# OPTIMAL RISK ALLOCATION IN THE PROVISION OF LOCAL PUBLIC SERVICES: CAN A PRIVATE INSURER BE BETTER THAN A PUBLIC MUTUAL FUND?

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Fiscal Federalism

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ABSTRACT: In this paper we consider the institutional arrangements needed in a decentralised framework to cope with the potential adverse welfare effects caused by localized negative shocks, that impact on the provision of public services and that can be limited by precautionary investments. We model the role of a public mutual fund to cover these "collective risks". We first study the under-investment problem stemming from the moral hazard of Local administrations, when investments are defined at the local level and are not observable by the Central government that manages the mutual fund. We then examine the potential role of private insurers in solving the under-investment problem. Our analysis shows that the public fund is almost always superior to the private insurance solution.

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## 1. Introduction

In many countries, whether they have or not a federal structure, most public services (e.g., schooling, health care, public safety) are provided and managed at the local level, while they are financed – at least partly – with funds from the centre. The reason for Central government funding is usually recognised in the need of "equalising" the provision of such services across the country, since most of these represent constitutional basic rights for citizens. However, the provision of local public services can be affected by a number of different risks, which result in a potentially unequal level of provision[1]. For instance, natural disasters or terrorist attacks can destroy public schools or hospitals; organizational inefficiencies or even human mistakes by public employees can generate adverse welfare shocks that heavily impact on both the level and the quality of services.

Indeed, in all the previous examples - which we classify as *collective risks borne by local communities* - two questions are put at the forefront of the public discussion whenever an unfortunate event occurs: what can public administrations do to alleviate the adverse welfare effects on communities hit by negative shocks? What should have been done in order to avoid the occurrence of these negative shocks? As for the first question, depending on the level of damage, a transfer policy aimed at providing initial help and at least a partial reimbursement by the central government of the adverse effects of the shocks is usually called for. This expresses a common claim for solidarity toward those communities who suffered welfare losses in the provision of local services, which are sometimes coupled with welfare losses at the individual level[2]. As for the second question, much of the damage (or some of its consequences at least) can be avoided by *investing in mitigation*[3]. In the case of floods, for instance, dams and barriers can be built to reduce the likelihood of losses occurring, or the severity of damage; in the case of clinical errors, better organized work shifts can be of great help.

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[1] Lockwood (1999) considers stochastic shocks affecting income disparities across local administrations, as well as the cost of producing a pure public good or the demand for the public good. We depart from this literature by focusing here on collective risks affecting the ability of local administrations to provide local services and – more importantly – by studying the potential role of private insurers in coping with these kind of risks.

[2] For instance, in the case of a natural disaster, the destruction of a school or a hospital will be almost always coupled with the destruction of private houses.

[3] As reported by Linnerooth-Bayer and Mechler (2008, p. 5), "*in many contexts every Euro invested in risk prevention returns roughly 2 to 4 Euros in terms of avoided or reduced disaster impacts on life, property, economy and environment*".

However, the economic literature has almost neglected two features common to all these situations. First, the ex-post transfer is implemented by the Central government, which assigns financial resources to local administrations (municipalities, regions, hospitals, etc.). In this case, as shown by the vast amount of literature on fiscal federalism, a potential problem of opportunistic behaviour by local levels of government can emerge. But looking at our context, the possibility that the ex-post transfer can influence the ex-ante precautionary investment has been investigated only by Goodspeed and Haughwout (2007) and Wildasin (2008).

Second, despite the possibility for public administrations to design intra-national risk-sharing arrangements in order to alleviate localized economic negative shocks[4], local administrations often buy coverage on private insurance markets, transferring risks to private companies. Examples include coverage for a variety of risks, from damage to public infrastructures to liability insurance for public administrations[5].

To the best of our knowledge, why a public administration should insure itself is a very intriguing question, that has never been addressed before. Indeed, as it has been suggested by the literature on public bankruptcies (see, e.g., McConnell and Picker, 1993), the imposition of new taxes, at least in principle, is in fact a remedy for coping with welfare losses that no private insurer can duplicate, and thus makes private insurance a Pareto-inferior solution in a *centralised* framework. To put it differently, as Arrow and Lind (1970) have shown, the expected utility losses are approximately zero as the number of taxpayers becomes larger and larger. In other words, in a centralised framework, the costs of risk-bearing can be optimally spread throughout the community by central government[6].

In this paper, we analyse different institutional arrangements to cope with collective risks, focusing on the potential role of private insurers in solving the under-investment problem

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[4] An example is given in the U.S. by the "rainy day funds" – more formally known as "budget stabilization funds" – i.e. States reserve funds used to partially offset revenue shortfalls and to maintain the level of public expenses (see, e.g., Maag and McCarthy, 2006).

[5] Private coverage for smaller collective risks is widely diffused: for instance, the "Supplement to the Official Journal of the European Union", dedicated to European public procurement, weekly reports hundreds of tender notices from public administrations in the European Economic Area. Private coverage for larger catastrophic events is common especially in small countries and/or in the form of public-private partnership (e.g., Hofman and Brukoff, 2006; CEA, 2007; Linnerooth-Bayer and Mechler, 2008).

[6] As we will show below, buying a private insurance implies a direct cost (the premium, that possibly includes also a rent for the insurer) and an indirect cost (the dilution of incentives to invest in mitigation). Not surprisingly, insurance for public assets in some countries is consequently illegal (in Sweden, for example: see Linnerooth-Bayer and Mechler, 2008).

in protection stemming from the moral hazard of local administrations in a *decentralised* framework. In particular, we compare the welfare properties of a public mutual fund (i.e., a system of ex-ante defined inter-governmental transfers[7]) with those of a private insurance for local administrations, both in the case of a hard or a soft budget constraint. These two institutional arrangements require local administrations to pay a contribution – implicit in the case of the mutual fund, explicit in the case of a premium to be paid to an insurer – in order to obtain coverage for local collective risks. Our analysis shows that a public fund is always superior to the private insurance solution in the presence of hard budget constraints for local administrations. However, when the central government cannot credibly commit to an optimal transfer rule, private insurers are sometimes able to improve on the mutual public fund solution by inducing a higher level of precautionary investments. The main intuition for these results is that while the public mutual fund operates with *ex-post* contributions defined on the *actual* realisation of losses, private insurers need to define an *ex-ante* premium. This latter mechanism is less efficient because – given a level of equality among local administrations – an optimally designed public fund mechanism provides more incentives to invest in mitigation.

The remainder of the paper is structured as follows: Section 2 describes the baseline model, and the outcome in the presence of a system of inter-governmental transfers, both under a hard and a soft budget constraint regime. The role of private insurers is discussed in Section 3. Section 4 discusses the results and Section 5 briefly concludes the paper.

