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ADRIANA DI LIBERTO - FRANCESCO PIGLIARU

VESTED INTEREST AND LOCAL DECISION MAKING  
AS BARRIERS TO ERADICATING A PANDEMIC DISEASE.  
THE CASE OF AFRICAN SWINE FEVER IN SARDINIA

SOMMARIO: 1. Introduction. – 2. Commons. – 3. The tragedy of the commons. – 4. Sheep and pigs. – 5. Vertical subsidiarity. – 6. Conclusions.

1. African swine fever (ASF) is a highly contagious viral disease affecting pigs. There are neither vaccines nor cures. Despite the virus is harmless to humans, it causes significant socio-economic disruption in terms of financial losses due to the loss of animals and their products, and the cost of control measures.

In recent years, there has been a significant acceleration in its spread to Asia and Europe. As a recent WOAAH report states, “since January 2020, 10 countries have reported ASF as the first occurrence in the country, while 13 countries have reported its spread to new zones. ... This spread confirms the global threat of the disease and highlights the importance of implementing biosecurity measures” (WOAH, 2022).

Implementing these measures is a complex task, and typically, the disease can take several years to eradicate. The length of the eradication process is not caused by uncertainty about the appropriate health measures to adopt, since there is widespread agreement on these (for instance, European Commission, 2021). Rather, the challenge stems from the fact that these measures can only be successfully implemented with a broad consensus among the people and companies involved in the pig farming supply chain. In some cases, where pig farming reflects deeply rooted traditional practices, it can

be more difficult to obtain the necessary consensus to implement the eradication measures especially when these involve a significant part of the local communities. Several studies have recognized local cultural traditions as a critical component in the eradication of ASF (Chenais et al. 2015; Danzetta et al., 2020). Underestimating these aspects can damage the effectiveness of eradication interventions.

However, other socioeconomic factors may also have an equally significant role. In this study, we concentrate on rational decision-making by livestock farmers who prioritize profit maximization. Our specific aim is to assess how their choices may affect the context in which policies for the eradication of ASF are implemented and how to circumvent the barriers to effective actions. As far as we know, the analysis of the link between the presence of local economic mechanisms of this nature and the appropriate policy design to fight the pandemic have been mostly ignored in the current literature on ASF. In other words, we argue that the assessment of how economic incentives works at local level and how they may create barriers to ASF eradication is not context-free and should be taken into account. Institutional settings, farming methods, and land availability are examples of factors likely to exert an influence.

Our analysis focuses on the Italian island region of Sardinia. Since 1978, when it first appeared, the presence of ASF in the region has been a tale of persistence, spanning 40 years of failed policies attempting to eradicate the disease. Only recently the situation has significantly changed following the action taken by the Project Unit of the Sardinia Region established in 2014, which we discuss later. Our aim is to explain the reasons of these 40 years of inertia, focusing on economic rather than cultural factors.

We proceed as follows. We study two contexts in which economic rationality imposes barriers to the adoption of measures against ASF. First, we focus on private pig farmers based on open-access land. We show that this case boils down to the classical case of “the tragedy of the commons” (TTC): rational individuals have no incentive to choose a cooperative equilibrium in which anti-ASF regulation is adopted, and everybody is better off. This leaves a role to the public authority to act as the coordinator that would allow that equilibrium to be obtained.

Our TTC analysis explains why, despite the large overall costs of the pandemic, a community of shepherds may find it difficult to support the eradication measures. However, this does not explain the inertia of public authorities. Therefore, we propose a second hypothesis where economic vested interests are strictly linked with political interests and prevent any effective action to fight the pandemic.

In this case, we use a feature of the Sardinian context, namely in some area the livestock industry operators raise not only pigs but also sheep, with the latter being the primary source of economic profits on an open-access resource. Unlike the TTC case mentioned earlier, we show that the gains associated with eradicating ASF could be outweighed by the losses imposed on sheep farming activity due to strict regulation of open-access resources. Therefore, in the affected areas even very small economic incentives of profit-maximizing livestock operators may create obstacles to the adoption of anti-ASF measures. These obstacles are likely to materialize in the political arena, leading to a lack of electoral support for local government candidates who advocate for ASF regulations. In other words, when the responsibility to act against ASF is borne at local level, to avoid losing electoral support, the local policy makers may act against the implementation of effective actions to fight ASF. The result is that external costs are imposed on intensive pig farming in other parts of the region. We argue that this is a classic example of a “multilevel governance” problem, where the solution lies in transferring responsibility for action to a higher level where the decision maker is less likely to be influenced by the risk of losing consensus in the areas affected by ASF.

The remainder of this paper is organized as follows. In Section 2 we present some stylized facts about ASF in Sardinia and the role played by the “commons”, open-access lands of great importance especially in the mountain areas. In Section 3, we present a formal discussion of how the TTC approach can be applied to the ASF case in Sardinia. In Section 4, we extend the analysis to the joint presence of pigs and sheep in livestock firms in affected areas. In Section 5, we describe an important reform in the regional governance of the ASF epidemic and its apparent consequences in terms of the pre-post number of recorded outbreaks of ASF. Section 6 concludes.

