The potential relationship between direct payments distribution and agricultural productivity: an EU overview

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Abstract

This study investigates the potential relationship between inequality in agricultural direct aid distribution and productivity in the European Union. Using Eurostat data and the Gini coefficient to measure inequality, this study analyses the possible correlations between direct aid distributions and various productivity indicators. The findings reveal significant negative correlations between inequality and work-unit-based productivity measures, suggesting that a more equitable direct aid distribution could enhance labor productivity. However, its relationship with land-based productivity measures remains unclear. A comparative analysis of Croatia, Austria, and Slovenia demonstrated the concentration of direct aid recipients in lower categories, supporting small- and medium-sized farms. This study emphasizes the importance of equitable direct aid distribution in promoting agricultural productivity and recommends that policymakers consider these dynamics when designing direct aid frameworks to enhance productivity and support sustainable agricultural development.

INTRODUCTION

Agricultural subsidy plays a crucial role in shaping productivity and income boosting in the farming sector (Biagini et al., 2023; Garrone et al., 2019; Mamun, 2024). However, the relationship between subsidy inequality and agricultural productivity is complex and multifaceted, with studies showing mixed results in different contexts. This study aims to explore the potential relationship between the distribution of direct aid among beneficiaries (represented by the Gini coefficient) and various development indicators in the EU agricultural sector.

Previous studies have found varying effects of subsidies on farm productivity and efficiency. For instance, input subsidies have shown strong positive impacts on output growth and labor productivity, whereas output payments have smaller positive effects on output growth only (Mamun, 2024). However, some studies have revealed contradictory results; for example, subsidies negatively affect farm productivity but positively influence technical efficiency in Norwegian grain farms (Kumbhakar & Lien, 2010).

Subsidy distribution can lead to significant inequalities, potentially harming the overall productivity of the agricultural sector. In some regions, direct aid programs tend to benefit elites, which can negatively impact poor farmers and hinder sector-wide growth (Goyal and Nash, 2017). Unequal land distribution, often reflected in the high Gini coefficients for landholdings, is associated with lower productivity. Research has shown that reducing land inequality can lead to substantial increases in productivity (Vollrath, 2007).

In the European Union, the distribution of agricultural payments is uneven, with 20% of CAP beneficiaries receiving 80% of payments (European Commission, n.d.a). The distribution of subsidies varies significantly across regions, influenced by factors such as predominant farming systems and historical land ownership patterns.

Support through CAP strategic plans is primarily administered as area-based payments. Agricultural subsidies serve as a critical policy instrument to influence the distribution of farm income and enhance productivity. These subsidies can exert diverse effects on economic inequality, often quantified by the Gini coefficient, and consequently impact broader development indices. Notably, agricultural subsidies, particularly direct payments, tend to be concentrated among a limited number of large farms, potentially exacerbating income inequality (Sinabell et al., 2013). For instance, in 2010, less than 2% of direct payment recipients accounted for a substantial share of total subsidies, underscoring a skewed distribution that may elevate the Gini coefficient (Severini and Tantari, 2015). The distribution of subsidies and their impact on inequality exhibit significant regional variation. For example, in Portugal, the allocation of direct payments is shaped by prevailing farming systems, with larger farms and specific crop types receiving greater support, which can intensify regional income disparities (Dinis, 2024).

In Central and Eastern European countries, an uneven distribution of subsidies has been observed, with large farms frequently dominating fund allocation, resulting in higher Gini coefficients in these regions than the EU average (Sadłowski et al., 2022). Subsidies are pivotal for sustaining farm profitability, which is vital for rural economic development. However, the unequal distribution of these subsidies may constrain their efficacy in fostering equitable economic growth (Severini and Tantari, 2015). The concentration of subsidies on larger farms may impede the development of smaller farms, which is essential for sustainable rural development and mitigating regional disparities (Sinabell et al., 2013).

The issue of payment distribution within the CAP is highly complex, involving a number of interrelated factors, from production structure to the institutional and economic development of Member States.

Actual policy reforms aimed at more equitable redistribution of subsidies, such as the introduction of redistributive payments and capping mechanisms, have been proposed to reduce inequality and enhance development outcomes.

