization problem:

$$max_{g_i} u\big(g_i + S(T)g_j\big) + y - ag_i - bt_i.$$

Therefore, the FOC is:

$$(11)\ u'\big(g_i + S(T)g_j\big) = a.$$

It is equal to (7). Indeed, also in this dynamic decentralization institutional design, the government does not internalize the spillovers when it chooses the intensity of the local public good. Using (7) and (11), we know that $u(g_i^D + S(T^D)g_j^D) = u(g_i^S + S(T^S)g_j^S)$. Thus, we observe that the scheduling institutional design does not affect the public component of welfare. In particular, both systems choose a lower level of public component of welfare than the first-best. In other words, when the government does not internalize the spillovers, for each decision on the quality of transportation infrastructure the decision on the intensity of the local public goods returns always the same level of the public component of welfare, $u\big(g_i + S(T)g_j\big)$, and this is true for both decentralized institutional designs. Like before, (7) differs from (2) because there are externalities of local public goods. This problem could be solved if the government internalizes the public benefit of the local public good of the other region, $u\big(g_j + S(T)g_i\big)$, in the decisional process.

By symmetry, $g_i = g_j = g$, then, from (11), we obtain $(1 + S(T))dg + gS'(T)dT = 0$. Therefore, we can conclude that:

$$(12)\ g'(T) = -\frac{gS'(T)}{1 + S(T)} < 0.$$

Like Besley and Coate (2003), we obtain a negative relationship between the intensity of local public good and strength of spillovers (and the quality of transportation infrastructure). Therefore, if the governments increase the quality of transportation infrastructure then, on the one hand, it increases the strength of spillovers and this affects positively the welfare; and, on the other hand, it decreases the intensity of the local public good and this affects negatively the welfare. Formally, the maximization problem is:

$$max_{t_i} u(g(T)(1 + S(T))) + y - ag(T) - bt_i.$$

Hence, the FOC is:

$$\frac{1}{2}u'\Big(g(T)\big(1 + S(T)\big)\Big)\Big(g'(T)\big(1 + S(T)\big) + g(T)S'(T)\Big) = ag'(T) + b.$$

By symmetry, $t_i = t_j = t$. Thus, from (12) previous equation becomes:

$$(13)\ g = \frac{b}{a}\frac{1 + S(2t)}{S'(2t)}.$$

Therefore, the differences between (9) and (13) are given by the better coordination of policies with the dynamic decentralization institutional design. In addition, comparing (9) with (13), the functional form of (13) is closer to the (5) one. Indeed, (13) differs from (5) only because there is a new externality problem that could be solved if the regional government internalizes the public cost of the local public good of the other region, ag_j, in the decisional process.

Putting (13) in (12), we obtain that $g'(T) = -b/a$. The same result derives choosing the quality of transportation infrastructure, t, that maximizes the private component of welfare, x. Indeed, $x_t(g,t) = -b - ag'(T) = 0$ if and only if $g'(T) = -b/a$ and $x_{tt}(g,t) = -ag''(T) < 0$.[4] Therefore, we can conclude that t^D maximizes x, i.e. $x(g^D, t^D) > x(g^S, t^S)$. In other words, when the transportation policy is a priority in the political agenda then the level of taxes is the lowest. Thus, from $u(g^D, t^D) = u(g^S, t^S)$ and $U(g,t) = u(g,t) + x(g,t)$, we obtain that (g^D, t^D) is the second-best solution, i.e. $U(g^D, t^D) > U(g^S, t^S)$. Intuitively, with this two-step design the regional government is unable to affect the level of the public component of welfare, u, because, independently of t^D, the regional government chooses the g^D such that u is fix. Thus, to maximize the overall welfare, U, the government chooses the highest level of the private component of welfare, x. The following Propositions summarize the results:

Proposition 3 *Assume that the government does not internalize spillovers. In the two-step decentralized system, where the transportation infrastructure is a priority in the political agenda, the unique policies solution (g^D, t^D) is given by:*

$$(14) \begin{cases} u'\left(\dfrac{b}{a}\dfrac{\left(1+S(2t^D)\right)^2}{S'(2t^D)}\right) = a \\ g^D = \dfrac{b}{a}\dfrac{1+S(2t^D)}{S'(2t^D)} \end{cases};$$

and it is the second-best policy mix.

Proposition 4 *In the two-step decentralized system the decentralization failure is partially solves. Indeed, when the transportation infrastructure is a priority in the political agenda, the policy mix affects in the same way the public component of welfare but it uses a lower level of taxation.*

Intuitively, with the two-step design, the local governments choose, independently of t, a level of u; then the only possible previous strategy is to minimize the taxes. Finally, note that the political scheduling potentially could delete the externality problem. Indeed, if the government chooses a level of transportation t such that $S(T) = 0$ the spillovers disappear. However, this is probably not the optimal policy because it deletes the positive indirect effect that the local public good has on the other region.