## 2. The baseline model

Our analysis is based on a very simple and stylised model, somewhat in the vein of Goodspeed and Haughwout (2007). We consider a game where a Federal ("Central") government interacts with $N$ lower level ("Local") administrations. One can think of these actors as Regional (or State) governments, or some other local autonomous public bodies

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[7] The Central government could finance the ex-post transfer policy with general-purpose reserve funds discretionally activated after the occurrence of the shock, or with specific funds which are regulated ex-ante and financed by the local administrations under exposure to a specific risk. This second type of arrangement is frequently used in order to publicly cover individual risks (think for instance to pension plans) even if they are rarely formally defined in the case of collective risks. In the next sections of the paper we analyse the properties of this type of fund, which we call "public mutual fund".

such as schools, hospitals, or universities. The main differences between the two layers of governments are related to the assignment of taxing power and to the management of public assets. Only the Central government retains the power to tax citizens, whereas this right is not awarded to Local administrations[8]. The latter are entitled to manage some public assets essential to produce local public services. The assets face specific risks: local administrations can reduce potential losses by investing in protection, but these investments are not observable by the Central government. A typical example would be a public hospital: risks range from clinical errors (assuming that the hospital is liable for the economic losses caused by such errors, as it is in many countries) to natural disasters which can hit the infrastructure. Managers can reduce clinical error risk by better organizing work shifts, and earthquake risk by adopting anti-seismic building techniques.

The Central government $C$ defines ex-ante a global budget $N\Omega$ of total transfers to Local (identical) administrations to be used for three main purposes: (a) current expenditures (i.e., expenditures for providing the public service); (b) precautionary investments; (c) repayment of losses. The global budget is fixed here to $N\Omega$, even though the distribution of funds to the Local administrations might be discretionary depending on whether the Central government is able to commit ex-ante to a specific transfer rule or not. In the first decentralised situation we consider, the commitment to the transfer rule is credible (i.e., soft budget constraint problems are ruled out). This assumption is relaxed later in the paper.

There is only one period: precautionary investments exhaust their preventive impact during the period that also coincides with the electoral cycle, at both the local and the central level. The timing of the game is defined as follows:

a) first, Central government announces a 'transfer rule' $T$, i.e. the amount of funds that will be transferred to each Local administration $(T_1, T_2, \ldots, T_N)$;

b) then, Local administrations (acting simultaneously) define the amount of resources to be invested in protection $I_i$. Investments are not verifiable by the Central government (i.e., transfers cannot be contingent to investments);

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[8] This is clearly a simplifying assumption. In real world cases, local governments often have their own taxes. However, the central government retains the possibility to "equalise" resources by smoothing differences in fiscal capacity among local administrations.

c) Nature determines the realisation of loss $d_i$ in each single administration $i$, which are assumed to be independent (i.e. $\text{Cov}[d_i, d_j] = 0$) and observable by all players.[9] To simplify the presentation of our argument, we also assume that $d$ takes up only two possible outcomes $D$ ($> 0$) and $0$ with probability respectively $\delta(I)p$ and $(1 - \delta(I)p)$. Investments $I$ clearly influence the loss probabilities[10]; we assume that $\partial\delta/\partial I < 0$, $\partial^2\delta/\partial I^2 > 0$, and we normalize $\delta(0) = 1$;

d) finally, the Central government implements the transfers, according to the pre-determined transfer rule $T$ and the budget constraint regime (hard or soft), and each Local administration $i$ is able to define the (ex-post) budget for current expenditure $x_i = T_i - I_i - d_i$.

Central government's payoff is represented by an "abbreviated" social welfare function (SWF)[11], explicitly defined on a standard efficiency-equality trade-off, in order to account for both the total (expected) amount of current expenditures $x_i$ and the (expected) inequality in expenditures among Local administrations:

$$\Pi_C = E\left[\sum_{i=1}^{N} x_i\right] - \alpha\, E\left[\sum_{i=1}^{N} (x_i - \bar{x})^2\right], \tag{1}$$

where $\bar{x}$ is the mean expenditure of Local administrations. Notice that $\alpha$ ($\geq 0$) accounts for the degree of inequality aversion of the Central government: the higher $\alpha$, the higher the loss in utility stemming from inequality. Moreover, as the first term in Eq. (1) is the sum of current expenditures, Central government payoff shows a sort of "aversion" to losses, since these clearly reduce the expected current expenditures.[12]

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[9] Notice that the independence assumption easily stems from the *localised* nature of these risks. Fires, floods, terrorist attacks, clinical mistakes are all investing in a *specific* local community, not a whole country.

[10] The literature (see for example Jullien *et al.*, 1999) distinguishes between protection investments (when the investment is aimed at reducing the probability of the adverse event) and prevention investments (when the investment is aimed at reducing the severity of the damage). In our setup, $I$ is consequently a 'protection' investment.

[11] An "abbreviated" SWF is an increasing function of efficiency and equality. This term has been introduced by Lambert (1993); Champernowne and Cowell (1997) use the alternative term "reduced" SWF.

[12] Notice that our payoff function can be derived as an utilitarian SWF that aggregates the utilities of risk-averse individuals, or as a non-utilitarian SWF in the presence of inequality aversion *per se* of the social planner (see, e.g., Carlsson et al., 2005). The inequality index we are using – the variance of the current expenditures – belongs to the set of "appropriate" indexes considered in this literature. It is important to notice that our results do not hinge on the specific index we use, and hold also considering alternative

Local administrations' payoffs are defined only on expected current expenditures:

$$\Pi_i = E[x_i]; \quad i = 1,...,N \tag{2}$$

The intuition behind this formulation is quite simple: local politicians are rewarded for local expenditures, but not for investments in protection, which are not observable by assumption. Hence, the higher $x_i$, the higher the probability they will be re-elected. Notice that we have modelled Local administrations as risk-neutral players[13] and that the Central government's objective is not the sum of Local government utilities.

The transfer rule $T$ defined ex-ante by the Central government takes into account the commitment to a global budget fixed to $N\Omega$. However, $T_i$ can be made contingent to the distribution of losses. If $M$ is the number of Local administrations hit by losses $D$ ($0 \leq M \leq N$), the transfer rule able to perform full mutualisation of losses is the following:

$$T_i(d_i) = \Omega + d_i - \bar{d}(M) \tag{3a}$$

where $\bar{d}(M) = D\,M/N$ represents the average actual loss. In other words, the transfer rule expressed by Eq. (3a) can be interpreted as the sum of three components: (a) a symmetric flat transfer $\Omega$; (b) a transfer from a 'mutuality fund' that repays each loss $d_i$ ($d_i = D$ or 0); (c) a contribution to the 'mutuality fund', equal to the average realised loss $\bar{d}(M)$.

The Central government might prefer only a *partial* mutualisation of losses. The general form of the transfer rule is then:

$$T_i(d_i) = \Omega + \vartheta[d_i - \bar{d}(M)] \tag{3b}$$

The second term, again, represents the working of the public mutual fund, composed of the reimbursement of losses $\vartheta d_i$, and the mutuality contribution $\vartheta \bar{d}(M)$ needed to finance (partial) reimbursements of losses. Clearly, $\vartheta \in [0,1]$ is the degree of mutuality, or namely the coverage.