These measures can potentially decrease the Gini coefficient by providing increased support to smaller farms. The success of these reforms is contingent on their implementation at the national level, as member states possess considerable discretion in shaping subsidy policies (Severini & Tantari, 2015).
Despite the importance of this topic, there is a lack of comprehensive analysis of how direct aid inequality, specifically measured through the Gini coefficient, impacts agricultural productivity across different European contexts. This study aimed to fill part of this gap by addressing the following research questions:
1. Is there a relationship between the (uneven) distribution of beneficiaries of paid direct payments at the member state level, and national output per agricultural work unit or per hectare in the EU?
2. If yes, what is the relationship between direct aid distribution inequality and gross value added per agricultural work unit per hectare?
3. What are the results of the comparative analysis of direct aid distributions in Croatia, Slovenia, and Austria?

MATERIAL AND METHODS

Data Sources

This study utilized secondary data from Eurostat database to ensure the reliability and comparability of indicators across different EU member states. The following development indicators from Eurostat were used to measure productivity: Agricultural Output per Agricultural Work Unit, Agricultural Output per Utilized land area, Gross Value-Added per Agricultural Work Unit, and Goss value-added per Utilized land area. These indicators were chosen because they provide a comprehensive view of agricultural productivity, capturing both labor and land efficiency. Additionally, data (European Commission, 2024) on the distribution of direct aid to farmers through the European Agricultural Guarantee Fund (EAGF) for the 2022 financial year were used to analyse the impact of direct aid distribution on productivity.

Calculation of Gini Coefficient

The Gini coefficient, a measure of inequality, was calculated using data from the stratification of agricultural support classes and the distribution of direct aid recipients (European Commission, 2024: European Commission, Directorate-General for Agriculture and Rural Development, Indicative Figures on the distribution of aid, by size class of aid, received in the Context of Direct Aid Paid to the Producers According to Regulation (EU) No 1307/2013 (Financial Year 2022)). The Gini coefficient was calculated by plotting the cumulative share of the population against the cumulative share of income or subsidies received, resulting in a Lorenz curve. The Gini coefficient in the study shows the evenness of the distribution of the number of users of all direct payments into the following classes: less than 0 €, between 0 and 0.5 K €, between 0.5 K and 1.25 K €, between 1.25 K and 2 K €, between 2 K and 5 K €, between 5 K and 10 K €, between 10 K and 20 K €, between 20 K and 50 K €, between 50 K and 100 K €, between 100 K and 150 K €, between 150 K and 200 K €, between 200 K and 250 K €, between 250 K and 300 K €, between 300 K and 500 K €, and more than 500 K € in each EU member state.

$$G = \frac{2\sum_{i=1}^{n} iy_i}{n\sum_{i=1}^{n} y_i} - \frac{n+1}{n}.$$

Correlation Analysis

Spearman's rank correlation coefficient was used to examine the relationship between the direct aid distribution (Gini) and productivity measures. This non-parametric measure assesses the strength and direction of the association between the two ranked variables, providing insights into the correlation between direct allocation and productivity outcomes. Spearman's correlation coefficient has been selected because it measures monotonic relationships, uses data ranks, is robust to outliers, applicable to ordinal and non-normally distributed data, and is easy to interpret.

$$r_s = 1 - \frac{6 \sum D^2}{N^3 - N}$$

RESULTS AND DISCUSSION

Table 1 provides a comprehensive overview of Gini Coefficient and various agricultural productivity metrics across different European countries.

Gini Coefficient and Output and Gross Value Added

The measure of inequality (GINI) in the direct aid distribution classes varies widely among countries. For example, Malta (MT) has the highest Gini coefficient at 86, indicating a highly unequal distribution of subsidies, whereas the Czech Republic (CZ) has the lowest at 48, suggesting a more equitable distribution. The average Gini coefficient across all the countries was approximately 67.04.

Countries with higher Gini coefficients, such as Malta (MT) and Romania (RO), tend to have lower productivity performance when considering output per agricultural work unit (OUTPUT/AWU) and gross value-added per used land area (GVA/HA). For instance, despite its high Gini coefficient, Malta shows a relatively high OUTPUT/UTILISED

AREA (EUR/HA) at 13,828, but its GVA/HA is significantly lower at 5,211. This suggests that, while output per area is high, the value added per hectare is not proportionally high, indicating inefficiencies in value addition.

