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From productivity to abandonment: Sub-national evidence from the Italian farm sector in the context of EU agricultural policy

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A B S T R A C T

Farmland abandonment is a growing concern, with labour productivity playing a central role. Using FADN (Farm Accountancy Data Network) data (2010–2022), segmented by type of farming, macro-area, and economic size, this study analyses Italian farm labour productivity, both gross and net of EU subsidies. Results show that more than one third of Italian farms, representing over 2 million hectares of Utilised Agricultural Area, present great difficulties in achieving levels of value added per worker adequate to sustain their activity. Olive farms are the most exposed, with more than half at risk of abandonment, particularly medium-sized farms in the South and Islands. While viticulture shows moderate resilience, arable farms have experienced persistent declines in real productivity, largely due to reduced subsidies. Convergence analysis highlights widening structural disparities, particularly between the Centre and the South. These findings stress the urgent need for a reflection on current strategies addressing the issue of farm abandonment.

1. Introduction

Over recent decades, farmland abandonment has become a pressing issue across Europe (Calafat-Marzal et al., 2023; Fayet et al., 2022; Dax et al., 2021). According to the Joint Research Centre (2018), approximately 11 % of the EU's Utilised Agricultural Area (UAA), equivalent to more than 20 million hectares, faces a high risk of abandonment by 2030. Large swathes of cultivated land are being left unused. This process is particularly evident in areas where traditional low-input farming systems are no longer viable (Cusens et al., 2024; Quintas-Soriano et al., 2022; Ustaoglu and Collier, 2018). While widespread across Europe, the causes of abandonment differ regionally, reflecting local conditions and broader policy contexts (Vik et al., 2025; Pawlewicz et al., 2023; Renwick et al., 2013). Factors range from natural limitations and environmental degradation to socioeconomic and demographic changes, as well as institutional frameworks (Xie et al., 2025; FAO, 2006). Among these, low and unstable agricultural income and the widening gap between farm earnings and alternative employment opportunities are consistently identified as decisive triggers: when farming does not provide a viable livelihood, out-migration becomes a rational response, accelerating depopulation and withdrawal from agriculture (Romero-Díaz et al., 2024; Lasanta et al., 2017).

Within this context, agricultural labour productivity emerges as a critical link between income generation and abandonment risk. Low labour productivity implies low returns per unit of work, directly undermining the capacity of farms to ensure sustainable livelihoods. Productivity is therefore not only a technical measure of efficiency but also an economic indicator of farm viability and social resilience. A pan-European analysis shows that productivity and competitiveness drive the concentration of production in the most efficient areas, while less productive regions struggle to maintain sufficient incomes and face higher risks of abandonment, particularly in mountainous and marginal zones (European Parliament, 2020). Castillo et al. (2021), using high-resolution spatial models, projected an average abandonment rate of about 373,000 ha per year across Europe and the UK, strongly correlated with low agricultural yields in marginal areas. Similar findings emerge from Liu et al. (2018), who emphasise low productivity as a key driver of abandonment alongside geographical and structural constraints. Lasanta et al. (2017) confirm that reduced productivity explains abandonment in mountain regions with biophysical limitations and rural depopulation, as well as in peripheral and semi-arid areas of Southern Europe. Pawlewicz and Pawlewicz (2023) show that countries with lower agricultural incomes, including Romania, Poland, Austria, Finland, Lithuania, Greece, Cyprus, Ireland, and Slovenia, are more vulnerable, whereas stronger economies such as Belgium, Denmark, Germany, and the Netherlands prove more resilient. Consistent with this evidence, case studies in Lithuania (Juknelienė et al., 2025) and Armenia (Gorgan et al., 2024) demonstrate that abandonment rates rise significantly where farms are structurally unproductive.

Building on this evidence, the present study adopts an explicit income-based perspective on abandonment risk, operationalised through labour productivity measured as gross value added per annual

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work unit (GVA/AWU). This indicator directly reflects the remuneration of farm labour relative to off-farm opportunities, thereby capturing whether agriculture can provide a viable livelihood. Persistently low GVA per AWU indicates structural inability to generate sufficient income, leaving farms highly exposed to abandonment.

Beyond absolute levels of productivity, it is equally important to examine whether regional disparities are narrowing or widening over time. Convergence analysis addresses this question by assessing the dynamics of productivity across territories. At EU level, evidence is mixed. Bielik et al. (2023) find fragile and potentially unending convergence. Baráth and Fertő (2017), Alexiadis (2012), and Jaroszewska and Pietrzykowski, 2017 instead highlight persistently low rates. Gołaś (2019), Kijek et al. (2019), and Kijek et al. (2020) show that new Member States tend to converge, whereas long-standing members diverge. Wicki (2012) finds no convergence between the two groups, attributing divergence to structural differences in farm organisation. Hamulczuk (2015) points to total factor productivity convergence in new Member States, underlining the role of EU integration and structural funds. Novotná and Volek (2016) show that convergence in the Czech Republic occurs only thanks to subsidies. In Italy, Esposti (2007) observes that convergence drivers such as technological spillovers are offset by divergence forces like scale effects. Garrone et al. (2018) further warn that the ongoing decline of the EU agricultural labour force threatens sustainability, making CAP support decisive. Taken together, this literature shows that convergence, and the policy interventions shaping it, are central to understanding territorial imbalances in productivity and their implications for abandonment.

We focus on Italy, where abandonment is particularly severe in mountainous and hilly areas (Zavalloni et al., 2021; Malavasi et al., 2018; Cocca et al., 2012). Traditionally characterised by small-scale farming, these regions face difficulties in competing with more favourable areas and often fail to offer sufficient prospects, particularly to younger generations (Riccioli et al., 2016). According to the seventh Italian General Census of Agriculture, the number of active farms declined by 1.2 million between 2000 and 2020, with over 600,000 ha of farmland lost (ISTAT - Italian National Institute of Statistics -, 2021). In 2020 only 1,133,023 farms remained active, confirming a long-term structural contraction of the sector (ISTAT, 2021). The contraction is especially marked in southern Italy and inland areas, where agriculture has historically sustained rural economies (Cardillo and Cimino, 2022; Salvia et al., 2019; Vastola et al., 2017).