2. The main factor contributing to the persistence of ASF in Sardinia is the tradition of free-range pig farming (henceforth FRP: free-range pigs), primarily practiced in the inner areas of the region. Figure 1 provides important information on the spread of ASF throughout the territory. Sardinian municipalities are classified on the basis of official records of outbreaks based on an index of disease persistence (Mur et al., 2014). The darker areas (which we henceforth call the “red zone”) identify municipalities in which the disease has been documented for a particularly long period. They represent what has been defined as the “reservoir” of the ASF. These are areas with a high density of SRF and wild boars (Loi et al., 2019), where 70% of outbreaks were recorded between 1978 and 2012 (Mur et al., 2014).

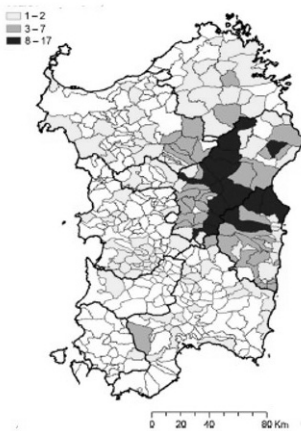


Figure 1. Persistence of ASF, years

The purpose of this type of FRP farming is typically self-consumption or supply to local informal markets. This traditional type of farming coexists with intensive farming practices conducted by modern companies that industrially process pork to obtain products for the formal market of small to large-scale distribution. For simplicity, we assume that the informal and formal sectors operate in separate market segments (more on this in Section 5 below).

In most cases, free-range pigs are managed illegally, without health certifications, veterinary, or other types of control by public authorities. This makes disease eradication extremely difficult. Epidemiological models have shown that in Sardinia, in the absence of FRP, ASF would be quickly eradicated, without the need for specific interventions on wild boars, which are also carriers of the disease in the same areas (Mur et al., 2014).

Why does Sardinia have the problem of FRP, with the associated high risk of disease persistence, and other Italian or European areas do not? The answer lies in the widespread use of “civic uses”



(“commons”, from now on), particularly in areas that, due to their altitude, are not cultivated and are mainly or exclusively suitable for farming.

As shown by data from the Regional Department of Agriculture, these lands are geographically concentrated. The province of Nuoro (including Ogliastra), which represents only 23% of the total regional area, has nearly 50% of the land subject to civic use. These are largely unsuited to agriculture due to their altitude.

Therefore, the persistence of ASF appears to be linked to the spread of FRP, favored by the presence of commons. However, before proceeding, it should be noted that commons are not necessarily a source of ASF diffusion. If properly regulated and governed, pig farming can be shielded from health risks, even when it is based on the exploitation of common lands. In this sense, the eradication of ASF centers on the problem of *collective capacity*, an essential factor for a territorial community to adopt, through informal rules and/or formal political and administrative representation, regulatory changes to traditional land use required by health rules.

To what extent does this initiative exist in Sardinian territories affected by the ASF? As we will see in detail later, official data and widespread anecdotes converge, signaling a considerable difficulty in providing the necessary regulations to ensure adequate management of such important collective resources. Therefore, this difficulty is fundamental for understanding the persistence of ASF in Sardinia. In the following Sections, we formulate hypotheses on economic mechanisms capable of explaining its causes.

3. To eradicate ASF, it is necessary to adopt rules and constraints necessary to combat the disease. These rules can be the result of informal norms that successfully develop within a community, or they can be adopted by formal political and administrative institutions of the same community.

We begin by analyzing the first hypothesis. Are local communities able to spontaneously implement the anti-ASF actions? To do so, a high level of cooperation among the parties involved is necessary. First, pig farming must move from an informal market, where no taxes are paid, sanitary protocols are ignored, and private costs are

very low, to a regulated market. Additionally, a transition from “free range” to “semi-free range” pig farming is necessary, where pigs are certified and controlled from a sanitary point of view and kept in properly enclosed areas. To impact the spread of ASF, a sufficiently high number of pig farmers must adhere to these rules and cooperate to enforce them. If successful, ASF can be eradicated, and the value of pork will increase.

Can this high level of cooperation be spontaneously generated among operators with free access to the collective resource? A classic answer to this question is the negative one provided by the so-called theory of the “tragedy of the commons” (TTC).

In the case at hand, the TTC is a situation in which farmers who use a collective resource act based on their own personal interests without coordinating with each other (coordination is costly). In the case where the number of farmers is too high relative to the available resources, individual choices lead to excessive use, a decline in quality, and harm to the community and each individual operator.<sup>1</sup>

To adapt this general result to our case, it is necessary to shift the emphasis from the general problem of pasture quality and sustainability to the diffusion of ASF. To this end, we assume that eradicating ASF simply requires farmers to reduce the number of pigs and that these pigs must be raised, as mentioned, in fenced areas (semi-free-range farming). Cooperation, therefore, entails costs (which we summarize here as the need to reduce the number of pigs) and benefits (the increase in the value of pork).<sup>2</sup> The problem is that, in the absence of coordination, the “cooperative equilibrium” will not be reached through individual initiative. Let’s see why.