Comparing (6), (10) and (14), we can conclude that also the dynamic decentralization institutional design is inefficient, but it partially solves the decentralization failure using a better coordination of transportation infrastructure and local public good policies. In particular, we observe that there are two different faces of the decentralization failure. On the one hand, it affects the intensity of the local public goods and could be solved internalizing the public benefit of the local public good of j in the decisional process. On the other hand, it affects the strength of spillovers (using the quality of transportation infrastructure) and could be solved internalizing the public cost of the local public good of j in the decisional process. Therefore, we obtain the following Lemma:

Lemma 5 *Assume that the regional government chooses the quality of the transportation infrastructure in a region internalizing the public cost of the local public good of the other region and it chooses the intensity of local public good internalizing the public benefit of the local public good of the other region. In the two-step decentralized system the policy mix is also the first-best solution (g^B, t^B).*

[4] From (12), we also know that $g''(T) = -gS''(T)/(1 + S(T)) > 0$.

3 Welfare comparisons

Using the benchmark solution (g^B, t^B), we can analyze how the government scheduling affects the policies and the welfare in the decentralized system. We start studying the transportation good, t. From the first equation in the systems (6) and (14), we have that $u'(g^B, t^B) < u'(g^D, t^D)$; and using $u''(g,t) < 0$, we obtain:

$$\frac{b}{a}\frac{\left(1+S(2t^B)\right)^2}{S'(2t^B)} > \frac{b}{a}\frac{\left(1+S(2t^B)\right)^2}{2S'(2t^B)} > \frac{b}{a}\frac{\left(1+S(2t^D)\right)^2}{S'(2t^D)}.$$

Therefore, from $S'(T) > 0 > S''(T)$, we can conclude that $t^D < t^B$. Similarly, comparing the first equation in the system (10) with the (14) one, we know that $u'(g^D, t^D) = u'(g^S, t^S)$ and using $S(T) > 0$, we have:

$$\frac{b}{a}\frac{1+S(2t^S)}{S'(2t^S)} > \frac{b}{a}\frac{\left(1+S(2t^D)\right)^2}{S'(2t^D)} > \frac{b}{a}\frac{1+S(2t^D)}{S'(2t^D)}.$$

Reusing $S'(T) > 0 > S''(T)$, we can also conclude that $t^D < t^S$. Unfortunately, we are not able to conclude anything on the t^S and t^B relationship. Therefore, we have two possible outcomes: either $t^D < t^B < t^S$ or $t^D < t^S < t^B$; and we have the following Proposition:

Proposition 6 *The two-step decentralized system has the lowest quality of transportation infrastructure.*

A positive externality implies underproduction of local public goods, and remembering that, on the one hand, the policy mix (g^B, t^B) solves this decentralization failure and that, on the other hand, the policy mix (g^D, t^D) partially solves the decentralization failure, we would be conclude that $g^S < g^D < g^B$. Furthermore, t^D is lower than t^B and t^S could be lower than t^B then we are not able to conclude anything both on the g^D and g^B relationship and on the g^S and g^B relationship. Nevertheless, by Proposition 4, that $u'(g^D, t^D) = u'(g^S, t^S)$; then Proposition 6 implies that $g^S < g^D$. Indeed, in the two-step decentralized system the decentralization failure is partially solved. Therefore, we have three possible outcomes: $g^S < g^B < g^D$, $g^S < g^D < g^B$, or $g^B < g^S < g^D$. The following Propositions summarize the results:

Proposition 7 *Also if the government does not internalize the positive spillovers it may occur that there is an overproduction of local public goods. However, the one-step decentralized system has a lower intensity of local public goods than the two-step decentralized system.*

In the previous section, we observed that $U(g^B,t^B) > U(g^D,t^D) > U(g^S,t^S)$; $x(g^D,t^D) > x(g^S,t^S)$ and $u(g^D,t^D) = u(g^S,t^S)$. Now, we complete the analysis to understand how the scheduling of the institutional designs affects each component of welfare. Knowing that t^D maximizes the private component of welfare, we can conclude that $x(g^D,t^D) > x(g^B,t^B)$ and to obtain $U(g^B,t^B) > U(g^D,t^D)$, then $u(g^S,t^S) = u(g^D,t^D) < u(g^B,t^B)$. However, from $t^S \lesseqgtr t^B$, we cannot conclude anything on the $x(g^B,t^B)$ and $u(g^S,t^S)$ relationship. The following Proposition summarizes the results:

Proposition 8 *The first-best solution does not only have the highest level of welfare but also the highest level of the public component of welfare.*

Hence, we can obtain the following Lemma:

Lemma 9 *Assuming that $U(g,t) = u(g,t) + x(g,t)$, where $u(g,t) = u(g_i + S(T)g_j)$ and $x(g,t) = y - t_i - bg_i$. Then:*

- $|u(g^B,t^B) - u(g^S,t^S)| = |u(g^B,t^B) - u(g^D,t^D)|$;
- $|x(g^B,t^B) - x(g^S,t^S)| \lesseqgtr |x(g^B,t^B) - x(g^D,t^D)|$;
- $|U(g^B,t^B) - U(g^S,t^S)| < |U(g^B,t^B) - U(g^D,t^D)|$.