Within this setting, our study investigates Italian labour productivity trends from 2010 to 2022 across four macro-areas (North West, North East, Centre, and South & Islands) and three major farm categories. These categories correspond to the Types of Farming (TFs) used in the Farm Accountancy Data Network (FADN), a classification based on the economic prevalence of production activities within each holding. Specifically, we analyse TF 15 “Specialist cereals, oilseeds, and protein crops”, TF 35 “Specialist vineyards”, and TF 37 “Specialist olives”. For clarity, these are referred to as TFcrops, TFwine, and TFolives. Together, they account for 27 % of Italy’s utilised agricultural area and represent key pillars of national agriculture (Fantechi et al., 2025; Bosi et al., 2023; Del Rey and Loose, 2023; Cardone et al., 2021).

The analysis develops along three interrelated directions. First, it assesses the evolution of agricultural labour productivity in Italy between 2010 and 2022 across the three TFs and four macro-areas, explicitly comparing values in nominal and real terms and considering the role of CAP subsidies. This dual perspective is crucial because it disentangles the effects of inflation and public transfers from underlying productivity dynamics, thereby clarifying whether current levels are sufficient to sustain farming independently of external support. Second, it examines whether productivity differences across macro-areas tend to narrow or widen over time, thereby contributing to the broader debate on convergence in EU agriculture while offering a sub-national, TF-specific perspective on abandonment risk. Third, it analyses the role of economic farm size, testing whether larger farms display stronger productivity dynamics than medium-sized farms and whether disparities increase over time. This sheds light on whether structural consolidation enhances resilience or exacerbates exclusion, aggravating abandonment pressures.

The marginal contribution of this study lies in both its empirical focus and its methodological design. Previous research on productivity has typically concentrated either on single-crop or livestock systems (for example Cechura et al., 2017; Veysset et al., 2015), or on farm-level analyses aggregated at the national scale (Castillo et al., 2021; Lasanta et al., 2017). Our approach, by applying FADN microdata, provides updated evidence on labour productivity at the farm level, allowing for a more accurate assessment of the overall economic potential of individual holdings. At the same time, by aggregating these data by TF, economic farm size, and territorial units, the analysis captures within-country heterogeneity and highlights the importance of structural differences, producing results directly relevant to the assessment of farm profitability. Although the contribution is primarily empirical rather than theoretical, it adds value to the European debate by linking productivity dynamics to farm-level vulnerability and by offering transferable insights for Mediterranean contexts facing comparable structural challenges.

On the basis of this framework, we test the following hypotheses.

H1. Current levels of labour productivity are critically low in many farming systems.

H2a. Ongoing trends indicate a further deterioration in productivity.

H2b. Real-term dynamics suggest even more adverse conditions than nominal figures.

H3. CAP subsidies are often decisive in sustaining adequate farm incomes.

H4. Larger farms show better productivity prospects, with widening disparities over time compared to smaller farms.

By addressing these hypotheses, the study contributes to ongoing debates on rural development and EU agricultural policy. Italy’s experience is particularly instructive for Mediterranean countries with similar structural vulnerabilities (Terres et al., 2015), where targeted public support, sustainable farming practices, and stronger rural livelihoods remain essential to counter abandonment.

The remainder of the paper is organised as follows. Section 2 describes the data and methodology, including the use of FADN microdata and the operationalisation of labour productivity and convergence analysis. Section 3 presents the main empirical findings on productivity trends and regional disparities across different types and sizes of farms. Section 4 discusses these results in relation to the hypotheses and to the objectives of the Common Agricultural Policy, highlighting the persistence of economic vulnerability in many systems. Finally, Section 5 concludes by drawing policy implications concerning the effectiveness of current CAP instruments and the need for more targeted strategies to support economically fragile farms, particularly in marginal areas where the risk of widespread rural desertification remains high.

2. Methodology

This study relies on the Italian sample of the FADN (Farm Accountancy Data Network) for the period 2010–2022. FADN is the official and harmonised EU system for collecting microeconomic data on farms, established to monitor agricultural income and the business activities of agricultural holdings across all Member States (European Commission, 2022a). The chosen timeframe ensures a coherent classification of farms according to the EU typology, which groups them by Type of Farming (TF) and Economic Size Unit (ESU), as defined in the FADN Standard Results methodology (European Commission, 2022b).

Labour productivity is measured using Gross Value Added (GVA) per Annual Work Unit (AWU), expressed at constant prices (2010 = 100). In line with FADN conventions, the GVA considered here includes factor income together with operating subsidies received, so that the indicator reflects the effective contribution of agricultural work to farm income under existing policy conditions. To complement this measure, we also calculate a variant that excludes subsidies, which we refer to as Net Productivity (NP). This second indicator provides a clearer picture of the structural capacity of farms to generate income from their own productive resources, without the cushioning effect of policy transfers.

To assess the risk of farm abandonment, we adopted a threshold-based approach already established in the literature (Terres et al., 2015). Specifically, the weighted average Gross Value Added (GVA) per annual work unit, normalised by national GDP per capita, was used as an indicator of low farm income. GVA reflects the resources available to remunerate labour, land and capital, before depreciation. A substantial gap between GVA per AWU and national GDP per capita indicates limited economic sustainability of farming, potentially prompting individuals to exit agriculture in search of better opportunities. Following Terres et al., we adopted a threshold of 60 %, on the assumption that values below this level do not provide a viable livelihood and farmers are therefore more likely to shift to other domestic sectors. Applying this benchmark enables us to estimate both the share of farms and the share of utilised agricultural area (UAA) at risk of abandonment across regions, economic farm sizes and types of farming.

To evaluate changes in labour productivity over time by Type of Farming, macro-area, and economic farm size, we calculated both nominal and real GVA per Annual Work Unit (GVA/AWU) and Net Productivity per Annual Work Unit (NP/AWU, net of subsidies) for each year in the 2010–2022 period. Real values were adjusted using national consumer price indices (ISTAT, 2024) to allow comparison over time.