Formally, we consider a situation where  $N$  farmers have access to a common of size  $\bar{T}$  for their free-range pigs. Let  $T_i$  be the land used by farmer  $i$ . We assume that all farmers are equal, so they use the same amount of land  $T_i = T/N$ , where ( $T \leq \bar{T}$  ( $T$  is the total amount of land used to raise FRP)). The number of FRP,  $n_s$ , is proportional to the size of the used land:  $n_s = \delta T$ . For simplicity, we as-

<sup>1</sup> The problem of overexploitation is also present in the Sardinian commons, especially those in the mountain areas. See Bullitta (1993).

<sup>2</sup> The formalization of the TTC in this Section is based on Gibbons (1992).

sume that  $\delta = 1$  in the remainder of this Section. Since reducing  $T$  helps to fight ASF, the value of the pork, which we define as  $v(T)$ , depends inversely on:  $T: v'(T) < 0$ . We assume that  $v''(T) = 0$  is also negative: the value of FRP decreases more quickly the closer the communal land  $\bar{T}$  is to being fully utilized. The profits of farmer  $i$  are as follows:

$$(1) \quad \pi_i = T_i v(T)$$

where  $T_i$  is included in  $T = \sum_i T_i$ ). Profit maximization requires that

$$(2) \quad v(T) + T_i v'(T) = 0$$

Equation (2) shows that every increase in  $T$  has two effects: first, the benefit that comes from the increase in the number of FRP, measured by the term  $v(T)$ ; second, the cost that reflects the reduction in the value of farmer  $i$ 's FRP stock, measured by the term  $T_i v'(T)$ . Note that each farmer evaluates the impact of this second effect solely on their own flock ( $T_i$ ) while ignoring its impact on the value of the stocks of all other farmers.

Let's consider the Nash equilibrium of this problem.<sup>3</sup> Let  $T_i^*$  be the value chosen by all the farmers in this equilibrium. If everyone chooses  $T_i^*$ , then farmer  $i$  will also choose  $T_i^*$ , as all the farmers are assumed to be equal.<sup>4</sup> When all the farmers choose  $T_i^*$ , the maximization of each farmer's profit is given by:

$$(3) \quad v(T^*) + \frac{T^*}{N} v'(T^*) = 0$$

In this case, individual choice leads to a sub-optimal outcome for the community as a whole. To demonstrate this point, we adopt

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<sup>3</sup> In this equilibrium, each player chooses, in the absence of cooperation, the best possible strategy based on the choices of other players. Once that position is reached, no player has an incentive to change his strategy if other players do not change theirs. This strategy, rational from an individual point of view, prevents achieving the optimal result from the point of view of the community.

<sup>4</sup> If another value of  $T_i$  were optimal would be optimal for farmer  $i$ , it would  $T_i^*$  also be optimal for all farmers. Consequently, would not be a Nash equilibrium.

an aggregate perspective. This perspective is conventionally attributed to an abstract figure called the “social planner,” whose role is to maximize not individual profit but that of the entire community of farmers. In this case, instead of starting from equation (1), we start from total profit defined by  $\pi = Tv(T)$  (with  $\pi = \sum_i \pi_i$ ). If we define  $T^{ps}$  as the optimal level chosen by the social planner, profit maximization implies that:

$$(4) \quad v(T^{ps}) + T^{ps}v'(T^{ps}) = 0$$

Clearly, the social planner must consider the fact that the decrease in the value of pigs due to the increase in FRP affects the stocks of *all* farmers, an aggregate effect that the individual farmer ignores.

The implication of this result is that individual choices lead to an excessive exploitation of  $\bar{T}$ , resulting in harm to the community. The reason for this is as follows: Equation (3) is satisfied by  $T^*$ . Let us evaluate condition (4) for  $T = T^*$ . While the first term on the left-hand side is equal in value in both equations, the second term is smaller in equation (4) because, in this case,  $T^*$  is not divided by  $N$ . Therefore, the sum of the left-hand side of equation (4) is negative for  $T = T^*$ . Satisfying condition (4) requires values lower than  $T^*$  such that  $v(T)$  rises and  $|v'(T)|$  falls (because  $v''(T) < 0$ ). In summary, maximizing aggregate profit requires  $T^{ps}$  to be less than  $T^*$ . This result depends on the fact that the social planner considers the externality associated with each individual farmer’s choice of  $T$ ; if not taken into account, it would result in an excessive presence of FRP which, in turn, would make eradication of the disease more difficult.