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inequality indexes. Moreover, a sufficiently low $\alpha$ ensures monotonicity of the SWF. The use of a payoff function for the central planner allowing for the standard efficiency-equality trade-off is of course not new in the literature. See, e.g., Konrad and Seitz (2003), for the study of the optimal mutual insurance contract between States within a federation, and Picard (2008), for an analysis of the role of private insurance in the prevention of natural disasters.

[13] The assumption of risk neutrality for local politicians is quite arbitrary, as it is any alternative assumption. We rely of this hypothesis since it quite simplifies calculations. However, we will discuss the implication of relaxing this assumption in Section 4.

The expected payoff for the Central government can then be expressed as:

$$\Pi_C = E\left[\sum_{i=1}^{N}(T_i - I_i - d_i)\right] - \alpha \, E\left[\sum_{i=1}^{N}(x_i - \bar{x})^2\right] = \tag{4}$$

$$= N\Omega - \sum_{i=1}^{N}\left(I_i + \delta(I_i)\hat{d}_0\right) - \alpha(1-\vartheta)^2 \Psi\left(N, \delta(I_1),...,\delta(I_N)\right)$$

where $\hat{d}_0 = D\,p$ is the *expected* loss in the absence of any investments, and:

$$\Psi(N,\delta(I)) = \sum_{M=0}^{N} \pi(M)\frac{M(N-M)}{N}D^2 = \tag{4a}$$

$$= D\sum_{M=0}^{N}\frac{N!}{M!(N-M)!}[\delta(I)p]^{M}[1-\delta(I)p]^{(N-M)}(N-M)\bar{d}(M)$$

Each term of the sum represents the variance of current expenditures among local administrations in the specific state of nature when $M$ shocks occurred, weighted for the probability of such state of nature $\pi(M)$. Notice that the first term in Eq. (4) (i.e. $E[\Sigma\,x_i]$) does not directly depend on $\vartheta$ since $\vartheta$ only affects the level of compensating transfers (added to some Local administrations and subtracted from others).[14] The term $\Psi$ does not depend on $\vartheta$ either, and decreases as $N$ increases.[15]

Finally, the payoff of Local administration $i$ is the following:[16]

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[14] As will soon become clear, the transfer rule indeed affects the investment strategies of the Local administrations, thus defining the ultimate amount of the budget that is free for current expenditures.

[15] As is evident in Eq. [4a], given $N$, $\Psi$ is increased in particular by the terms where $(N-M)$ and $M$ assume similar values. When damage is uncommon, the probability of such states of nature decreases when the number of administrations $(N)$ is greater. In the simplest case of only two Local administrations, the variance of current expenditures is equal to $2\delta(I_i)p(1-\delta(I_i)p)\dfrac{(1-\vartheta)^2 D^2}{4}$, which is the probability of observing an unequal outcome (only one Local administration is hit by a shock) times the variance of expenditures.

[16] Notice that the payoffs expressed in Eq. (4) and (5) are obtained assuming that losses can take only two possible outcomes, an hypothesis we maintain throughout the paper. Clearly enough, this assumption of a binomial distribution of losses is made only to simplify presentation. All of our results can be easily interpreted in the more general framework also, where losses are distributed according to a generic probability density function including those describing extreme events as discussed in Wildasin (2008). In this framework, the average actual loss $\bar{d}(M)$ and the average expected loss in the absence of precautionary investments $\hat{d}_0$ are still defined accordingly. The definition of $\Psi$ becomes more complex, but it retains the property of independence from $\vartheta$, and of a negative correlation with $N$.

$$\Pi_i = E[T_i - I_i - d_i] = \tag{5}$$

$$= \Omega + \vartheta\,\delta(I_i)\hat{d}_0 - \vartheta\,E\left[\sum_{M=0}^{N}\pi(M)\bar{d}(M)\right] - I_i - \delta(I_i)\hat{d}_0 =$$

$$= \Omega - I_i - (1-\vartheta)\delta(I_i)\hat{d}_0 - \frac{\vartheta}{N}\sum_{j=1}^{N}\delta(I_j)\hat{d}_0.$$

## 2.1. The benchmark case: full centralisation

We begin our analysis by defining a benchmark case, without any strategic interaction between different layers of government, and considering all decisions to be centralised. In this case, Central government defines both the transfer $T$ and investments $I$ in each Local administration. Remember that since Local administrations are identical, it follows that $I_i=I$ $\forall i$. The Central government problem can then be simplified to:

$$max_{I,\vartheta}\,\Pi_C = max_{I,\vartheta}\left\{N\left[\Omega - I - \delta(I)\hat{d}_0\right] - \alpha(1-\vartheta)^2\Psi(N,\delta(I))\right\} \tag{6}$$

Central government first determines $\vartheta$ (given $I$), then selects the amount of resources to be invested in protection $I$. The F.O.C. for the solution of the problem is:

$$\frac{\partial\Pi_C}{\partial\vartheta} = 2\alpha(1-\vartheta)\Psi(N,\delta(I)) = 0 \tag{7}$$

which bring us to the optimal 'degree of mutuality' $\vartheta^{*c} = 1$ (where superscript $c$ is a mnemonic for 'centralised').[17] Notice that $\vartheta^{*c}$ is determined by looking solely at the 'equality component' of the Central government's payoff function. Given the fixed budget $N\Omega$, the result is not surprising: Local administrations will be sharing losses, whenever they occur. $\vartheta^{*c}$ makes null the second term of Eq. (1) (the equality component): consequently, given $\vartheta^{*c}$, the Central government defines the optimal investment in protection $I$ to be implemented, by maximising the 'efficiency component' of its payoff:

$$max_I\left[\Omega - I - \delta(I)\hat{d}_0\right] \tag{8}$$

The F.O.C. implies:

$$1 = -\frac{\partial\delta(I)}{\partial I}\hat{d}_0 \tag{9}$$

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[17] Identical results could be obtained in the case of *observable* investments, thanks to the opportunity for the Central government to design transfers which are contingent to the actual value of *I*.

which implicitly characterizes the optimal investment $I^{*c}$.[18] Interpretation of Eq. (9) is straightforward: marginal benefits of investing in protection (given by the marginal reduction in the value of expected losses) equals marginal costs.


## 2.2. The decentralised case: the public mutual fund with credible commitment

In the benchmark case all decisions are centralised. However, in most real-world cases, precautionary investment are in the hands of Local administrations; and these can decide their amounts, which Central government cannot observe. We solve the game by backward induction, and look for sub-game perfect Nash equilibrium. We then begin with the decision of Local administrations to invest, and then we analyse the definition of the transfer rule $T$ (i.e. the level of $\vartheta$) by the Central government.