Linear regression analyses were then applied to assess trends in productivity relative to 2010. Separate models were run for nominal and real productivity, as well as for gross (GVA/AWU) and net productivity (NP/AWU). Regressions were estimated without a constant, as productivity values are measured relative to 2010, and robust standard errors were used to account for heteroskedasticity.

Analyses of productivity trends and convergence over time were conducted using labour productivity, defined as the ratio of GVA to AWU per farm, following methods established in Kijek et al. (2020), Gołaś (2019), Jankowska (2021), and Jaroszewska and Pietrzykowski (2017). By presenting both versions, the analysis acknowledges the crucial role that subsidies play in sustaining farm income, while at the same time disentangling the underlying productivity dynamics that would prevail in their absence.

For each farm, data on value added, EU operating subsidies, and labour input were retrieved from the official FADN database (European Commission, 2022a). The resulting series were then adjusted for inflation using national consumer price indices for households of manual and clerical workers (ISTAT, 2024).

For the three Types of Farming analysed (TF 15; TFcrops – Specialist cereals, oilseeds, and protein crops; TF 35; TFwine – Specialist vineyards; and TF 37; TFolives – Specialist olives) over the period 2010–2022, we obtained a total of 45,921 observations: 18,457 for TFcrops, 19,935 for TFwine, and 7529 for TFolives. To focus on economically viable farms, the analysis was limited to those with an ESU (European Size Unit) above €25,000 annually, consistent with ISTAT's (2022) ASIA (Agricultural Innovation Special Agency) Agriculture Survey (2022), which records only agricultural enterprises active in the market. The ASIA Agriculture survey for 2020 covered approximately 8.2 million hectares of Utilised Agricultural Area (UAA), compared to 12.5 million reported in the 2020 Agricultural Census, with our sample[1] representing an estimated 9.7 million UAA. The final sample consists of 26,497 observations: 9386 for arable crops, 14,623 for viticulture, and 2938 for olive cultivation. This breakdown reflects a key characteristic of Italian agriculture: a predominance of very small farms, often supplementary to other activities, with over 50 % having less than 3 ha of UAA (ISTAT, 2021).

The analysis divided Italy into four macro-areas, based on ISTAT's classification: North West (NW: Liguria, Lombardy, Piedmont, and Valle d'Aosta); North East (NE: Friuli-Venezia Giulia, Emilia-Romagna, Trentino-Alto Adige, and Veneto); Centre (C: Lazio, Marche, Tuscany, and Umbria); and South and Islands (SI: Abruzzo, Molise, Campania, Puglia, Basilicata, Calabria, Sicily, and Sardinia). Table 1 presents the distribution of farms by TF and macro-area. Each macro-area exhibits significant diversity in climatic, environmental, agricultural, and socioeconomic conditions, making it essential to analyse labour productivity separately to identify convergence or divergence in agricultural development processes.

The impact of economic size on productivity was assessed by dividing the sample into two subgroups: "Large" farms, classified per the Denomination of Economic Size Classes (European Commission, 2008) with values above €100,000, and "Medium" farms with an ESU between €25,000 and €100,000. This classification is the standard EU typology and ensures comparability across Member States. Table 2 shows the distribution of sample UAA by economic farm size, macro-area, and TF.

To evaluate productivity convergence across Italian macro-areas, we used both β-convergence and σ-convergence analyses on real data for GVA per employee and NP. σ-convergence assesses the convergence process by examining changes in dispersion over time. A negative σ-convergence value signals reduced dispersion, indicating convergence. β-convergence evaluates the change dynamics of the phenomenon based on the initial situation. Once again, a negative β-convergence indicates convergence, meaning that areas with initially lower productivity levels grow at a faster rate than those with higher productivity levels. These two parameters are widely used in agricultural and non-agricultural sector convergence studies (e.g., Anjani and Prasetyo, 2024; Isla-Castillo et al., 2024; Gołaś, 2019; Adamowicz and Szepeluk, 2018; Baráth and Fertő, 2017; Baer-Nawrocka and Markiewicz, 2012). While this methodological framework is well established, its application to Italian agriculture with a simultaneous focus on specific farming systems and sub-national regions remains underexplored, which constitutes the originality of our contribution.

For σ-convergence analysis, we used the logarithmic standard deviation SD_{lnWP} (Equation (1)) and the coefficient of variation V_{lnWP} (Equation (2)):

$$SD_{lnWP_t} = \sqrt{\frac{1}{N}\sum_{m=1}^{N}\left(lnWPm(t) - \frac{1}{N}\sum_{m=1}^{N} ln\ WP_m(t)\right)^2} \qquad \text{(Equation 1)}$$

$$V_{lnWP} = \frac{SDlnWP}{ln\left(\frac{1}{N}\sum_{m=1}^{N} ln\ WP_m(t)\right)} \times 100 \qquad \text{(Equation 2)}$$

where WP_{mt} represents labour productivity (both inclusive and net of subsidies) in macro-area m at time t. We then ran regressions (Equations

Table 1
Distribution of number of farms and Sample Utilised Agricultural Area (UAA) by Type of Farming (TF) and Macro-Area. The percentages refer to the total for each TF.

	TFcrops		TFwine		TFolives	
Macro-area	Farms (%)	UAA (%)	Farms (%)	UAA (%)	Farms (%)	UAA (%)
NW	41	41	18	12	0	0
NE	20	18	33	27	0	0
C	21	24	16	25	13	16
SI	18	17	33	36	87	84

Note: NW=North West; NE=North East; C=Centre; SI=South & Islands.

[1] For the methods used to extrapolate sample data, please refer to "La Rete di Informazione Contabile Agricola Nota metodologica," CREA (2024).

Table 2
Distribution of number of farms and Sample Utilised Agricultural Area (UAA) by Type of Farming (TF), Macro-Area, and Economic Size. The percentages refer to the total for each TF.

	TFcrops		TFwine		TFolives	
Macro-area	Farms (%)	UAA (%)	Farms (%)	UAA (%)	Farms (%)	UAA (%)
NW Large	19	31	7	8	0	0
NW Medium	23	10	11	4	0	0
NE Large	5	11	13	19	0	0
NE Medium	15	7	20	8	0	0
C Large	5	13	7	19	3	8
C Medium	15	11	9	6	10	8
SI Large	2	5	10	23	14	36
SI Medium	16	12	23	13	73	48

Note: NW=North West; NE=North East; C=Centre; SI=South & Islands.