Individual choices, therefore, do not favor the adoption of spontaneous rules capable of obtaining, through cooperation, an optimal self-regulation of the resource.<sup>6</sup> This failure of the individual incentive justifies coordinated action by the public authority. In its

<sup>5</sup> Remember that  $T^*v'(T^*)$  and  $\frac{T^*}{N}v'(T^*)$  are negative numbers since  $v'(T^*) < 0$ .

<sup>6</sup> There are examples of communities where cooperative equilibrium has prevailed even in the absence of intervention by public authorities. These communities are generally characterized by a high level of civic capital, in which cooperation is based on a collective culture of reciprocity, reputation, and trust (Ostrom, 1990).

absence, the overall profit and that of each individual operator are lower than those achievable with a coordinated action.

In the present context, pig farmers should look favorably upon the intervention of the public authority (at any level of government) and the resulting regulation, since it would produce an increase in the payoff of all operators involved. However, as we have already mentioned (and as we will see better in a moment), regional data over the years have revealed a widespread difficulty on the part of public authorities in adopting actions to combat ASF. Clearly, to explain this difficulty, it is necessary to identify additional mechanisms to complement those analyzed in this Section. In the next Section, a modified analytical context will allow us to identify some of the factors that may have hindered the action of the public authorities responsible for the fight against ASF.

4. In mountainous commons, farmers often work simultaneously with sheep and pigs, with FRP relegated to marginal activity (Bullitta, 1993; Porcu et al., 2004; Meloni and Farinella, 2015). Therefore, in this Section we broaden our analysis to a more realistic case in which operators' profits depend on this mixed form of farming.

In setting up the analysis that follows, we will consider that the European legislation identifies two reasons for public intervention against ASF. The first relates to strict health reasons, and the second to the economic damage that ASF causes to the pig sector as a whole. We separately analyze these two cases, starting with the one in which regulation responds to health needs.

To simplify the analysis, in this part we will assume that the coordination problems discussed at length in the previous pages have been overcome, and therefore the decisions of the farmers are not influenced by the difficulties of this nature.<sup>7</sup>

*Regulation based on health measures.* In this case, the public authority is responsible for identifying the needed level of regulation

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<sup>7</sup> From a technical point of view, a simple way to put the TTC problem aside is to assume that  $N$  is equal to one.

based solely on health data, independent of broader economic assessments.

To evaluate the impact of this regulation on farmers' activities, we use a simple function in which profits depend, as mentioned, on both sheep and pig farming. In the case of sheep, for which there is no health problems due to ASF, *fewer* constraints on the use of communal land always lead to higher profits, but this is not necessarily true for pig farming.

Let's see in detail. The basic assumptions are as follows. The price of sheep products is constant, meaning that it does not depend on the number of sheep brought to the pasture.<sup>8</sup>

As before,  $\bar{T}$  is the total size of the communal land and the number of FRP is  $n_s = \delta T$ . The number of sheep is also proportional to the land used:  $n_o = \alpha T$ . The regulation of fighting ASF has two contrasting effects on profits. First, it reduces the land available to farmers,<sup>9</sup> with a negative effect on the profits generated by the quantity of products obtained from both sheep and pig farming. Second, as in the previous Section, it has a positive effect because it increases the quality of pig meat and its value  $v_s(\delta T)$ , which therefore moves inversely with  $T$  (as before,  $v_s'(\delta T) < 0$  and  $v_s''(\delta T) < 0$ ). Profits<sup>10</sup> are given by:

$$(5) \quad \pi = \bar{p}_o n_o + v_s(T) n_s = \bar{p}_o \alpha T + v_s(\delta T) \delta T$$

where and define the proportion of sheep and pigs for any value of  $T$ . The condition for maximum profit is

$$(6) \quad \bar{p}_o \alpha + v_s(\delta T) \delta + v_s'(\delta T) \delta T = 0$$

The profits from this type of joint production follow the trend shown by the dashed parabola in Figure 2. The parabola is calcu-

---

<sup>8</sup> This assumption describes the situation of a small economy compared to national and international markets in which the product is traded.

<sup>9</sup> For example, the mentioned need to create large enclosures to allow semi-wild pig grazing protected from the risk of contagion subtracts available pasture for sheep.

<sup>10</sup> For simplicity, costs are ignored.

lated by setting  $\alpha = \delta$  to obtain a general reference point for subsequent analysis.<sup>11</sup> When the area used for grazing ( $T$ ) is small, increases in its extension, and thus more sheep and more FRP, have an overall positive effect. In this first phase, the reduction in the value of pig products, determined by the easier circulation of ASF due to the increased number of FRP, has little impact. As  $T$  increases, the negative factor gains more weight and generates a descending parabolic trend. The point corresponding to the vertex of the parabola maximizes profits,<sup>12</sup> and, therefore, will be chosen by economically rational farmers in the absence of public regulation. In the graph, this point is identified by  $T'$ .