Table 1. Agriculture Development Indicators and Gini coefficient for EU members in 2022 and Spearman's Rho (ρ) Correlation analysis results

Geo	Gini[a]	Output of the agricultural 'industry' (milion EUR)	Gross value added at basic prices	Annual work units (000)	Utilised agricultural area (ha)	Output/Awu (Eur/Awu)[a]	Output/Utilised Area (Eur/Ha)[a]	Gva/Awu[a]	Gva/Ha[a]
BE	65	11,694.11	2,837.51	51.57	1,368,120	226762	8548	55022	2074
BG	58	6,596.76	3,023.42	152.7	4,564,150	43201	1445	19800	662
CZ	48	7,809.85	2,608.17	93.93	3,492,570	83145	2236	27767	747
DK	57	14,039.96	3,425.10	47.43	2,629,930	296014	5339	72214	1302
DE	59	77,923.88	31,812.25	463.83	16,595,020	168001	4696	68586	1917
EE	56	1,630.46	488.45	17.19	975,320	94849	1672	28415	501
IE	71	12,922.13	5,041.87	156.94	4,920,270	82338	2626	32126	1025
GR	70	14,600.71	6,712.02	328.76	3,916,640	44411	3728	20416	1714
ES	62	63,068.36	29,380.95	850.29	23,913,680	74173	2637	34554	1229
FR	66	97,344.81	40,160.32	722.41	27,364,630	134750	3557	55592	1468
HR	73	3,245.19	1,717.11	173.31	1,505,430	18725	2156	9908	1141
IT	68	72,678.76	37,540.26	978.6	12,523,540	74268	5803	38361	2998
CY	80	822.35	340.18	18.64	134,140	44117	6131	18250	2536
LV	69	2,354.77	825.86	62.61	1,968,960	37610	1196	13191	419
LT	68	5,321.49	2,031.07	120.1	2,914,550	44309	1826	16911	697
LU	69	597.24	172.72	3.53	132,140	169190	4520	48929	1307
HU	64	10,398.36	3,450.69	289.53	4,921,740	35915	2113	11918	701
MT	86	135.51	51.07	6.12	9,800	22142	13828	8345	5211
NL	69	40,556.20	13,302.60	161.55	1,817,900	251044	22309	82344	7318
AT	70	10,540.17	4,483.69	120.39	2,602,670	87550	4050	37243	1723
PL	72	39,546.32	14,253.27	1,427.50	14,784,120	27703	2675	9985	964
PT	73	10,669.55	3,385.66	223.1	3,963,940	47824	2692	15176	854
RO	80	22,218.82	9,929.62	1,035.00	12,762,830	21467	1741	9594	778
SI	73	1,590.98	523.19	72.92	483,440	21818	3291	7175	1082
SK	57	3,001.11	888.74	38.6	1,862,650	77749	1611	23024	477
FI	65	5,824.62	1,719.83	63.9	2,281,710	91152	2553	26914	754
SE	62	8,251.22	2,773.58	56.21	3,005,810	146793	2745	49343	923
Spearman's Rho[a]						rs = -0.56623, p (2-tailed) = 0.00208.	rs = 0.26797, p (2-tailed) = 0.17657.	rs = -0.54971, p (2-tailed) = 0.00298.	rs = 0.368, p (2-tailed) = 0.05894.

[a] Own calculation

Source: Eurostat 2025. Economic accounts for agriculture - values at current prices; European Commission. (2024). Direct aid breakdown. Distribution of direct aid to farmers – indicative figures 2022 financial year. European Union.