We can conclude that (g^S, t^S) and (g^D, t^D) induce the same level of public component of utility function, $u(g, t)$; and that (g^D, t^D) is always more efficient than (g^S, t^S), also when $x(g^S, t^S)$ is closer to $x(g^B, t^B)$ than to $x(g^D, t^D)$. This is particularly interesting because the utility function is a sum of these two components, $U(g, t) = u(g, t) + x(g, t)$. The result derives from the fact that in $u(g, t)$ and in $x(g, t)$ the two different policies g and t interact in a negative and complex way. In the next sub-section, we show a simple example where this happen.

3.1 Example

Without a specific functional form of $u(g, t)$ the comparison between the different decentralized institutional designs is incomplete. In particular, it is impossible fully compare the quality of transportation infrastructure, the intensity of local public goods and the private component of welfare. In this section, we will assume that $u(g, t)$ is a logarithmic function, to better understand how the scheduling process affects the policies. Then, the utility function is:

$$U_i(g, t) = ln(g_i + S(T)g_j) + x_i.$$

In this case $u'(g_i + S(T)g_j) = 1/(g_i + S(T)g_j)$ then, after some calculations, the systems (6), (10) and (14) become:

$$(15)\ \begin{cases} \dfrac{S'(2t^B)}{b(1 + S(2t^B))} = \dfrac{1}{2} \\ g^B = \dfrac{1}{a} \end{cases};$$

$$(16)\ \begin{cases} \dfrac{S'(2t^S)}{b(1 + S(2t^S))} = 1 \\ g^S = \dfrac{1}{a(1 + S(2t^S))} \end{cases};$$

$$\begin{cases} \dfrac{S'(2t^D)}{b(1 + S(2t^D))^2} = 1 \\ g^D = \dfrac{1}{a(1 + S(2t^D))} \end{cases}.$$

Remembering that $S'(T) > 0 > S''(T)$ then, by the first equation in (15) and (16), we obtain that $t^S < t^B$; and by Proposition 6, we know that t^D is always the lower quality of transportation infrastructure. In addition, from $S(T) > 0$, we know that $g^D < g^B$ and $g^S < g^B$; and by Proposition 7, we know that $g^S < g^D$ is always the lower intensity of local public goods. Therefore, we know that in the one-step institutional design the quality of transportation infrastructure is closer to the optimal level, $t^D < t^S < t^B$; but this affects positively the intensity of local public goods, $g^S < g^D < g^B$. Finally, observing that $x(g^B, t^B)$ and that t^B and g^B are the higher levels of the public goods, then $x(g^B, t^B)$ is the lowest level of the private component of welfare; and by Proposition 4, we know that $x(g^D, t^D)$ is always the highest level of the private component of welfare. Therefore, we can conclude that $x(g^B, t^B) < x(g^S, t^S) < x(g^D, t^D)$. By Proposition 8 and the previous discussion, we can write the following Proposition:

Proposition 10 *Assuming* $U(g,t) = u(g,t) + x(g,t)$*, where* $u(g,t) = ln(g_i + S(T)g_j)$ *and* $x(g,t) = y - at_i - bg_i$*. Then:*

- $t^D < t^S < t^B$;
- $g^S < g^D < g^B$;
- $u(g^S, t^S) = u(g^D, t^D) < u(g^B, t^B)$;
- $x(g^B, t^B) < x(g^S, t^S) < x(g^D, t^D)$;
- $U(g^S, t^S) = U(g^D, t^D) < U(g^B, t^B)$.

The Proposition 10 shows that when there is interaction between policies, the only way to study the efficiency is the global one. Indeed, in this example also if the quality of transportation infrastructure is closer to the first-best quality with the static decentralization system that than the dynamic decentralization system, then it is farther to the first-best welfare than with the dynamic decentralization system. Then, the following Lemma is the special case of Lemma 9 when the public component of welfare has a logarithmic form:

Lemma 11 *Assuming that* $U(g,t) = u(g,t) + x(g,t)$*, where* $u(g,t) = ln(g_i + S(T)g_j)$ *and* $x(g,t) = y - at_i - bg_i$*. Then:*

- $|u(g^B, t^B) - u(g^S, t^S)| = |u(g^B, t^B) - u(g^D, t^D)|$;
- $|x(g^B, t^B) - x(g^S, t^S)| > |x(g^B, t^B) - x(g^D, t^D)|$;
- $|U(g^B, t^B) - U(g^S, t^S)| < |U(g^B, t^B) - U(g^D, t^D)|$.

4 Conclusion

This paper shows, along with the literature on the "vote with their feet" started by Tiebout (1956), how the study of the inter-regional transportation infrastructure is a pivotal theme of the debate on decentralization. Indeed, a key assumption of this paper is that the strength of spillovers is endogenously affected by transportation policy.

Using this idea, we find a partial solution of the decentralization failure that derives from the not internalization of inter-regional spillovers in regional governments' decisions. Indeed, we find that when the transportation infrastructure is a priority in the political agenda it is possible to choose the most efficient policy mix in a decentralized framework. This argument considerably reduces the advantages of a centralized framework.

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