When each Local administration decides the optimal investments to be implemented, given $\vartheta$, it will maximise its own expected payoff, considering only the total current expenditures $x$ in its administration. The problem to be solved by Local administration $i$ (see Eq. (5)) amounts to:

$$max_{I_i} \; \Pi_i = max_{I_i} \left[ -I_i - (1-\vartheta)\delta(I_i)\hat{d}_0 + \Omega - \frac{\vartheta}{N}\sum_{j=1}^{N}\delta(I_j)\hat{d}_0 \right] \tag{10}$$

The F.O.C. for the solution of the problem can then be written as:

$$1 = -\frac{\partial\delta(I_i)}{\partial I_i}\left(1 - \vartheta\frac{N-1}{N}\right)\hat{d}_0 \tag{11}$$

which implicitly defines the optimal investment $I_i^{*}$, which clearly depends on $\vartheta$.

Given that the Local administrations are identical, we will of course have $I_i^{*} = I^{*d}$ $\forall i$ (where now superscript $d$ is mnemonic for 'decentralised'). Notice that – by simply comparing Eq. (9) with Eq. (11) – it is clear that protection investments are reduced with respect to the benchmark case, for every $\vartheta > 0$; moreover, $I^{*d}$ decreases when $N$ increases. This is a strategic effect stemming from $\vartheta$ itself: each Local administration prefers to free-ride on investments and spend in $x$; the free-riding effect being clearly emphasised when the

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[18] An interior equilibrium solution (i.e., $I > 0$) is obtained only if mitigation investments are sufficiently productive. More formally, in this case, only if $\delta'(0) < -1/\hat{d}_0$. We assume that $\delta'(0)$ is sufficiently negative in all the cases illustrated in the paper so that an equilibrium solution with positive investments always exists.

number of Local administrations is greater. Indeed, own investments increase the probability that Local administration will subsidise the other ones for (potential) losses, and this clearly reduces the incentive to invest. There is then a *vertical externality* quite common in the literature on fiscal federalism, which influences the optimal amount of $\vartheta$ that will be chosen by the Central government. This effect could be also be interpreted as a *common-pool problem*, since the mutual fund is a sort of public good whose financing is shared among Local administrations. Notice also that $I^{*d}$ will be strictly positive even when $\vartheta = 1$.[19] As we will show in the next Section, the presence of interregional externalities marks a striking difference between public transfer rules and private insurance mechanisms: when insurers are involved, the premium paid by a specific Local administration is not affected by the realisation of losses, while in the public case, each realised loss increases the mutuality contribution, $\vartheta \bar{d}$, of each single administration (see Eq.(3b)).

Given the choice of the investments to be implemented by the Local administrations, Central government will then define the optimal transfer rule $T$, which amounts to defining the mutualisation degree $\vartheta$, since the total budget $N\Omega$ is fixed. The optimal additional transfer $\vartheta^{*d}$ will stem from two countervailing effects: on the one hand, Central government has the incentive to fix $\vartheta^{*d}$ as close as possible to $\vartheta^{*c} = 1$ in order to guarantee equality among local constituencies; on the other hand, by guaranteeing full mutualisation of losses, it reduces the incentive of a Local administration to invest in $I$, since $\partial I^{*d}/\partial \vartheta < 0$. The problem to be solved can be written as:

$$max_{\vartheta}\, \Pi_C = max_{\vartheta} \left\{ N\left[\Omega - I - \delta(I)\hat{d}_0\right] - \alpha E\underbrace{\left[\sum_{i=1}^{N}(x_i - \bar{x})^2\right]}_{\alpha(1-\vartheta)^2 \Psi(N,\delta(I))} \right\} \tag{12}$$

$$s.t. \quad I = I^{*d}(\vartheta)$$

F.O.C. for the solution of the problem is:

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[19] The optimal investment $I^*$ monotonically decreases when $\vartheta$ and $N$ increase, until it becomes zero. If the absolute value of $\delta'(0)$ is sufficiently high, $I^*$ is positive in the whole range [0,1] of $\vartheta$. See again footnote 16.

$$-N\frac{\partial I^{*d}}{\partial \vartheta}\left(1+\hat{d}_0\frac{\partial \delta(I)}{\partial I}\right) = \alpha\frac{\partial E\left[\sum_{i=1}^{N}(x_i-\bar{x})^2\right]}{\partial \vartheta} \qquad (13)$$

Eq. (13) shows the efficiency-equality trade-off implicit in the payoff function of the Central government.

First, one can notice that the LHS of Eq. (13) – which corresponds to $\dfrac{\partial E\left[\sum_{i=1}^{N}x_i\right]}{\partial \vartheta}$ – is always negative for every $\vartheta > 0$. Intuitively, the lower the additional transfer, the closer the investment will be to its efficient level, which in turn implies a better trade-off between investments and expected loss, hence higher current expenditures $x$. More formally, considering the F.O.C. in Eq. (11) and $\partial I^{*d}/\partial \vartheta < 0$, one can show that:

$$-N\frac{\partial I^{*d}}{\partial \vartheta}\left(1+\hat{d}_0\frac{\partial \delta(I)}{\partial I}\right) = -\frac{\partial I^{*d}}{\partial \vartheta}\left(\hat{d}_0\frac{\partial \delta(I)}{\partial I}\vartheta\frac{N-1}{N}\right) < 0 \qquad (14)$$

given $\vartheta > 0$.

Second, the function $E\left[\sum_{i=1}^{N}(x_i-\bar{x})^2\right]$ is always non-negative, and reaches a minimum at $\vartheta=1$, when all losses are fully shared and expenditures equalised in every Local administrations. In particular, when $\vartheta < 1$, $E\left[\sum_{i=1}^{N}(x_i-\bar{x})^2\right]$ strictly decreases with $\vartheta$, while for $\vartheta > 1$ the inequality component of the payoff of the Central government increases. As a consequence, the RHS of Eq. (11) assumes negative values in the $0 \le \vartheta < 1$ range.

Moreover, note that if $\alpha = 0$ (i.e. the Central government cares only about efficiency), the F.O.C. reduces to Eq. (9) and investment will consequently be fixed like in the benchmark case. The higher $\alpha$, the closer the additional transfer $\vartheta^{*d}$ will be to 1, hence $\dfrac{\partial \vartheta^{*d}(\alpha)}{\partial \alpha} > 0$.