Productivity Indicators and Spearman's Rank Correlation Coefficient

The study utilized secondary data from Eurostat databases to measure agricultural productivity using several key indicators. The output per Agricultural Work Unit (AWU) represents the output per worker, with countries such as the Netherlands (NL) and Denmark (DK) showing the highest values, indicating the leading productivity per work unit among EU countries. The output per Utilized Area measures the output per hectare of utilized agricultural land, where the Netherlands again demonstrated high productivity, reflecting efficient land use. The Gross Value Added (GVA) per Agricultural Work Unit indicates the value added per worker, with higher values in countries such as the Netherlands and Denmark suggesting greater efficiency and value addition per worker. Finally, GVA per hectare

shows the value added per hectare, with countries such as the Netherlands and Italy (IT) exhibiting more efficient and valuable land use.

Spearman's rank correlation coefficients (rs) provide insight into the relationships between the Gini coefficient and various productivity measures. The correlation between the Gini coefficient and output per AWU is significantly negative (rs = -0.56623, p = 0.00208), indicating that higher inequality in direct aid distribution is associated with lower output per worker and that a more equitable direct aid distribution can enhance worker productivity. Conversely, the correlation between the Gini coefficient and output per hectare is positive but not statistically significant (rs = 0.26797, p = 0.17657), implying that inequality does not have a clear impact on output per hectare, and other factors such as land management practices may play a more significant role. The correlation between the Gini coefficient and GVA per AWU is significantly negative (rs = -0.54971, p = 0.00298), reinforcing the idea that higher inequality is associated with lower value-added per worker, supporting the need for equitable direct aid distribution. Finally, the correlation between the Gini coefficient and GVA per hectare is positive but marginally significant (rs = 0.368, p = 0.05894), suggesting a potential positive relationship between inequality and value-added per hectare, although this result is less robust and may imply that higher inequality might be associated with more efficient land use in some cases.

Croatia, Slovenia and Austria - Comparative Analysis of Direct aid Distribution

Agriculture plays a pivotal role in the economic and rural development of Croatia, Slovenia, and Austria, each exhibiting unique characteristics that are influenced by historical, geographical, and policy factors.

According to the national strategic plans of the Common Agricultural Policy (CAP), the following is a brief description of the agricultural structure of each member state.

Croatian agriculture is characterized by small family agricultural holdings and very diverse because, in a small area, there are simultaneously three agro-climatic zones - Central European, mountainous, and Mediterranean. This sector contributes with approximately 3% to the economy, with a focus on arable land (68%) and permanent grasslands and meadows (26%). The main agricultural products include cereals, industrial crops, forage plants, vegetables, and wines. The government aims to support sustainable development, improve living conditions in rural areas, and protect natural resources through incentives and policies.

Similarly, Slovenia's agriculture is predominantly composed of small family farms, with 60% of the holdings having less than five hectares of land. The agricultural sector is vital for rural development, utilizing 36% of the land for agriculture and 61% covered by forests. Key agricultural products include forage plants, milk, wines, and cattle. Despite the natural constraints impacting agricultural production, Slovenia's CAP Strategic Plan focuses on ensuring food security and sustainable development.

Austria's agricultural sector is characterized by a mix of small- and medium-sized family farms, with crops accounting for approximately 50% of the agricultural output and animal production slightly over 40%, with milk production being a major contributor. Rural areas in Austria cover approximately 75% of the country's land area and are home to over 3.6 million people. Austria's CAP Strategic Plan for 2023-2027 aims to enhance sustainable competitiveness, resilience, and environmental protection in agriculture.

Table 1 provides a detailed breakdown of the number of direct aid recipients across different stratification categories for the three EU member states: Croatia (HR), Slovenia (SI), and Austria (AT).

Table 1. Distribution of direct aids to the producers - Financial year 2022, Number of beneficiaries per range of expenditure in Croatia, Slovenia and Austria

Size-class of aid (all direct payments)	Croatia	Austria	Slovenia
< 0 €	221	4	n/a
≥ 0 and < 0.5 K €	24298	1885	10929
≥ 0.5 K and < 1.25 K €	38640	15788	17892
≥ 1.25 K and < 2 K €	15779	10673	9029
≥ 2 K and < 5 K €	16911	29888	11475
≥ 5 K and < 10 K €	6416	24271	3600
≥ 10 K and < 20 K €	4184	15736	1374
≥ 20 K and < 50 K €	2094	4289	411
≥ 50 K and < 100 K €	332	381	35
≥ 100 K and < 150 K €	67	51	6
≥ 150 K and < 200 K €	37	21	2
≥ 200 K and < 250 K €	10	3	1
≥ 250 K and < 300 K €	9	4	1

≥ 300 K and < 500 K €	19	4	4
≥ 500 K €	24	3	3
Total	**109041**	**103001**	**54762**

Source: European Commission. (2024). Direct aid breakdown. Distribution of direct aid to farmers – indicative figures 2022 financial year.