Let us now move to the specific case of Sardinia, in which it is necessary to consider the greater importance of sheep compared to pigs. According to official Istat data, in 2020 there were about three million sheep and just over one hundred thousand pigs, with a ratio of 27 to 1. Using this information and calculating the profit function with  $\alpha = \delta$ , we obtain the trend described by the solid line in Figure 2. Compared to the case of  $\alpha = \delta$  (the dashed line), the increasing part of the parabola becomes wider, thus extending the range of values of for which the farmers' profits increase in proportion to the overall number of animals raised (the simultaneous decrease in the value of pigs due to the presence of ASF has a slower impact).

More generally, this result shows that the higher the ovine component, the higher the optimal level of  $T$  is for the individual farmer. The intuition is simple: if pigs count little in the overall profit calculation, the loss of value of their products caused by the persistence of ASF also counts little.<sup>13</sup> In the specific case of the continuous line shown in Figure 2, profits are maximized at  $T''$ .

---

<sup>11</sup> To compute Figure 2,  $v_s(\delta T)$  in equation (5) takes the specific form of  $(A - (\delta T)^\gamma)$ , with  $\gamma > 1$  and, therefore,  $v'(\delta T) < 0$  e  $v''(\delta T) < 0$ , consistent with the assumptions adopted in our analysis.

<sup>12</sup> The value of  $T$  that solves equation (6).

<sup>13</sup> In the extreme case where  $\delta$  were equal to zero, the profit function would have a constant positive slope, and for livestock farmers, the optimal level of would  $T$  coincide with the entire communal area  $\bar{T}$ .

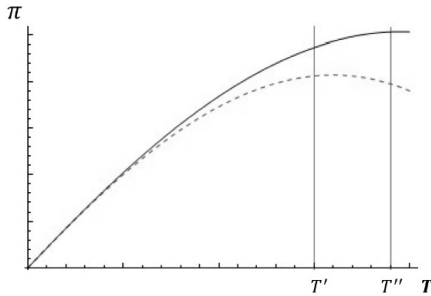


Figure 2. Profits and use of the common

Now, let us suppose that health data indicate that it is necessary to reduce grazing levels to  $T^{ps}$ . Figure 2 shows that the greater the sheep component, the greater is the reduction in profit generated by this regulated grazing level.<sup>14</sup> Consequently, the more the sheep component dominates in farming activity, the more plausible it is that actions to counter ASF, based on tightening the rules governing access to civic uses, will encounter significant resistance in the local community.

actions to counter ASF, based on tightening the rules governing access to civic uses, will encounter significant resistance in the local community.

Unlike the case of the TTC analyzed above, in this new context, an anti-ASF intervention announced by the local government (or by candidates for it) could encounter serious difficulties in garnering a sufficiently broad consensus. In other words, we are facing a possible obstacle to the eradication of ASF, both economic (the cost in terms of expected profits) and political (the creation of a consensus).

*Economic-based regulation.* Let us now set aside strictly health-related issues and address the problem of the overall economic effects of ASF.

Let us return to Figure 2 for a moment. If sheep and FRP farmers were left free to choose, they would opt to coexist with ASF, because the damage from the disease would be more than compensated by the scale of production allowed by the absence of restrictive regulations. From a technical point of view, this choice would be perfectly rational because it would maximize their profit (point  $T''$ ). However, this decision refers to this particular group of farmers and does not necessarily coincide with the optimal solution for the entire pig-farming sector.

<sup>14</sup> “Many sheep” means moving along the solid line, passing from  $T''$  to  $T^{\pi\sigma}$ , with a greater reduction in profits than would be obtained with a lower proportion of sheep, which would require moving from  $T''$  to  $T^{\pi\sigma}$  along the dotted line.



In addition to the farmers considered so far, whom we will call “type A farmers,” there are also modern and intensive pig farms in the pig farming sector that are different and parallel to traditional FRP farming. These are companies whose facilities typically occupy private land, which do not compete for the use of available land in municipal areas, and which do not simultaneously raise sheep (we will call them “type B farmers”).

The presence or absence of ASF has an important effect on the economic prospects of these intensive farms because it determines the possibility of exporting their goods or whether they must remain confined to the regional market. This is, therefore, an additional “externality” of the phenomenon: the decisions of type A farmers inevitably involve other sectors of the pig farming industry. This external effect is ignored by these farmers and is absent in equation (5). To consider this effect, we use again the “social planner” viewpoint. To this aim, we assume that the quantity of pigs raised in intensive farms (IF) is fixed, equal to  $\bar{N}_I$ . Using the previous notation, the externality can be represented as  $v_I(\delta T)\bar{N}_I$  (with  $v'_I(\delta T) < 0$ ,  $v''_I(\delta T) < 0$ ), where the value of the products obtained by IF depends on the spread of ASF and, therefore, on the size of the free pasture that type A farmers decide to use for their sheep and pigs.

