



# High-voltage overhead transmission lines and farmland value: Evidences from the real estate market in Apulia, southern Italy



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## ABSTRACT

The construction of high-voltage overhead transmission lines on farmland implies a permanent easement, involving expropriation of land and depreciation of the remaining farm area. The Italian system operator should pay compensation for both aspects, but recognizes only the former. Therefore, landowners often appeal to the law courts and claim compensation for the depreciation of the entire non-occupied area, often obliging the system operator to pay substantial amounts. This delays the provision of new power lines and increases their respective costs.

In order to verify the correctness of the *modus operandi* by the system operator and landowners, a study was carried out into the impact of several characteristics of power lines on farmland value in northern Apulia, south Italy. The results highlighted that the area occupied by plinths and cabins, the height of towers and the type of intersection were the main sources of depreciation, which varies depending on the crop. Moreover, depreciation on the residual area exists, but only involves two narrow strips of land on either side of infrastructure. Finally, it is not constant, but tends to decrease rapidly as the distance from the infrastructure increases, and zeroes at 30–70 m from the power line.

## 1. Introduction

The Italian national electricity grid has a total of 71,000 km of lines, consisting of 49,000 km of 150 kV-lines and 22,000 km of 220–380 kV-lines (High-Voltage Overhead Transmission Lines - HVOTLs), with a density of 0.23 km per km<sup>2</sup> (Terna, 2015). Terna S.p.a. is the national transmission system operator, which owns and manages the power lines, together with their planning and development. Between 1992 and 2015, 220-kV lines decreased by 23%, but 150- and 380-kV lines increased by 15% and 20%, respectively. In Apulia Region, southern Italy, the energy demand has increased by 18% over the last twenty years (Regione Puglia, 2014), thus requiring modernization and improvements to the regional HVOTL grid, including new infrastructures, especially on extra urban areas.

The construction of HVOTLs on cultivated land implies several problems: occupation of land by the plinths of towers, electric cabins, etc.; disturbance of agricultural activities for inspection and maintenance; visual and landscape impacts; damage to crops during installation phase; reduced farm profitability; influence on future land uses; depreciation of farmland. Therefore, the assessment of suitable compensations related to these issues is necessary and usually refers to two aspects, namely land expropriation for occupation by power line

components and depreciation of the residual (i.e. unoccupied) farmland. The Italian transmission system operator considers only the former, which is calculated as the sum of the following economic items: 100% of the market value of the occupied areas; 25% of the market value of the area of cable projected onto the ground; 7% of the market value of the respect areas. Additional returns are recognized in the case of direct management of farm by the landowner and of voluntary acceptance of the compensation calculated.

However, the construction of HVOTLs often also causes depreciation of the remaining farm area. Hence, the following questions:

- does the depreciation concern the entire residual area, or only a part of it?
- does the effect of depreciation remain constant over the affected area, or does it progressively decrease to zero at a certain distance?

Answering these questions is crucial for fair compensation mechanisms. For example, the impact of power lines on the value of residential properties tends to decrease rapidly as the distance from the power lines increases (Colwell and Foley, 1979; Hamilton and Schwann, 1995), so that only a part of the total area is affected and should be compensated. Nevertheless, as said, the Italian system

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operator does not include this further effect in assessment of total compensation, so that landowners often appeal to law courts claiming that the entire residual farm area has decreased in value, entitling them to the maximum level of compensation. Finally, the system operator uses subjective criteria to assess the compensation related to land expropriation and does not consider the depreciation of the remaining farmland; landowners, however, subjectively claim the highest compensation on the residual area, forcing the system operator to make substantial payments. This clash of interests causes difficulties in siting (Vajjhala and Fischbeck, 2007), delays in the provision of new power lines, and considerably increases the cost of these infrastructures (Buijs et al., 2011; Cotton and Devine-Wright, 2013; Jay, 2004).

Only the real estate market of farmlands can provide useful information capable of resolving this conflict, hence the need for accurate studies able to measure the influence of power lines on the value of these properties. Therefore this paper: a) investigated the influence of HVOTL characteristics on farmland value; b) assessed the coefficients related to the impacts of power line characteristics on farmland value, in order to apply them to quantify total compensation for the construction of new HVOTLs; c) studied the extent and trend of depreciation on the residual farmland. In other terms, the paper detects real-estate market-based criteria for the assessment of proper compensations in the presence of HVOTLs on farmland, and at the same time checks the consistency of the economic behaviours by the system operator and landowners. The analysis focused on northern Apulia (southern Italy), and referred to the region's three most important crops (durum wheat, olives and vines).

The paper contributes to the literature in two ways. Firstly, no applied economic study has investigated the impact of HVOTL characteristics on farmland value in Italy, or focused on different crops. Secondly, this research helps stakeholders and decision makers with suitable compensation criteria for the construction of new power lines on private farms. Moreover, the findings allow the definition of useful indicators for grid development plans and related strategic environmental assessment.