We are now able to show the following Proposition 1:

**Proposition 1:** *The degree of mutuality in the case of decentralisation is lower than the one in the*

*centralised case, i.e.* $\vartheta^{*d} < \vartheta^{*c} = 1$, *and* $\partial\vartheta^{*d}/\partial N < 0$. *Protection investments* $I^{*d}$ *will be reduced with respect to the centralised case* $I^{*c}$, *unless Central government cares only about efficiency.*

**Proof:** Directly from discussion above, since LHS of Eq. (13) is always negative and RHS of Eq. (13) is negative only for $\vartheta^{*d} < 1$, it must be that the optimal degree of mutuality $\vartheta^{*d}$ is lower than the one in the centralised case $\vartheta^{*c} = 1$. As far as $\partial I^{*d}/\partial N < 0$, the optimal trade-off between efficiency and equality asks for stronger investment incentives, i.e. a lower $\vartheta$, when the number of Local administrations increases. ∎

Proposition 1, in line with the findings of Goodspeed and Haughwout (2007), suggests that decentralisation almost always leads to an inefficient outcome: precautionary investments will be reduced with respect to the centralised case. By fixing $\vartheta$, the Central government trades off equality and efficiency: on the one hand, a lower $\vartheta$ is used to induce more incentives to invest in protection; on the other hand, $\vartheta$ must be higher in order to guarantee a sufficient degree of mutualisation of losses. Since we have ruled out commitment problems thus far, notice that the inefficiency stems *only* from the free-riding behaviour of Local administrations:[20] risk is mutualised amongst all the Local administrations and the effort to lower the probability of negative events decreases the mutuality contribution $\vartheta\bar{d}$ for all the participants. This inefficiency will be magnified when the Central government is not able to credibly commit to a pre-determined level of financing, a point that will be discussed below.

### 2.3. The decentralised case: the public mutual fund when commitment is not credible

We have assumed so far that Central government is able to commit to a predetermined transfer rule and a predetermined budget. While this may be true in some situations,

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[20] Interestingly, this idea of free-riding behaviour among local governments has received the attention of legislators. One example is the arrangement provided by Law 353/2000 in the case of forest fires in Italy. In the experimental period between 2000 and 2002, the Central government defined a budget of 10 million euro per year ($N\Omega$ in our notation) to be distributed to regional governments. In turn, regions redistribute financial resources to various municipalities according to the following rule: half proportional to the size of the local forestry area; half inversely related to the ratio between the size of forestry land destroyed by fire and the original size of forested land. As noted by Pazienza and Beraldo (2004), the law "has tried to introduce a management of the financial resources used in the fight of forest fires in such a way as to discourage any form of free-rider behaviour that could be taken up by regional or other local authorities".

especially when the Central government cares only about efficiency, it is definitely difficult to sustain when *large* welfare losses occur. In the case of floods, earthquakes or other natural disasters, and more generally when there are huge losses, Central government might not be able not to renege on its ex-ante commitment. In other words, in all these cases, *after* the disaster occurred, Central government can step in and redefine the transfers ex-post.[21] Clearly enough, if Local administrations anticipate this move by the Central government, the announcement of the transfer rule at the first stage of the game is not credible. To be more precise, the actual transfer rule will be fixed *after* the state of nature (the level of damage in every Local administration) has been observed, and it will maximise ex-post the Central government's payoff.

The equilibrium strategies are easily obtained from the results of the previous section. Simply note that, since the first move of the Central government is "cheap talk", the sequence of moves are reversed here: at the final stage of the game, given protection investments are sunk once losses are realised, the transfer rule has no incentive role, and Central government maximises the equality component of its payoff by fixing $\vartheta^{*dnc}=1$ (whereas now superscript *dnc* is mnemonic for 'decentralised and no commitment'), regardless of what was announced before; moving backwards, each Local administration decides the optimal investments to be implemented, anticipating the optimal response of the Central government. The problem to be solved amounts to:

$$max_{I_i} \, \Pi_i = max_{I_i} \left\{ -I_i + \Omega - \frac{\sum\limits_{j=1}^{N} \delta(I_j)\hat{d}_0}{N} \right\} \tag{15}$$

The F.O.C. for the solution of the problem can then be written as:

$$1 = -\frac{\partial \delta(I_i)}{\partial I_i} \frac{\hat{d}_0}{N} \, , \tag{16}$$

which can also be obtained directly from Eq. (11) by setting $\vartheta = 1$. Given our assumption of identical local administrations, the optimal investment implicit in Eq. [16] is symmetric,

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[21] Notice that this is a simple application of the well-known Samaritan's dilemma, a typical situation of time inconsistency of public policies. See the seminal paper by Buchanan (1975).

i.e. $I_i^* = I^{*dnc}$. Notice also that by simply comparing Eq. (16) with Eq. (11), protection investments are reduced by the inability of the Central government to commit to a predetermined transfer rule, since $\vartheta^{*d} < 1$ (see Proposition 1).

We are now able to show the following Corollary to Proposition 1:

**Corollary to Proposition 1:** *In the case of decentralisation, when Central government is unable to commit to a pre-determined transfer rule, protection investments $I^{*dnc}$ will be reduced with respect to the case with perfect commitment $I^{*d}$, unless Central government cares only about efficiency.*

**Proof:** Directly from discussion above.∎

Notice that $I^{*dnc}$ will be strictly positive[22] because a loss $d$ in each Local administration, *ceteris paribus*, increases the mutuality contribution, $\vartheta\bar{d}$, by the amount $\vartheta d / N$. However, for even a very small degree of inequality aversion by the Central government, the inability to commit to a pre-determined transfer rule will result in a lower level of investments in protection by Local administrations. Could the present situation be improved by allowing for a private insurance solution? This is what we will present in the next section of the paper.

## 3. The role of private insurers

In the previous section of the paper we assumed that Local administrations can recover from losses only by resorting to additional transfers by the Central government. As already discussed in the introduction, however, in many real world cases Local administrations (as broadly defined before) buy insurance coverage from private providers to hedge against the risks they face in producing local services. Therefore, one intriguing question is to understand the role of private providers as *substitutes* for the Central government system of inter-governmental transfers. Before moving on to a more formal analysis, we can list a number of advantages and disadvantages of private insurers. On the one hand, private insurers may be better suited than the Central government to observe a proxy for the

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[22] See footnote 17 again.

realised investment in protection. On the other hand, in the case of imperfect competition in private insurance markets, for instance, private insurers will gain positive profits, hence extracting rent from the public administrations. To avoid easy arguments in favour of institutional arrangements where private insurers can play a role, we rule out these possibilities here. We assume perfectly competitive insurance markets and we then normalise loadings to zero[23]. Moreover, we hypothesise that private insurers can only observe realisation of losses, as the Central government is able to do.

In the presence of private insurers, the Central government will transfer the amount $\Omega$ to each Local administration, possibly leaving the private market the task of covering the risk of damage. The fair premium $P$ charged by the insurer to the Local administration depends on the level of coverage $\lambda$, where $\lambda$ is the share of total losses to be reimbursed. In particular, the premium is fixed equal to the expected loss, $P(\lambda) = \lambda \delta(I) \hat{d}_0$ and, in return, the Local administration receives the amount $\lambda d$ from the insurer.