(3) and (4)) to analyse the dynamics over time, with SD_{lnWP} and V_{lnWP} as dependent variables and year t as the independent variable:

$$SD_{lnWP_t} = \sigma_0 + \sigma_1 t + \varepsilon \; (t = 0, \ldots, 13) \quad \text{(Equation 3)}$$

$$V_{lnWP_t} = \sigma_0 + \sigma_1 t + \varepsilon \quad \text{(Equation 4)}$$

where SD_{lnWPt} is the standard deviation of the logarithm of labour productivity across macro-areas in year t, V_{lnWPt} is the coefficient of variation of productivity across macro-areas in year t, and ϵ represents error.

We calculated β-convergence with the following panel regression, used by Jiang et al., in 2018 (Equation (5)):

$$ln\left(\frac{WPm_t}{WPm_{t-1}}\right) = \alpha + \beta\, ln(WPm_{t-1}) + u_m + \varepsilon_{mt} \quad \text{(Equation 5)}$$

where WPm_t is the labour productivity of macro-area m in year t (with t ranging from 2011 to 2022), WPm_{t-1} is the labour productivity of the same macro-area at time t-1, u_m is the macro-area-specific error term, and ϵ is the random error. A fixed effects model was used, as a random effects model is unsuitable given the structural differences between macro-areas (Jiang et al., 2018; Islam, 2003). This assumption is confirmed by subsequent analyses. The β estimate allowed us to calculate the coefficient γ for analysing convergence. Specifically, $\gamma = \frac{-ln\,(1+\beta)}{T}$ where T represents the time interval examined, and γ indicates the percentage speed of the convergence/divergence process between macro-areas. If $\gamma > 0$, convergence is in progress. To gain clearer insight into the convergence (or divergence) process in progress, we calculated a temporal index: HL (half-life), representing the theoretical time required to halve the differences identified by the model, computed as the ratio of ln2 to γ (Isla-Castillo et al., 2024).

All analyses were performed with STATA18 statistical software.

3. Results

3.1. Analysis of labour productivity dynamics

This section first presents the results of the abandonment risk assessment, based on the threshold of 60 % of national per capita GDP defined in the methodology, before examining convergence patterns in labour productivity from 2010 to 2022.

For 2022, this threshold corresponded to approximately €22,000 per annual work unit (AWU). Using this benchmark, we find that about 36 % of Italian farms fall below the line of economic viability, equivalent to 122,658 holdings and more than two million hectares of UAA (2,031,673 ha). The distribution of risk is not uniform: TFolives is the most exposed, with over half of olive farms (5470 holdings) and nearly 50 % of the olive UAA (110,990 ha) below the threshold. In addition, medium-sized farms are more often at risk than large farms, and vulnerability intensifies progressively from the northern to the southern regions (Table 3).

Trends in GVA/AWU and NP/AWU over 2010–2022, broken down by TF, macro-area, and economic farm size, were analysed using linear regression and are reported in Table 4 (TFcrops), Table 5 (TFwine), and Table 6 (TFolives).

For TFcrops, productivity showed no statistically significant changes in nominal terms, with negative trends evident only in the NE and some segments of the Centre, according to Table 4. However, real labour productivity generally declined overall. Net Productivity (NP/AWU, NP from here on) trends were more favourable than GVA/AWU (GVA from here on), reflecting the reduction of direct EU subsidies to arable crops introduced by the 2014 CAP reform, rather than changes in the structural performance of farms.

Economic farm size showed varied patterns across macro-areas: in the NW, large farms saw rising net productivity (in nominal terms), whereas medium farms displayed declining real productivity. In the Centre, large farms outperformed medium ones in NP. In the NE and SI macro-areas, differences across farm sizes were minimal, despite pronounced negative trends in the NE and a slight nominal increase in NP in the South for medium-sized farms. Real NP in the SI remained largely unchanged.

For TFwine, labour productivity increased in both nominal and real terms in the NE and SI, while the NW showed slightly positive nominal growth (inclusive of subsidies) but stagnation in real terms. Central Italy showed declining productivity overall.

In terms of economic size, both large and medium farms in the NE grew in real productivity. In the SI and NW, growth was limited to nominal terms. In the Centre, large farms recorded significant declines, while medium farms improved. Table 5 thus shows that medium farms cannot be considered systematically weaker; in certain contexts they outperform larger farms. Despite occasional outperformance, medium farms' labour productivity often remains close to the economic viability threshold, maintaining a significant risk of abandonment.

For TFolives, labour productivity declined overall, with the exception of large farms in the Centre, which showed increasing productivity in both nominal and real terms. In the SI, GVA is not significant for large farms, although NP remained negative. Table 6 indicates that the structural weakness of olive systems, and subsidies have not been sufficient to counterbalance declining productivity, leaving these farms particularly exposed to abandonment risk.

To provide further context for the trends observed in Tables 4–6, Table 7 presents the 2010 values (year zero in the regressions) for GVA and NP, along with their respective averages for the period 2010–2022 in real terms.

Comparisons reveal that TFcrops generally maintains high gross productivity, particularly among large farms, despite notable declines. For TFwine and TFolives, GVA values are lower, and for medium farms they frequently approach or fall below the high-risk threshold. These comparisons confirm the persistence of structural gaps that underpin the regional and sectoral disparities further analysed in the convergence tests.

3.2. Analysis of σ and β convergence

The analysis of labour productivity trends across Italian macro-areas revealed distinct convergence and divergence patterns. This section examines whether these areas are converging or diverging in terms of labour productivity.

σ and β convergence analyses were initially conducted across macro-areas without accounting for economic size (Tables 8 and 9).

Table 8 shows that productivity dispersion between macro-areas does not significantly change over time, as the σ_1 parameters are generally insignificant. The exception is the net productivity of TFolives, which exhibits significant positive coefficients, indicating divergence,

Table 3
Percentage of farms at risk of abandonment in Italy by type of farming.