Some key observations and differences in the distribution of agricultural subsidies among these countries are as follows:

- In Croatia (HR), the total number of direct aid recipients was 109,041. The average CAP income support per beneficiary in 2022 was €4,230, with an average of €410 per hectare (European Commission, n.d.b). Most recipients fell within the lower direct aid categories, particularly in the ranges of "≥ 0 and < 0.5 K €" (24,298 recipients, 22,2% of all recipients) and "≥ 0.5 K and < 1.25 K €" (38,640 recipients, 35,4%). There are very few recipients in the higher direct aid categories, with only 24 recipients (2,2%) receiving subsidies of "≥ 500 K €".
- In Austria (AT), the total number of direct aid recipients was 103,001. The average CAP income support per beneficiary in 2022 was €7,950, with an average of €357 per hectare (European Commission, n.d.b). Like Croatia, Austria has a significant number of recipients in the lower direct aid categories, but a notable concentration in the "≥ 2 K and < 5 K €" category (29,888 recipients, 29,02%). Austria also has a small number of recipients in the higher direct aid categories, with only three recipients receiving subsidies of "≥ 500 K €".
- In Slovenia (SI), the total number of direct aid recipients is 54,762. The average CAP income support per beneficiary in 2022 was €3,010, with an average of €374 per hectare (European Commission, n.d.b). Slovenia shows a similar pattern, with many recipients in the lower direct aid categories, particularly in the ranges of "≥ 0 and < 0.5 K €" (10,929 recipients, 19,96%) and "≥ 0.5 K and < 1.25 K €" (17,892 recipients, 32,67%). Slovenia has very few recipients in the higher direct aid categories, with only three recipients receiving subsidies of "≥ 500 K €".