A crucial point to be emphasised here is what distinguishes the private solution from the public one. The insurer gets from the Local administration a premium which is defined *ex-ante* (i.e., *before* the realisation of losses is known), and commits to repay *ex-post* a share $\lambda$ of the actual loss. Conversely, the transfer rule $T$ is wholly *contingent* on the distribution of realised losses. In other words, not only the reimbursement $\vartheta d$, but even the mutuality contribution $\vartheta \bar{d}(M)$ (see Eq (3b)) - which is a sort of 'premium' paid to the Central government - is determined on the basis of the damage actually realised.

Summing up, the funding mechanism of the Central government to the Local administration is very similar to the net flow of capital between the Local administration and the insurer: given a level of ex-ante coverage $\vartheta = \lambda$, the term $\vartheta d$ equals the amount paid out by the insurer $\lambda d$, while the *expected* value of the contribution $E(\vartheta \bar{d})$ equals the premium paid to the insurer $\lambda \delta(I) \hat{d}_0$. As for the incentive effect, however, a mutual fund is *different* from a private insurer: the (fair) premium $P$ is a sunk cost for the Local administration, while the mutuality contribution $\vartheta \bar{d}$ is fixed *ex-post* to cover the *actual* average loss. Hence, it does not represent a sunk cost for the Local administration and,

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[23] It is worth noting that we have already assumed the cost of managing the mutual fund by the Central government to be zero as well.

consequently, it generates different investment incentives. In other words, when the two mechanisms are based ex-ante on the same degree of coverage, they actually provide ex-post different equality. This difference makes interesting comparing the risk allocation efficiency of the private insurer and of the mutual fund, that is what we do next.

The premium charged by the insurer needs to deal with the moral hazard problem due to the unobservability of investments (Shavell, 1979). In particular, the insurer anticipates the disciplining effect of co-insurance on the investment strategy of the insured, i.e. $P(\lambda) = \lambda \delta \left( I^{*Ins}(\lambda) \right) \hat{d}_0$ (where *Ins* is now a mnemonic for the 'private insurance' case). Let's first assume that the Local administration can freely choose the coverage level together with the investment $I^{*Ins}$:

$$max_{I_i, \lambda_i} \, \Pi_i = max_{I_i, \lambda_i} \left[ \Omega - P(\lambda_i) - I_i - (1 - \lambda_i) \delta(I_i) \hat{d}_0 \right] \tag{17}$$
$$s.t. \quad P(\lambda_i) = \lambda_i \delta \left( I^{*Ins}(\lambda) \right) \hat{d}_0$$

We drop subscript *i*, since each identical Local administration deals individually with a number of competitive private insurers.

Noticing that investments are fixed after $\lambda$ has been chosen and the insurance premium represents a sunk cost, the F.O.C. for the solution of the problem is:

$$1 = -\frac{\partial \delta(I)}{\partial I}(1 - \lambda) \hat{d}_0 \tag{18}$$
$$\rightarrow I^{*Ins} = I^{*Ins}(\lambda)$$

and[24]:

$$\frac{\partial \Pi_i}{\partial \lambda} \bigg|_{I^{*Ins} = I^{*Ins}(\lambda)} = 0 \rightarrow \frac{\partial \left[ \Omega - I^{*Ins}(\lambda) - \delta \left( I^{*Ins}(\lambda) \right) \hat{d}_0 \right]}{\partial \lambda} = 0 \tag{19}$$
$$\rightarrow -\frac{\partial \delta(I)}{\partial I} \frac{\partial I^{*Ins}}{\partial \lambda} \hat{d}_0 = \frac{\partial I^{*Ins}}{\partial \lambda} \rightarrow \frac{1}{1 - \lambda} = 1 \rightarrow \lambda = 0$$

Summing up, none of the Local administrations purchases any coverage in the private insurance market, and the protection investments are fixed to the efficient level[25]. This result can be easily understood since the private insurer simply dilutes the investment incentives, and the optimal coverage is then the one that guarantees optimal individual

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[24] Remember that $P(\lambda) - (1 - \lambda) \delta(I) \hat{d}_0 = \delta(I) \hat{d}_0$.

[25] Notice that $\partial \Pi_i / \partial \lambda < 0$ when $\lambda > 0$.

incentives (see Eq. (9)). This solution – illustrated by Eq. (19) – maximizes $E[\Sigma x_i]$. Recalling our previous discussion, when a Central government simply provides a flat transfer $\Omega$ (i.e., $\vartheta = 0$), the outcome is suboptimal given that - as we have already shown - minimal equality is obtained.

An alternative strategy for the Central government could be the requirement of a compulsory minimal coverage level, $\lambda^m$. The maximisation problem of the Central government is then the following:[26]

$$
max_{\lambda^m} \, \Pi_C = max_{\lambda^m} \left\{ N \left[ \Omega - I \underbrace{- P(\lambda^m) - (1 - \lambda^m) \delta(I) \hat{d}_0}_{-\delta(I)\hat{d}_0} \right] - \alpha (1 - \lambda^m)^2 \Psi(N, \delta(I)) \right\} \tag{20}
$$

$$
s.t. \quad I = I^{*Ins}(\lambda^m)
$$

which implicitly defines the optimal coverage level $\lambda^{*m}$. The issue is then whether it is possible to obtain a larger payoff for the Central government if a minimal mandatory coverage $\lambda^{*m}$ on the private market substitutes the public mechanism described in the previous sections. Remember that the optimal transfer rule depends on the 'credibility regime', i.e. it is $T^{*d}$ when the Central government is credible, while it merely requests perfect ex-post equality when the commitment is not credible. By simply comparing Eq. (9) with Eq. (18), it is clear that if $\lambda^m > 0$, precautionary investments are reduced with respect to the benchmark case.[27] This is a strategic effect which is different from the free-rider problem in the decentralised solution: in the present case, no positive externality is generated by precautionary investments in each single Local administration on the cost of coverage of the other ones. Here the level of investments is suboptimal because the unit price of coverage increases with $\lambda^m$ in order to discipline the moral hazard. Each Local administration thus prefers to retain the risk and devote more resources to current expenditures $x$. By imposing a minimal coverage, the Central government trades off

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[26] Again, the strategies of the Local administrations are symmetric, so that we can simplify notation to $I_i = I^{Ins}$ $\forall i$.

[27] Remember from footnote 23 that the Local administration will choose the minimal compulsory coverage. This is due to the risk-neutrality assumption of the players. When the risk aversion of Local administrations is sufficiently high, there is no need to impose coverage.

efficiency and equality.