	Italian farms		TFcrops		TFwine		TFolives	
Macro-area	Farms at risk (%)	UAA at risk (%)	Farms at risk (%)	UAA at risk (%)	Farms at risk (%)	UAA at risk (%)	Farms at risk (%)	UAA at risk (%)
NW Large	11	8	2	1	22	19		
NW Medium	42	33	31	26	43	38		
NE Large	9	4	1	1	9	5		
NE Medium	31	27	20	18	35	30		
C Large	17	9	0	0	17	7	56	44
C Medium	47	39	24	21	48	47	36	27
SI Large	22	12	4	4	22	17	56	40
SI Medium	54	41	26	20	53	47	62	55
Total at risk (%)	36	21	21	12	38	24	56	46
Overall total (Ha)	340,718	9,674,634	21,259	1,247,370	67,285	863,850	9769	241,282

Note: NW=North West; NE=North East; C=Centre; SI=South & Islands.

Table 4
Labour productivity trend for TFcrops (2010–2022).

Macro-area	Nominal GVA/AWU	Nominal NP/AWU	Real GVA/AWU GVA/AWU GVA/AWU	Real NP/AWU
NW	−314.71	521.65	−1293.20**	15.06
NW Large	492.07	1816.74**	−887.32	1204.37
NW Medium	−665.16**	−342.99	−1286.16***	−784.19**
NE	−2185.78***	−1489.59***	−3263.20***	−2229.09***
NE Large	−3957.02***	−2769.57***	−5874.18***	−4094.30***
NE Medium	−1617.47***	−1073.36***	−2401.77***	−1608.16***
C	−600.71**	−109.27	−1324.51***	−499.47*
C Large	103.89	706.78**	−900.98**	195.05
C Medium	−325.27	−97.03	−857.77***	−393.34*
SI	−141.93	258.18	−697.26***	14.97
SI Large	−291.97	555.22	−1185.80**	209.76
SI Medium	−62.68	239.73*	−554.43***	17.40

Note: ***p < 0.01; **p < 0.05; *p < 0.1. NW=North West; NE=North East; C=Centre; SI=South & Islands. GVA/AWU = Gross Value Added per Annual Work Unit; NP/AWU=Net Productivity per Annual Work Unit.

Table 5
Labour productivity trend for TFwine (2010–2022).

Macro-area	Nominal GVA/AWU	Nominal NP/AWU	Real GVA/AWU	Real NP/AWU
NW	314.14*	262.87	−205.36	−246.43
NW Large	375.12	302.52	−318.87	−376.63
NW Medium	711.17***	652.55***	381.06**	326.24**
NE	952.41***	899.84***	579.72***	539.53***
NE Large	1758.68***	1643.84***	1291.07***	1189.28***
NE Medium	1244.77***	1195.18***	1077.91***	1033.85***
C	−181.17	−197.97*	−643.72***	−624.44***
C Large	−418.26**	−487.80**	−1060.31***	−1089.27***
C Medium	902.14***	869.60***	760.48***	749.38***
SI	597.27***	580.73***	329.42***	344.59***
SI Large	480.51**	347.76**	−16.24	−121.80
SI Medium	816.56***	840.61***	676.46***	732.36***

Note: ***p < 0.01; **p < 0.05; *p < 0.1. NW=North West; NE=North East; C=Centre; SI=South & Islands. GVA/AWU = Gross Value Added per Annual Work Unit; NP/AWU=Net Productivity per Annual Work Unit.

Table 6
Labour productivity trend for TFolives (2010–2022).

Macro-area	Nominal GVA/AWU	Nominal NP/AWU	Real GVA/AWU	Real NP/AWU
C	−596.52***	−877.80***	−1164.23***	−1433.95***
C Large	1965.09***	1362.92**	1836.46**	1236.86*
C Medium	−1049.70***	−1221.71***	−1684.60***	−1837.25***
SI	−470.08***	−743.24***	−905.22***	−1087.74***
SI Large	79.03	−1025.90***	−359.87	−1427.13***
SI Medium	−505.87***	−648.52***	−928.02***	−974.68***

Note: ***p < 0.01; **p < 0.05; *p < 0.1. NW=North West; NE=North East; C=Centre; SI=South & Isands. GVA/AWU = Gross Value Added per Annual Work Unit; NP/AWU=Net Productivity per Annual Work Unit.

particularly between the C and SI.

Table 9 indicates a convergence trend, as evidenced by the significant negative β coefficients across all analyses. Among the three TFs, convergence is fastest in TFolives, followed by TFwine, while TFcrops converges more slowly. Notably, when productivity is assessed net of subsidies (NP), the convergence rate is higher for TFwine and TFolives.

Table 7
GVA/AWU (gross value added per annual work unit) and NP/AWU (net productivity per annual work unit) values in 2010 and average for 2010–2022.

	TFcrops			
	Real GVA/AWU		Real NP/AWU	
Macro-area	2010 value	Average 2010–2022	2010 value	Average 2010–2022
NW	€ 79,586	€ 70,679	€ 44,037	€ 43,340
NW Large	€ 117,508	€ 108,823	€ 59,679	€ 64,527
NW Medium	€ 47,440	€ 39,771	€ 30,776	€ 26,172
NE	€ 76,002	€ 52,763	€ 51,533	€ 34,997
NE Large	€ 135,279	€ 92,703	€ 92,323	€ 61,779
NE Medium	€ 55,080	€ 38,231	€ 37,137	€ 25,253
C	€ 56,962	€ 47,593	€ 31,362	€ 27,378
C Large	€ 85,707	€ 77,916	€ 47,084	€ 46,629
C Medium	€ 42,722	€ 37,109	€ 23,574	€ 20,721
SI	€ 47,373	€ 42,432	€ 22,935	€ 22,872
SI Large	€ 76,705	€ 67,264	€ 35,065	€ 35,757
SI Medium	€ 42,439	€ 38,743	€ 20,894	€ 20,959
	TFwine			
	Real GVA/AWU		Real NP/AWU	
Macro-area	2010 value	Average 2010–2022	2010 value	Average 2010–2022
NW	€ 46,899	€ 44,566	€ 45,733	€ 43,265
NW Large	€ 62,012	€ 58,499	€ 60,260	€ 56,544
NW Medium	€ 34,053	€ 36,169	€ 33,385	€ 35,263
NE	€ 39,665	€ 43,048	€ 38,166	€ 41,254
NE Large	€ 54,521	€ 60,446	€ 52,398	€ 57,740
NE Medium	€ 23,976	€ 31,320	€ 23,136	€ 30,142
C	€ 38,417	€ 33,425	€ 35,124	€ 30,260
C Large	€ 51,861	€ 43,787	€ 47,762	€ 39,560
C Medium	€ 19,210	€ 24,420	€ 17,069	€ 22,178
SI	€ 27,888	€ 29,444	€ 25,030	€ 26,898
SI Large	€ 46,132	€ 43,654	€ 42,779	€ 40,104
SI Medium	€ 18,840	€ 23,401	€ 16,227	€ 21,282
	TFolives			
	Real GVA/AWU		Real NP/AWU	
Macro-area	2010 value	Average 2010–2022	2010 value	Average 2010–2022
C	€ 44,405	€ 34,551	€ 41,194	€ 29,246
C Large	€ 28,013	€ 42,287	€ 23,267	€ 32,756
C Medium	€ 46,226	€ 32,547	€ 43,186	€ 28,337
SI	€ 35,172	€ 28,983	€ 24,893	€ 17,178
SI Large	€ 40,974	€ 39,077	€ 28,920	€ 19,282
SI Medium	€ 33,557	€ 27,098	€ 23,772	€ 16,785