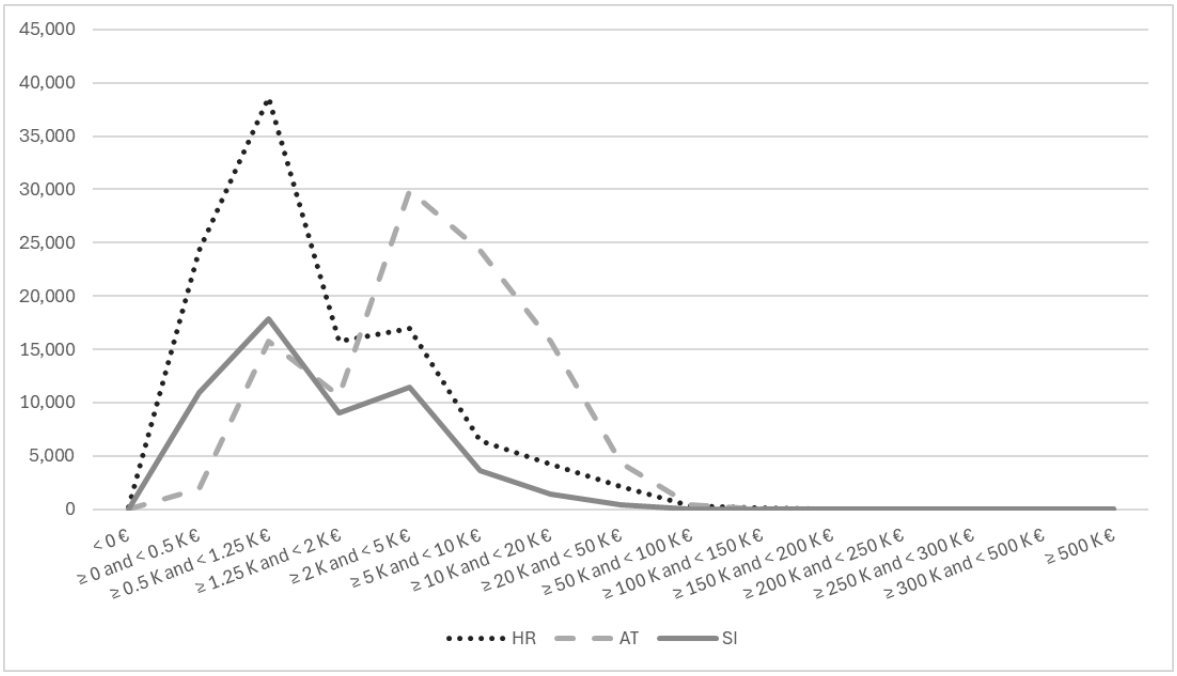

Figure 1 Distribution of direct aids to the producers - Financial year 2022, Number of beneficiaries per range of expenditure in Croatia, Slovenia and Austria
Source: Table 1

Key differences and observations reveal that Croatia has the highest total number of direct aid recipients, followed by Austria and Slovenia, indicating a broader distribution of subsidies in Croatia. All three countries show a significant concentration of recipients in the lower direct aid categories, suggesting that many small-scale farmers benefit from these subsidies. However, Austria stands out with a relatively higher number of recipients in the "≥ 2 K and < 5 K €" category compared to Croatia and Slovenia. Additionally, the number of recipients in the higher direct aid categories (≥ 50 K € and above) is very low across all three countries, indicating that large-scale farms receiving substantial subsidies are rare.

Overall, the Figure 1 highlights that most agricultural direct aid recipients in these countries fall within the lower financial brackets, with a sharp decline in the number of recipients as the direct aid amount increases. This distribution pattern is consistent across all three countries.

CONCLUSION

This study investigates the association between direct aid inequality and agricultural productivity within the European Union by employing the Gini coefficient as a measure of inequality in direct aid distribution, alongside various productivity indicators. The results demonstrate significant negative correlations between the Gini coefficient and both output per agricultural work unit and gross value-added per agricultural work unit, indicating that a more equitable distribution of subsidies could enhance productivity per unit of work.

Although the analysis highlights certain patterns in the distribution of payments relative to productivity, it is important to emphasize that these relationships are influenced by a range of additional factors, including production structure, farmers' qualifications, the strength of agri-food chains, and the broader economic context. These aspects further complicate the issue of fairness and efficiency within the CAP. Particularly noteworthy is the growing debate in scientific and professional literature on income equality per unit of labour, even though this is not an official CAP criterion.

These results highlight the complex relationship between the direct aid distribution and agricultural productivity. The significant negative correlations between the Gini coefficient and both OUTPUT/AWU and GVA/AWU suggest that a more equitable direct aid distribution can enhance productivity per unit of work. However, the mixed results for the OUTPUT/UTILISED AREA and GVA/HA indicate that other factors, such as land management practices and regional agricultural policies, also play crucial roles.

The distribution patterns observed in the three EU members comparative analysis of direct aid distribution reflect the broader context of agricultural direct aid policies in the EU. The concentration of recipients in lower direct aid categories highlights the support provided to small and medium-sized farms, which are crucial for rural development and sustainability. The limited number of recipients in the higher direct aid categories suggests that large-scale farms, while fewer in number, may receive a disproportionate share of total subsidies, contributing to income inequality within the agricultural sector.

This study provides valuable insights into the relationship between direct aid distribution inequality and agricultural productivity in the EU. However, some limitations should be noted. The analysis is based on data from a single financial year (2022), which may not capture longer-term trends or account for year-to-year fluctuations in agricultural conditions and policies. A multi-year analysis would provide a more robust understanding of these relationships over time. Additionally, exploring alternative inequality metrics beyond the Gini coefficient could offer a more nuanced perspective on subsidy distribution complexity. Future research in this area would contribute to a deeper understanding of the dynamics between subsidy distribution and agricultural productivity in the EU context.

In conclusion, our findings underscore the importance of equitable direct aid distribution in promoting agricultural productivity. Policymakers should consider these dynamics when designing direct aid frameworks, to ensure that subsidies effectively enhance productivity and support sustainable agricultural development.

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