### 3.1. The case with credible commitment

We first compare the private insurance solution to the public mutual fund when the ex-ante commitment by the Central government is credible. The decentralised and the private insurance solutions can easily be compared thanks to the following Proposition 2:

**Proposition 2:** *The decentralised mutual solution always dominates the private insurance solution when the optimal transfer rule is credible.*

**Proof:** The (market) incentive schemes expressed by Eq. (18) can always be perfectly replicated by the Central government (see Eq.(11)), i.e. for every value $\widetilde{\lambda}$, the degree of mutualisation $\widetilde{\vartheta} = \dfrac{N}{N-1}\widetilde{\lambda}$ generates equal incentive schemes. In other words, since $N/(N-1) > 1$, the incentive mechanism provided by the decentralised solution is more powerful than the insurer's, namely, equal investments can be induced by the decentralised solution by means of higher coverage[28]. For every pair $(\widetilde{\lambda}, \widetilde{\vartheta} \mid \widetilde{\lambda} = \dfrac{N-1}{N}\widetilde{\vartheta}; \widetilde{\lambda} \in [0,1])$ it is possible to compare $\varPi^{d}{}_{C}(\widetilde{\vartheta})$ with $\varPi^{Ins}{}_{C}(\widetilde{\lambda})$. Since $I^{*d}(\widetilde{\vartheta}) = I^{*Ins}(\widetilde{\lambda})$, the efficiency component of the payoff is the same; consequently, $\varPi^{d}{}_{C}(\widetilde{\vartheta}) > \varPi^{Ins}{}_{C}(\widetilde{\lambda})$ if and only if $(1-\widetilde{\lambda})^{2} > (1-\widetilde{\vartheta})^{2}$, which is always verified. ∎

The decentralised scenario with a public mutual fund strictly dominates the private insurer solution when the number of Local administrations is finite. When the number of Local administrations tends to infinity, decentralised mutuality and private insurance become isomorphic, i.e. every strategy in both regimes can be perfectly replicated in the other so

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[28] The reason is that - given the coverage level - a higher investment *I* does not reduce the premium *P,* while it reduces the term $\vartheta\overline{d}(M)$ in $T_i$. This is so because $T_i$ is determined ex-post observing the number of actual realized losses *M*, and *I* influences $T_i$ through *M*. The working of the mechanism becomes evident considering that complete insurance (i.e., $\lambda = 1$) generates null protection investments, while in the decentralised solution, even when $\vartheta = 1$ protection investments are positive.

that $\Pi^{*d}_C\left(\vartheta^{*d}\right) = \Pi^{*Ins}_C\left(\lambda^{*Ins}\right).$[29]


### 3.2. The case when Central government is unable to commit

We now compare the private insurance solution to the public mutual fund when the Central government cannot credibly commit to a predetermined transfer rule. In this case, Central government is expected ex-post to perfectly equalise current expenditures among local administrations in every state of nature (i.e., to fix $\vartheta^{*dnc} = 1$). The incentive constraint for Local administrations is then expressed by Eq. (16), leading to a payoff for Central government which is given by:

$$\Pi^{dnc}_C = N\left[\Omega - I^{*dnc} - \delta\left(I^{*dnc}\right)\hat{d}_0\right] \tag{21}$$

When the Local administrations are insured, the payoff for the Central government is given by:

$$\Pi^{Ins}_C = N\left[\Omega - I^{*Ins}(\lambda) - \delta\left(I^{*Ins}(\lambda)\right)\hat{d}_0\right] - \alpha\,\Psi\left(N, \delta\left(I^{*Ins}(\lambda)\right)\right)(1-\lambda)^2 \tag{22}$$

The question is whether an optimal $\lambda^m$ can be chosen such that $\Pi^{Ins}_C > \Pi^{dnc}_C$, or:

$$\left[\delta\left(I^{*dnc}\right)\hat{d}_0 + I^{*dnc}\right] - \left[\delta\left(I^{*Ins}(\lambda)\right)\hat{d}_0 + I^{*Ins}(\lambda)\right] > \frac{\alpha\,\Psi\left(N, \delta\left(I^{*Ins}(\lambda)\right)\right)(1-\lambda)^2}{N} \tag{23}$$

We need to distinguish between two cases based on the value of $\lambda^{*m}$, the optimal minimal degree of coverage imposed by the Central government. First remember that $\delta(I)\hat{d}_0 + I$ monotonically decreases with $I$, until its minimum for $I = I^{*c}$ (see Eq.(9)). Consequently, since both $I^{*Ins} < I^{*c}$ and $I^{*dnc} < I^{*c}$, $\left[\delta\left(I^{*dnc}\right)\hat{d}_0 + I^{*dnc}\right] - \left[\delta\left(I^{*Ins}(\lambda)\right)\hat{d}_0 + I^{*Ins}(\lambda)\right] > 0$ if and only if $I^{*dnc} < I^{*Ins}$.

If $\lambda^{*m} \geq (N-1)/N$, then $I^{*Ins}(\lambda^{*m}) < I^{*dnc}$:[30] LHS of Eq.(23) is negative and the condition is never verified (remember that RHS is always positive). The public solution gives better incentives to the Local administrations and perfect equality: the private market solution is then dominated by the decentralised public solution even when the Central government cannot credibly commit to an ex-ante defined transfer rule. In the interval $0 \leq \lambda^{*m} \leq (N -$

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[29] Indeed, when $N$ tends to infinity the cost of mutualisation for each single Local administration cannot be significantly reduced by its own protection investments.

[30] This is easily obtained by comparing Eq. (11) with Eq. (18), recalling that $\vartheta^{*dnc} = 1$.

1)/N, $I^{*Ins} \geq I^{*dnc}$ and $\delta(I^{*Ins}) < \delta(I^{*dnc})$. Consequently, LHS of Eq.(23) proves to be positive and the condition in Eq. (23) is verified for some combinations of the model's parameters. In particular, the private insurance market can generate higher payoffs for the Central government when, *ceteris paribus*: i) $\alpha$ is sufficiently low and/or the adverse events are very infrequent, i.e. when expected inequality is rather low or irrelevant, so that efficiency is more appreciated; ii) the productivity of protection investment is high, i.e. when the effect of better incentives is more valuable; iii) $N$ is high, which implies a limited incentive advantage for the public solution. This discussion is summarised in the following:

**Proposition 3:** *When the Central government cannot commit to a predetermined optimal transfer rule, the decentralised mutual public fund solution always dominates the private insurance solution for $\lambda^{*m} \geq (N-1)/N$. Under specific combinations of parameters $\alpha$, $p$, $\delta$, $N$, the private insurance solution dominates the decentralised mutual public fund solution if $0 \leq \lambda^{*m} < (N-1)/N$.*

**Proof:** Directly from discussion above. ∎

Proposition 3 suggests that even when the Central government is unable to commit to a predetermined level of transfers, the welfare-enhancing role of the private insurer is rather limited. Notice that this result, combined with Proposition 2, is obtained by assuming competitive insurance markets. As we discuss in the next Section, by introducing some rents, the room for private insurers shrinks further.