Note: NW=North West; NE=North East; C=Centre; SI=South & Isands.

The standard deviation (SD) of the unobserved time-invariant component u_m, reveals significant structural differences among macro-areas in most cases, except for GVA in TFolives. The u_m column shows the u_m values for each macro-area, except for cases where the relative SD was not significant. The u_m values indicate that the NW and NE macro-areas have structural advantages over other areas across all TFs. In TFolives, CAP subsidies mitigate but do not fully neutralize structural differences; disparities remain evident in NP, as convergence is observed in GVA, while net productivity still reflects underlying differences.

Table 10 (large farms) and Table 11 (medium farms) further explore σ convergence, distinguishing between large and medium farms.

Large farms generally show non-significant or positive σ_1 values (TFwine and net productivity for TFolives), suggesting limited changes in dispersion over time.

For medium farms, significant reductions in dispersion are observed in TFcrops and TFwine, while TFolives shows increased dispersion in NP.

Tables 12 and 13 present the β convergence analysis results for large and medium farms, respectively.

Overall, both large and medium farms exhibit convergence trends, though at different rates: large farms converge more quickly (HL < 10) than medium farms, except for TFolives.

The panel data results highlight structural differences among macro-areas via the u_m component. For TFcrops, structural differences are significant among large farms, with higher GVA and NP values in the North compared to the Centre-South, especially between the NW and SI. Subsidies partly cushion these gaps but do not eliminate them.

For TFwine, structural differences are evident between the North and Centre-South regions, regardless of economic farm size. For this TF there are no significant differences between the C and SI for both large and medium farms. Notably, a reversal occurs from the point of view of the structural aspects between large and medium farms: the NE prevails in the large farms, while medium farms prevail in the NW.

For TFolives's NP, structural similarities are observed between large and medium farms, with the C holding a structural advantage over the SI. In this context, subsidies play a crucial role in narrowing disparities between the two macro-areas.

4. Discussion

This study set out to analyse labour productivity as a central determinant of farmland abandonment in Italy. By examining three Types of Farming (TFcrops, TFwine, and TFolives) across four macro-areas between 2010 and 2022, we aimed to clarify whether current productivity levels are sufficient to sustain viable livelihoods, whether regional disparities are narrowing or widening, and whether differences by farm size point to structural vulnerabilities. Italy was chosen as a representative example of Mediterranean agriculture, where abandonment risks remain high and productivity is closely linked to demographic pressures, market conditions, and structural features of the agricultural sector (Terres et al., 2015). The analysis focuses on professional farms (ESU > €25,000), ensuring that the results reflect holdings for which profitability is decisive.

Our findings confirm H1, showing that labour productivity is critically low in many farming systems and directly connected to abandonment risk. Around one-third of Italian farms fall below the benchmark of 60 % of national per-capita GDP, indicating an income level insufficient to retain labour on-farm and thus a heightened probability of exit. The olive sector (TFolives) is the most vulnerable, with more than half of

Table 8
σ Convergence of Macro-Areas The first column reports the mean standard deviation across macro-areas for the period 2010–2022.

TF	Type of productivity	Mean SD 2010–2022	SDlnWP		VlnWP	
			σ_0	σ_1	σ_0	σ_1
TFcrops	GVA/AWU	16976.42	0.19***	−0.00	1.77***	0.00
	NP/AWU	12287.51	0.25***	0.00	2.38***	0.00
TFwine	GVA/AWU	10734.98	0.18***	−0.00	1.76***	−0.01
	NP/AWU	10904.31	0.21***	−0.00	2.02***	−0.01
TFolives	GVA/AWU	3695.61	0.09**	0.01	0.82**	0.07
	NP/AWU	4701.69	0.16**	0.02**	1.51**	0.22**

Note: ***p < 0.01; **p < 0.05; *p < 0.1. NW=North West; NE=North East; C=Centre; SI=South & Isands. GVA/AWU = Gross Value Added per Annual Work Unit; NP/AWU=Net Productivity per Annual Work Unit. SDlnWP = logarithmic standard deviation of Work Productivity: VlnWP = coefficient of variation of Work Productivity. TF = Type of Farming.

Table 9
β Convergence of Labour Productivity in Macro-Areas.