Without loss of generality, we simplify the notation by assuming that  $v_I(\delta T) = v_s(\delta T)$  and write the profits for the entire informal and formal sectors as follows:

$$(7) \quad \pi = \bar{p}_0\alpha T + v_s(\delta T)\delta T + v_s(\delta T)\bar{N}_I$$

As usual, maximization requires that

$$(8) \quad \bar{p}_0\alpha + v_s(\delta T)\delta + v'_s(\delta T)(\delta T + \bar{N}_I) = 0$$

By comparing the conditions defined by equations (6) and (8), and using a similar scheme as in Section 3 for equations (3) and (4), it is possible to show that the value of  $T$  that solves the social planner’s problem (the condition posed by equation 8) is lower than the value chosen by type A farmers (condition 6), who, as mentioned, maximize their profit by ignoring the external effect on intensive farms.

Figure 3(a) shows the values of the first member of equations (6) (dashed line) and (8) (solid line) as  $T$  varies. For  $T = T^*$ , equation (6) is satisfied but not equation (8), that of the social planner. For the latter value to be zero,  $T$  must be reduced to  $T^{ps}$ .

Figure 3(b) shows that the choice of farmers to go beyond the socially optimal level  $T^{ps}$  increases their profits (dashed line) but harms the overall economic outcome of the sector: the solid line describes the trend of total profit which, as can be seen, is higher at  $T^{ps}$  than at  $T^*$ . In other words, the increase in farmers' profit between  $T^{ps}$  and  $T^*$  comes at the expense of IF companies.<sup>5</sup>

Once again, the problem arises of how to bring the breeding sector to its optimal production level,  $T^{ps}$ .

The transition from  $T^*$  to  $T^{ps}$  imposes a cost on farmers of type A: the contraction of pastures generates a reduction in their profits, and it is plausible that this determines their resistance to proposals for regulation of this nature. This confirms what we analyzed in the previous case: in areas characterized by sheep and pig farming that use public land, public action may encounter difficulties in obtaining the necessary consent to adopt and implement actions to counter ASF.<sup>6</sup> In these territories, it is likely that economic obstacles to eradication exist and are high. Are they insurmountable? To answer this, it is necessary to consider that there are various levels of government, and that among these it is important to identify the one that can most adopt the social planner's point of view. This will be addressed in the next Section.

<sup>15</sup> It can also be shown that the damages caused to this sector by the unregulated choice of livestock farmers increase as (the ovine component) increases, because, as shown in Figure 2, the level of  $T^*$  increases, which depresses the value of pork products; and obviously as  $N_I$  (the size of the sector) increases.

<sup>16</sup> Examples of potential obstacles other than the electoral one analyzed in the text, including illegal ones, can be easily integrated into the framework outlined. The "Gruppo di Intervento Giuridico", for example, emphasizes that "thousands of hectares illegally occupied await recovery for collective use." (<https://gruppodinterventogiuridicoweb.com/2020/03/01/sardegna-ecco-il-nuovo-quasi-completo-inventario-regionale-delle-terre-civiche-il-92-dei-comuni-della-sardegna-ha-terreni-a-uso-civico/>).

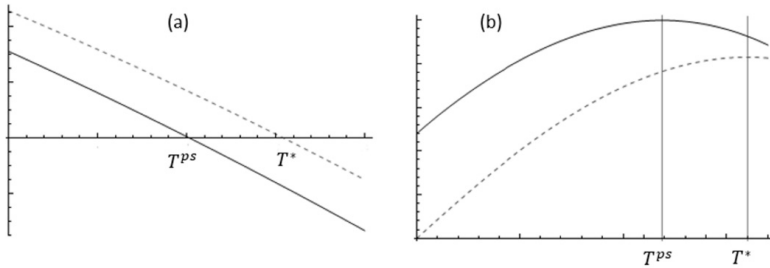


Figure 3. Optimal choice: the social planner and private farmers

5. In summary, we have shown that there may be groups of stakeholders with opposing interests: for one group, type B farmers, owners of intensive pig farms, eradicating ASF is crucial. For the other group, type A farmers, typically located in the “red zone,” it is not. Therefore, aggregate welfare is likely to be damaged if type A farmers decided for everyone, in the absence of constraints defined by adequate public norms.

How is this opposition of interests resolved? The “social planner” is obviously a theoretical construction: in the real world, choices are based on electoral mechanisms that allow those entitled to vote to express themselves, conditioning government action.

Existing regulations tend to assign responsibility for ASF control to the mayors of areas where the disease is present. Is this the most suitable level of government to pursue the general interest? This question implies another: to what extent are the above-mentioned opposing interests represented in the electorate of the areas affected by ASF?

An idea about the composition of the electorate of the municipalities in the “red zone” can be obtained from Figure 4. There is a high probability that in the areas in question, type A farmers have a significantly greater presence than type B farmers. In the province of Nuoro, in 2021, sheep farms per square kilometer were 0.90 compared to a regional average of 0.59. Figure 4 shows that the opposite is true for pig farms, which are largely located in other areas: 88% of “closed-cycle” breeding pigs are raised on farms located outside the province of Nuoro (LAORE, 2019).