## 4. Discussion

In this section we discuss our findings, which can be summarised as follows: (a) when the Central government can credibly commit to a predetermined transfer rule, the public mutual solution is a welfare-superior institutional arrangement compared to the private insurance solution, since it provides higher incentives to invest in protection and the same degree of equality[31]; (b) when the Central government is unable to commit to an ex-ante

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[31] To recall the intuition for this result, this is due to the different incentives provided by the ex-ante premium of the private insurer and by the ex post contribution of the mutual fund, which is not sunk for the Local administration.

optimal transfer rule, the private insurance solution (if insurance markets are competitive) might improve welfare with respect to the public mutual fund when: i) the number of local administrations is large; ii) the degree of inequality aversion is low; iii) the probability for damage to occur is low; iv) the productivity of protection investments on the probability for damage to occur is large. At the equilibrium, the following inequalities hold:

$$\vartheta^{*d} < \lambda^{*m} < \vartheta^{*dnc} = \vartheta^{*c} = 1 \tag{24}$$

$$I^{*dnc} < I^{*Ins}, I^{*d} < I^{*c} \tag{25}$$

$$\Pi_C^{*dnc} < \Pi_C^{*Ins} < \Pi_C^{*d} < \Pi_C^{*c} \tag{26}$$

This results obviously depends on the players' payoff functions: however, if we had modelled the Local administrators as risk averse individuals, the incentive to invest would have been higher both in the case of public mutual fund and in the case of private insurer, so that the ranking expressed by Eqs. (24), (25) and (26) would have remained unaffected.

Given that the public mutual fund provides more incentives to invest than the private insurance solution, the Central government prefers equality over efficiency in the case of a private insurance solution; hence, $\lambda^{*m} > \vartheta^{*d}$ according to Eq. (24). This makes the comparison between $I^{*Ins}$ and $I^{*d}$ unclear. Since the public mutual fund is always better than the private insurance solution when the Central government can credibly commit to a predetermined transfer rule, this comparison is irrelevant however. According to Proposition 3, $I^{*Ins}$ might be larger than $I^{*dnc}$, but this does not guarantee that $\Pi^{*Ins} > \Pi^{*dnc}$. Notice that in Eq. (25) and Eq. (26) we have ordered precautionary investments and Central government's payoffs assuming that the parameters of the model *assign* a welfare-improving role to private insurers.[32]

The rationale for these results is grounded in the institutional framework that we want to better illustrate in the rest of this section. Remember that in both institutional arrangements, local administrations pay a contribution – implicit in the case of the mutual fund, explicit in the case of a premium to be paid to an insurer – in order to obtain a coverage for these collective risks. However, while the public mutual fund operates with *ex-*

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[32] In other words, Eq. (25) and Eq. (26) are obtained assuming that Eq. (23) is satisfied. Otherwise, we obtain:

$$I^{*Ins} < I^{*dnc} < I^{*d} < I^{*c}$$

$$\Pi_C^{*Ins} < \Pi_C^{*dnc} < \Pi_C^{*d} < \Pi_C^{*c}$$

*post* contributions defined on the *actual* realisation of losses, private insurers need to define an *ex-ante* premium. The second mechanism is less efficient in terms of providing the right incentives to invest in protection.

The possibility that a private insurer could provide higher welfare in some specific regimes where Central government is unable to commit to a pre-determined transfer rule, can be explained by the different enforceability of the two "contracts". From this point of view, we have assumed that the contract with a private insurer is intrinsically more credible than the public fund mechanism. In the first case, the Local administration needs to pay an ex-ante premium $P$, and – in exchange – the insurer will reimburse a share $\lambda$ of losses in case a damage occurs. Whenever one of the parties does not accomplish its contractual obligation, the other can recur to a civil court and ask for the enforcement of the contract. This enforcement is more credible than the one provided by an administrative or constitutional court, because the Central government can always renege on the commitment and – through a special law – pump more money into specific communities hit hard by a disaster. However, these conclusions are based on the hypothesis that the private insurer will never default; otherwise, this enforceability advantage might disappear. This no-default hypothesis might be true in the case of liability insurance for public employees, but becomes more difficult to sustain for catastrophe insurance.

It is also worth noting that the mechanisms used by the Central government and by the private insurer in order to financially support the risks' coverage are actually associated with different risk profiles of these parties. The ex-ante definition of the premium of the private insurer implies that he is the one who bears the risk that the collected premiums (based on the *expected* losses) are insufficient to cover the ex-post *realised* losses. However, since we have not taken into account the cost of capital needed to finance coverage, no disadvantage for the private insurance solution emerges from this aspect. On the other hand, we have modelled the Central government as a player that perfectly commits to an aggregate transfer equal to $N\Omega$, so that he does not bear any risk similar to the one of the private insurer. However, in a more realistic situation the commitment to the ex-ante defined total transfer $N\Omega$, may be not credible. One might ask whether this situation could affect our results.

In particular, the Central government could be induced to increase *ex-post* equality by

transferring funds from constituencies not hit by losses to those that are damaged, given that the private insurer only partially covers the Local administrations. Recalling what we have already illustrated in par. 2.3, the Central government always equalises expenditures *ex post* when its commitment is not credible. As a consequence, the disciplining role of partial coverage used by the private insurer ceases to exist: the Local administration keeps mitigation investments low, relying on the intervention of the Central government. Consequently, the premium requested by the private insurer will be associated with those low investments. Summarising, the private insurer definitely loses its welfare-enhancing role if the Central government is unable to credibly promise that he will not pay for damage that is not completely reimbursed by a private insurer.

A final difference is clearly in the private nature of the insurer, which maximises its profits. This is unlike the Central government, which aims at maximising welfare. If insurance markets are not perfectly competitive, there is an additional disadvantage of the private insurer solution which is not currently modelled in the paper, and further reinforces our main conclusions.


## 5. Concluding remarks


In this paper, we have considered the institutional arrangements needed in a decentralised framework to cope with the potential adverse welfare effects caused by negative shocks which impact directly on the provision of public services and can be 'limited' by precautionary investments. We analyse the functioning of a public mutual fund (i.e., a system of inter-governmental transfers) aimed at covering losses from "collective risks" investing Local administrations. We then study the potential role of private insurers in solving the under-investment problem in protection that stems from the free riding of Local administrations facing a transfer rule by the Central government, which takes into account the equalisation of resources across Regions. Our analysis shows that a public fund is always superior to the private insurance solution in the presence of hard budget constraints for Local administrations. However, when the Central government cannot credibly commit to an optimal transfer rule, private insurers are sometimes able to improve on the mutual public fund solution by inducing a higher level of investments. In other words, our results suggest that an answer to the question of why a public administration

should insure itself is because private insurers act as strategic substitutes of redistributive policies for the allocation of collective risks. Public administrations do actually buy insurances then because they believe to be intrinsically unable to commit not to intervene in the case of an adverse welfare shock. In the light of our analysis, this solution is probably unwarranted for small risks, for which central government can commit to a hard budget constraint regime. It is probably not enough for large catastrophic risks, for which also private insurers become rapidly unfit. Not surprisingly, we observe *mixed solutions* (a sort of "public-private partnerships"), where a public fund is combined with compulsory private insurances for Local administrations. An interesting issue that remains to be analysed is the superiority of this mixed institutional arrangement. This is left for future research.

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