TF	Type of productivity	Macro-area	α	β	γ(%)	HL	SDu_m	u_m
TFcrops	GVA/AWU	General	4.69***	−0.43***	5	13	0.10***	
		NW						0.14
		NE						−0.02
		C						−0.04
		SI						−0.08
	NP/AWU	General	4.24***	−0.41***	5	14	0.11*	
		NW						0.15
		NE						0.02
		C						−0.05
		SI						−0.12
TFwine	GVA/AWU	General	5.77***	−0.55***	7	10	0.11***	
		NW						0.10
		NE						0.09
		C						−0.07
		SI						−0.12
	NP/AWU	General	6.24***	−0.60***	8	8	0.13***	
		NW						0.13
		NE						0.11
		C						−0.09
		SI						−0.15
TFolives	GVA/AWU	General	8.41***	−0.81***	15	5	0.10	
	NP/AWU	General	9.25***	−0.93***	24	3	0.37***	
		C						0.26
		SI						−0.26

Note: ***p < 0.01; **p < 0.05; *p < 0.1. NW=North West; NE=North East; C=Centre; SI=South & Isands. GVA/AWU = Gross Value Added per Annual Work Unit; NP/AWU=Net Productivity per Annual Work Unit. TF = Type of Farming. HL = half life; γ(%) = speed of convergence; u_m= macro-area-specific error term.

Table 10
σ Convergence of Large Farms by Macro-Area The first column reports the mean standard deviation across macro-areas for the period 2010–2022.

TF	Type of productivity	Mean SD 2010–2022	SDlnWP		VlnWP	
			σ_0	σ_1	σ_0	σ_1
TFcrops	GVA/AWU	20509.37	0.19***	0.00	1.67***	0.01
	NP/AWU	15938.37	0.24***	0.00	2.26***	0.02
TFwine	GVA/AWU	15878.71	0.16***	0.01*	1.45***	0.03*
	NP/AWU	15895.14	0.17***	0.01**	1.63***	0.04*
TFolives	GVA/AWU	5134.67	0.18***	−0.00	1.75***	−0.04
	NP/AWU	7115.42	0.09	0.03***	0.82	0.37***

Note: ***p < 0.01; **p < 0.05; *p < 0.1. NW=North West; NE=North East; C=Centre; SI=South & Isands. GVA/AWU = Gross Value Added per Annual Work Unit; NP/AWU=Net Productivity per Annual Work Unit. SDlnWP = logarithmic standard deviation of Work Productivity: VlnWP = coefficient of variation of Work Productivity. TF = Type of Farming.

Table 11
σ Convergence of Medium Farms by Macro-Area The first column reports the mean standard deviation across macro-areas for the period 2010–2022.

TF	Type of productivity	Mean SD 2010–2022	SDlnWP		VlnWP	
			σ_0	σ_1	σ_0	σ_1
TFcrops	GVA/AWU	4481.73	0.10***	−0.01***	0.89***	−0.03***
	NP/AWU	4373.40	0.18***	−0.01***	1.81***	−0.09***
TFwine	GVA/AWU	9692.85	0.22***	−0.01***	2.18***	−0.05***
	NP/AWU	9871.68	0.26***	−0.01***	2.63***	−0.07***
TFolives	GVA/AWU	11398.83	0.10***	0.00	0.99***	0.05
	NP/AWU	10744.05	0.17***	0.02*	1.65**	0.18**

Note: ***p < 0.01; **p < 0.05; *p < 0.1. NW=North West; NE=North East; C=Centre; SI=South & Island. GVA/AWU = Gross Value Added per Annual Work Unit; NP/AWU=Net Productivity per Annual Work Unit. SDlnWP = logarithmic standard deviation of Work Productivity: VlnWP = coefficient of variation of Work Productivity. TF = Type of Farming.

farms below the viability threshold. This pattern is most pronounced in the South & Islands, where medium-sized olive farms frequently cross the vulnerability line, echoing previous evidence of abandonment hotspots in Mediterranean regions (Salis et al., 2022; Andreoli and Tellarini, 2018; Streifeneder, 2016).

H2a and H2b are also supported. Between 2010 and 2022, labour productivity declines in most TFs and macro-areas both including and excluding subsidies, with sharper drops in real terms once inflation is accounted for. In TFcrops and TFolives, the contraction often reaches 20–30 %, while TFwine shows partial resilience in the North but remains near the vulnerability threshold for many medium farms. This divergence between nominal and real trends highlights the masking effect of price dynamics and transfers, underscoring the need to interpret nominal improvements with caution.

H3 is strongly corroborated: public support remains decisive for sustaining farm incomes in vulnerable systems. Net productivity (excluding subsidies) reveals a more fragile picture, especially in olives and arable crops, where GVA per worker frequently struggles to exceed viability levels. This aligns with recent evidence on the role of direct support in preventing exit (Pawłowska and Rembisz, 2024; Szálteleki

Table 12
β Convergence of Labour Productivity for Large Farms.

TF	Type of productivity	Macro-area	α	β	γ(%)	HL	SDu_m	u_m
TFcrops	GVA/AWU	General	8.13***	−0.72***	12	6	0.15***	
		NW						0.19
		NE						0.03
		C						−0.06
		SI						−0.17
	NP/AWU	General	6.12***	−0.57***	8	9	0.15**	
		NW						0.15
		NE						0.08
		C						−0.03
		SI						−0.20
TFwine	GVA/AWU	General	6.07***	−0.56***	7	9	0.11**	
		NW						0.09
		NE						0.14
		C						−0.13
		SI						−0.10
	NP/AWU	General	6.48***	−0.60***	8	8	0.14***	
		NW						0.07
		NE						0.12
		C						−0.10
		SI						−0.09
TFolives	GVA/AWU	General	6.80***	−0.64***	9	7	0.04	
	NP/AWU	General	7.99***	−0.80***	15	5	0.36**	
		C						0.25
		SI						−0.25

Note: ***p < 0.01; **p < 0.05; *p < 0.1. NW=North West; NE=North East; C=Centre; SI=South & Island. GVA/AWU = Gross Value Added per Annual Work Unit; NP/AWU=Net Productivity per Annual Work Unit. TF = Type of Farming. HL = half life; γ(%) = speed of convergence; u_m= macro-area-specific error term.

Table 13
β Convergence of Labour Productivity for Medium Farms.