Therefore, attributing the responsibility for ASF control to the municipal level of government empowers an electorate dominated by local interests. Interests that could lead to “voting” in favor of coexistence with the disease, making it difficult for local authorities to adopt adequate control actions.

In general, in cases where the decisions of individual territorial units impose costs on those who live and operate outside those territories, the intervention of a higher level of government is required, a level capable of considering the costs generated by the externality described in the previous pages.

It is ultimately a matter of applying the general principle of *vertical subsidiarity*: In case of difficulties in implementing actions that pursue the public interest, the responsibility for action should be transferred to a level of government that is less influenced by the local context.

The regional law of December 22, 2014, n. 34, cited at the beginning of this work, is inspired by this principle. In fact, it was born with the explicit objective of overcoming obstacles of context and local interests that could induce “inertia” in mayors. In these cases, the law states that responsibility is urgently transferred to a specific Project Unit of the Region of Sardinia, a higher level of government.

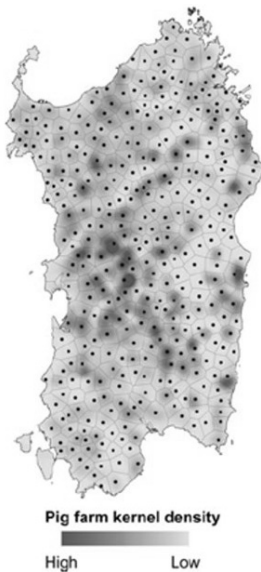


Figure 4. Distribution of industrial farms

The law was implemented in 2015, and today it is possible to begin evaluating what changes have accompanied its implementation. The effects of the transfer of responsibility provided by it are widely considered positive. In fact, ASF outbreaks have gone from an average of 75 per year in 2012-2014 to their complete disappearance from September 2018 to today.

Such clear results help give plausibility to the point developed in Section 4, according to which the local level of government is not the optimal one to adopt policies to combat ASF. The transfer of responsibility

carried out starting in 2015 presumably freed public action from obstacles that had limited the initiative of the local government.

However, even in this case, we are faced with an indication, not a proven causal relationship. Furthermore, it is too early to analyze the long-term effects on the value of Sardinian pork products of the partial green light for exports obtained from the European Commission. In the future, it will be important to evaluate these aspects empirically. After the emergency phase of ASF, it is necessary to thoroughly understand the nature of the local obstacles that have prevented and continue to prevent adequate regulation of customary uses.

6. Several studies have acknowledged that local cultural traditions, if not carefully considered, may become obstacles to the process of eradicating ASF, a viral disease of pigs and wild boar that in recent years has spread to EU and neighbouring non-EU countries, with recent outbreaks also in Asia, Oceania and some American countries. Other socioeconomic factors may also have an equally significant role, and it is important to identify them. In this study, our focus is on rational decision-making by livestock farmers, who prioritize profit maximization. Such purely economic mechanisms have largely been disregarded in the existing literature on ASF.

We focused on the case of Sardinia, where ASF was present for four decades, starting in 1978. What makes this case interesting is the tradition of free-range grazing of pigs in the common lands, and the presence of potentially large gains from ASF eradication. Faced with the appearance of ASF, one would expect to see widespread willingness to adopt measures necessary to fight it. However, these measures have been widely ignored.

In this study, we formulate two hypotheses based purely on economic mechanisms, which may explain the barriers to the implementation of the anti-AFS rules. First, we have shown that the lack of self-regulating rules in the case of ASF is a particular case of the more general one known as “the tragedy of the commons.” Individual farmers do not consider the externality associated with their choice of how many pigs to raise. This results in an excessive presence of free-range pigs in the common which, in turn, makes eradicating the disease more difficult.

Second, we have analyzed the rational choice of individual farmers in the case of mixed farming of sheep and pigs, with the latter in a marginal position, as typical in Sardinia. In this case, we have shown that the large collective gains from eradicating ASF may be more than offset by the small individual cost generated by the limitations on local sheep farming. Therefore, in this case, local politicians may encounter difficulties in obtaining the necessary consent to adopt and implement actions to counter ASF.

This latter result reveals a problem of multi-level governance: attributing the responsibility for implementing measures against ASF to local politicians may not be optimal. A more effective policy would be to transfer the responsibility to a level of government less influenced by the local context.

These hypothesis find some empirical support in the recent episode of the fight against ASF in Sardinia. We focused on the case of the Italian region of Sardinia where ASF was present for four decades, starting in 1978. What makes this case-study interesting is the tradition of free-range grazing of pigs in the common lands, and the presence of potentially large gains from ASF eradication. Faced with the appearance of ASF, one would expect to see widespread willingness to adopt measures necessary to fight it.

However, since the governance of the eradication process was responsibility of the local policy makers these measures have been widely ignored.