## 2. Literature review

Electricity transmission via HVOTLs can produce many negative externalities. They include: landscape and visual impacts (Tempesta et al., 2014; Devine-Wright and Batel, 2013); health risks associated with electrical and magnetic fields (Bickel and Friedrich, 2005); damage to the environment and wildlife (Sumper et al., 2010); damage to scientific, historical and cultural areas; reduced profitability of productive activities; land use conflicts (Doukas et al., 2011); decreased property values (Furby et al., 1988). The academic literature about the land depreciation is generally dated and mainly focused on residential areas (Chalmers and Voorvaart, 2009). In particular, when negative impacts are evident, studies have highlighted a discount between 1% and 10% of property value (Pitts and Jackson, 2007; Des Rosiers, 2002), which decreased rapidly as the distance from the power line increased, and usually disappeared at 60–90 m from the HVOTL (Colwell, 1990). No significant effect was found on the selling prices of vacant residential land with future potential residential use (Blinder, 1979; Kinnard and Mitchell, 1988; Mitchell and Kinnard, 1996).

The effects on the value of properties in rural areas were also uncertain. Several authors (Brown, 1976; Chalmers, 2012) found no effects, even where land use was recreational (for example, with a high level of environmental amenity) and rural-residential. On the contrary, Woods (1981) found some effect in a few percentage points, but perhaps related to the fact that these farms would soon become residential areas. Ball (1989) highlighted a 2% reduction, while Jackson and Pitts (2010) assessed a depreciation of 1–2.5%, although this was considered too small to be statistically significant and attributable to the presence of the line alone.

The above studies, which were mostly carried out in the US,

highlighted that the impacts of power lines on farmland value are varied and difficult to measure (Pitts and Jackson, 2007), giving conflicting results. Therefore, it is very difficult to generalise, since these studies involve a wide variety of property type and size, market segment, configuration and location, type of power lines and towers, as well as type and quality of the statistical approaches used (Wyman and Worzala, 2013). Moreover, many of these independent studies were not actually independent, but were financed by power line companies (Kinnard, 1990; Kroll and Priestly, 1992), who obviously have an interest in demonstrating a negligible impact on property value.

## 3. Materials and methods

### 3.1. Data and variables

The study focused on farmlands in the Municipalities of Ortanova, Foggia, Lucera, Troia and San Severo, in Apulia Region, southern Italy. Over the last decade, there has been significant expansion of HVOTLs in this area, raising issues concerning the payment of unfair compensation and generating conflictual siting, as well as delays in planning and construction of power lines.

The most common crops in the area are durum wheat (46.7% of the utilized agricultural area - UAA), olives for oil production (9.8%), and vine (5.4%) (Istat, 2017). Hence, the analysis referred to these crops, characterized by very different quantities of productive factors involved, i.e. land, labour and capital. In particular, durum wheat is characterized by large properties, and small use of labour and capital. Olive groves are related to medium-size properties and moderate recourse to labour and capital. Finally, vineyards have opposite characteristics compared to durum wheat fields.

The study was based on a comparison of properties with and without HVOTLs (Table 1), so that two samples were assembled, per crop. Data, collected from real estate transfer acts (62%) and estate agencies (38%), referred to transactions from 2011 to 2016, corresponding to a relatively stable period in the local land market. Using direct interviews with lawyers, brokers and landowners, several variables were identified as influencing the selling price of properties without power lines: the farm area (coded as *Area* and expressed in hectares), able to exploit economies of scale related to labour and capital and directly correlated to the selling price; the yield (*Yield* - tonne hectare<sup>-1</sup>) for durum wheat fields and vineyards, which influenced revenues and was directly correlated to the selling price; the age of plant (*Age* - Years) for olive groves, which influenced revenues and was directly correlated to the selling price; the orthogonal distance from the farm centre to the nearest HVOTL on nearby properties (*Proximity* - Metres), considered as an indicator of the influence of power lines on surrounding farms, and assumed to be directly correlated to the selling price; the distance between the urban residence of the landowner and its property (*Distance* - Kilometres), indicating more rapid movement to and from the workplace and assumed to be inversely correlated to the selling price; the location of the farm along highways or provincial roads (*Road* - Yes/No), which was an indicator of a faster and easier transport of commodities to and from market places, and was assumed to be directly correlated to the selling price. Finally, the effect of irrigation was not analysed, as it was always present in the olive groves and vineyards, but never in the durum wheat fields, regardless of HVOTLs.

The following additional variables were considered for properties with HVOTLs. The ratio between the area occupied by the infrastructure components (plinths, electric cabins, etc.) and the total farm area (*Occupied area* - Percentage) was an important indicator related to the expropriation of land, with further possible implications for farm layout (e.g. changes to farm roads) and managerial strategies (i.e. increased cultivation costs, variations in agronomic practices, etc.). The increase in this ratio was assumed to be directly related to the

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