TF	Type of productivity	Macro-area	α	β	γ(%)	HL	SDu_m	u_m
TFcrops	GVA/AWU	General	3.45***	−0.33***	4	19	0.02	
	NP/AWU	General	3.62***	−0.36***	4	17	0.03	
TFwine	GVA/AWU	General	4.92***	−0.48***	6	12	0.10**	
		NW						0.11
		NE						0.05
		C						−0.07
		SI						−0.09
	NP/AWU	General	4.96***	−0.49***	6	11	0.11**	
		NW						0.13
		NE						0.06
		C						−0.09
		SI						−0.10
TFolives	GVA/AWU	General	8.63***	−0.84***	17	4	0.10	
	NP/AWU	General	9.19***	−0.92***	23	3	0.35***	
		C						0.25
		SI						−0.25

Note: ***p < 0.01; **p < 0.05; *p < 0.1. NW=North West; NE=North East; C=Centre; SI=South & Isands. GVA/AWU = Gross Value Added per Annual Work Unit; NP/AWU=Net Productivity per Annual Work Unit. TF = Type of Farming. HL = half life; γ(%) = speed of convergence; u_m= macro-area-specific error term.

et al., 2024; Biagini et al., 2023). In the current EU policy framework, characterised by the 2023–2027 CAP Strategic Plans and the 2024–2025 simplification measures aimed at reducing burdens and better aligning rules with on-farm realities, income support remains a pivotal lever to contain abandonment pressures in marginal territories (European Commission, 2025a).

Regarding H4, our results show a persistent productivity gap between medium and large farms. Large farms, particularly in the North-West, manage to sustain or even increase productivity despite tighter support, suggesting economies of scale and favourable local conditions. By contrast, many medium-sized farms in the Centre and South & Islands hover at or below the risk threshold, raising concerns about their long-term viability. This asymmetry implies that in the medium term, in the absence of corrective measures, either through the allocation of public support or through forms of farm restructuring, territorial inequalities are likely to intensify.

The convergence analysis enriches this picture. β-convergence across macro-areas suggests that growth paths tend toward long-run steady states; yet σ-convergence points to persistent or widening dispersion in net productivity for TFolives and TFwine. Since divergence in productivity implies widening gaps in viability, this supports the persistence of structural vulnerability and, ultimately, the risk of farmland abandonment. In other words, convergence may occur at levels that remain too low to secure viable livelihoods in certain regions. This calls for policies that not only simplify compliance but also target profitability where vulnerability concentrates, consistent with the orientation set out in the Strategic Dialogue on the Future of EU Agriculture, which emphasises economic viability, territorial cohesion, and practical governance across the agri-food chain (European Commission, 2024).

The European Commission's new vision for CAP reform emphasises the need to make rural areas more attractive and to improve working conditions in agriculture. In some regions, structural decline may already be difficult to reverse, yet efforts to sustain agricultural activity remain essential. The causes of agricultural abandonment and, consequently, of rural depopulation are manifold. However, as highlighted by this analysis, we cannot overlook what is probably the most decisive factor: insufficient profitability. As previously discussed, many farming activities fail to generate incomes that are viable either in relative or absolute terms. The current distribution of support payments does not appear adequate to guarantee fair incomes in many situations. These findings suggest that EU agricultural policy should prioritise instruments that stabilise and lift labour returns in the most exposed TF–region–size combinations, most notably TFolives and TFcrops in the South & Islands, while safeguarding medium farms from sliding below viability. Recent EU initiatives, both the ongoing CAP Strategic Plans and the 2025 simplification package, explicitly aim to reduce administrative burdens and better align interventions with on-farm realities; our evidence suggests that such streamlining should be coupled with targeted income support and productivity-enhancing measures (European Commission, 2025a, 2025b). We are aware that labour profitability is only one of the factors that may lead to agricultural abandonment, and that on its own it may not be sufficient, for instance, if not accompanied by adequate living conditions in rural areas. Despite this evident limitation, we consider it equally true that below certain levels profitability becomes a limiting factor for the persistence of agriculture, and our results show that in vast areas these threshold values are not being reached.

Despite its contributions, this study presents some limitations. Our analysis uses macro-area aggregates and three TFs; as such, it cannot fully capture fine-grained territorial features. For instance, variations related to orography, such as mountain, hilly, and plain areas, as well as elevation differences, are not reflected, even though they strongly shape production conditions and abandonment risks. While FADN is the EU's most comprehensive micro-dataset, certain limitations remain: farm revenues may be underestimated because the income may not be fully reported in official records and on the other side the Gross Value Added per Annual Work Unit can be overestimated because the family labour, particularly that of the farm holder, is often undervalued in accounting conventions. Finally, cross-country generalisation beyond Mediterranean contexts should be approached with caution. Future work should integrate micro-spatial data, extend TF coverage, and test comparability across Member States under the evolving EU policy framework.

5. Conclusion

In Italy's marginal agricultural regions, we are approaching a critical juncture: most farmers are nearing retirement, the sector attracts little interest from younger generations, and demographic dynamics are reinforcing both trends. The risk of large-scale depopulation and farmland abandonment is therefore tangible. At both the European and national levels, awareness is growing of the mutually reinforcing relationship between demographic decline and agricultural contraction. Safeguarding the future of rural areas calls for urgent action. This requires that forthcoming resources be deployed with the highest possible effectiveness, through multi-level governance, a shared and conceptually robust development vision, and context-specific territorial analysis. Our study demonstrates that ensuring sufficient profitability is the key priority for maintaining agricultural activity across many regions. About one-third of farms in three major TFs operate below the viability threshold, with olive farms in the South and Islands under the most severe pressure. Since 2010, real productivity has declined in most systems, and the widening gap between gross and net productivity highlights the central role of public support. Current CAP instruments do not appear capable of addressing the economic sustainability of many farming systems. The reform currently under discussion cannot overlook the situation illustrated here for Italy, which is likely shared by many other marginal European areas. Given the limited resources available, difficult choices will be unavoidable; yet without a strategy specifically aimed at supporting economically fragile farms of particular socio-environmental importance, the risk is one of uncontrolled and widespread rural desertification.

CRediT authorship contribution statement

Tommaso Fantechi: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Caterina Contini:** Writing – review & editing, Writing – original draft, Supervision, Conceptualization. **Leonardo Casini:** Writing – review & editing, Writing – original draft, Supervision, Software, Methodology, Data curation, Conceptualization.

Declaration of competing interest

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Data availability

Data will be made available on request.

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