Only in 2014, the regional government adopted a law with the explicit objective of overcoming obstacles created by local interests that could induce “inertia” in mayors. In case of inaction, the law provides that responsibility should be urgently transferred to a specific Project Unit of the Region of Sardinia. After the implementation of the law began, the number of ASF outbreaks decreased from an average of 75 per year in 2012-2014 to complete disappearance from September 2018 to today. Although this dramatic decrease in outbreaks does not demonstrate a causal effect from the adoption of the law to the disappearance of outbreaks, it encourages further empirical research on the effect that this change in the level of government may have played.

Overall, this analysis confirms that eradicating pandemic diseases requires considering factors that extend beyond health considerations. Given the presence of externalities, any action should be based on a preliminary and careful analysis of the local context and its social, cultural, or even purely economic characteristics that may create barriers to eradication. Additionally, effective implementation of local policies may require higher levels of governance to prevent small vested interests at the local level from generating negative effects on neighboring territories.

### References

- BULLITTA, PIETRO, 1993, *Aspetti e problemi nell'utilizzazione dei pascoli montani*, Delfino Editore, 263-272.
- CANALI G., L. FIORITI, M. MERENYI, P. PARMIGIANI e M. RONGA, 2020, La competitività del settore agricolo, *Rete Rurale Nazionale - Ministero delle politiche agricole alimentari e forestali*.
- CAPPAI S., S. ROLESU, A. COCCOLLONEA, A. LADDOMADA, F. LOI, 2018, Evaluation of biological and socio-economic factors related to persistence of African swine fever in Sardinia, *Preventive Veterinary Medicine*.
- CHENAIS E., S. BOQVIST, S. STERNBERG-LEWERIN, U. EMANUELSON, E. OUMA, M. DIONE, T. ALIRO, F. CRAFOORD, C. MASEMBE, K. STÄHL, 2015, Knowledge, Attitudes and Practices Related to African Swine Fever Within Smallholder Pig Production in Northern Uganda, *Transboundary and Emerging Diseases*, 64(1).
- DANZETTA, M.L., MARENZONI, M.L., IANNETTI, S., TIZZANI, P., CALISTRI, P., & FELIZIANI, F. (2020). African Swine Fever: Lessons to Learn from Past Eradication Experiences. A Systematic Review. *Frontiers in Veterinary Science*, 7.
- EUROPEAN COMMISSION, 2021, [<https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02021R0605-20210428&qid=1676634887239&from=en>].
- HUGHES G., S. SMITH, 1991, Economic Aspects of Decentralized Government: Structure, Functions and Finance, *Economic Policy*.
- JURADO C., E. FERNANDEZ-CARRION, L. MUR, S. ROLESU, A. LADDOMADA E J.M. SANCHEZ-VIZCAINO, 2017, Why is African swine fever still present in Sardinia?, *Transboundary and Emergency Diseases*.
- LAORE, 2019, *Filiera suinicola in Sardegna: dati su allevamento e macellazioni*, Cagliari.

- LOI F., LADDOMADA A., COCCOLLONE A., MARROCU E., PISEDU T., MASALA G., 2019, Socio-economic factors as indicators for various animal diseases in Sardinia, *PLoS ONE*, 14(6).
- MELONI B., D. FARINELLA, 2015, Cambiamenti ed evoluzione del pastoralismo in Sardegna, *Agriregionieuropa*, 11(43).
- MULLANO C., 2022, *La regolamentazione pubblica delle risorse collettive. L'analisi economica e il caso degli usi civici in Sardegna*, Università di Cagliari, Corso di laurea magistrale a ciclo unico in Giurisprudenza, Tesi di laurea.
- MUR L., M. ATZENI, B. MARTÍNEZ-LÓPEZ, F. FELIZIANI, S. ROLESU e J.M. SANCHEZ-VIZCAINO, 2014, Thirty-Five-Year Presence of African Swine Fever in Sardinia: History, Evolution and Risk Factors for Disease Maintenance, *Transboundary and Emerging Diseases*.
- OSTROM E., 1990, *Governing the Commons*, Cambridge.
- WOAH 2022 [<https://www.woah.org/app/uploads/2022/08/asf-report18.pdf>].

### *Abstract*

African swine fever (ASF) is a highly contagious disease that affects pigs and has rapidly spread across Asia and Europe. While eradicating ASF brings large benefits, achieving a broad consensus among stakeholders for the necessary health measures can be challenging. The case of Sardinia, where efforts to eliminate ASF have failed for an extended period, exemplifies this challenge. The measures to combat ASF have long been ignored by those working in the sector and the authorities responsible for their implementation. Our goal is to explain this inertia. To achieve this aim, we focus on purely economic factors. Our hypothesis is that at the local level, farmers' self-interest may conflict with the goal of eradicating ASF, thereby hindering progress. In this study, we provide a formal analysis of this hypothesis. The main implication of our findings is that responsibility for fighting ASF should be assigned to a level of government that is less influenced by local economic and political barriers.



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One of the authors, Francesco Pigliaru, was President of the Region from 2014 to 2019, during the period in which Regional Law no. 34 of December 22, 2014, was adopted and implemented.