Agris on-line Papers in Economics and Informatics

Volume XVIII Number 2, 2026

Landlocked: A Boon or Bane for EU Member States' Agricultural Trade Competitiveness?

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Abstract

Some European countries have no sea and are close to other countries' mainlands. Trading agricultural products from different places may be difficult because of this circumstance. This study assesses EU Member States' agricultural trade competitiveness and the impact of landlocked conditions on that competitiveness. This study analysed 27 EU countries between 2000 and 2022 using the Revealed Comparative Advantage, the Error Correction Model, and Propensity Score Matching. Landlocked conditions reduced the EU Member States' agricultural competitiveness. These findings support Diamond Porter's theory, which holds that any country must have factor conditions to generate advantages. Similarly, the New Trade theory promotes economic scale for all countries, even landlocked ones. Other factors in this study have varying impacts on the agricultural competitiveness of EU Member States.

Keywords

Production, value added, capital, temperature, unemployment, politics.

Nugroho, A. D., Kusumaningsih, A. and Prasada, I. Y. (2026) "Landlocked: A Boon or Bane for EU Member States' Agricultural Trade Competitiveness?", *AGRIS on-line Papers in Economics and Informatics*, Vol. 18, No. 2, pp. 135-145. ISSN 1804-1930. DOI 10.7160/aol.2026.180209.

Introduction

Landlocked countries do not always face difficulties because they can become transit countries and create economic opportunities. The key is the development of modern service infrastructure for cost efficiency and the formation of a new logistics industry (Sharapiyeva et al., 2019). In addition, countries without seaports can build infrastructure to facilitate the transportation of goods to and from neighboring countries (Adhikari and Ma, 2022). However, having access to the sea is a blessing for many countries. Countries with seaports have greater access to global markets than those without, as maritime routes are the most economical and effective means of cargo transport (Adhikari and Ma, 2022). If every country has access to seaports, the cost of shipping goods worldwide will decrease, raising competitiveness and lowering prices (Lane and Pretes, 2020).

In Europe, landlocked countries are supported by various regional trade agreements, such as the European Union (EU). The landlocked countries of Austria, the Czech Republic, Hungary, Luxembourg and Slovakia have excellent locations for trade in goods and services, particularly for Western European target consumers. The countries' locations also influence investment and decision-making. Numerous countries have achieved significant progress in enacting institutional and economic reforms and attracting trade and investment (Sharapiyeva et al., 2019). The EU's landlocked countries will make significant financial investments to update their infrastructure and capabilities, thereby strengthening their institutional frameworks, customs authority structures and transportation laws (Sharapiyeva et al., 2019).

Meanwhile, several researchers have conducted studies on the impact of landlocked countries on economic growth (Chaudhary and Paudel, 2024) and agricultural exports (Abdullahi et al., 2021). However, both studies have not examined the impact of landlocked areas on agricultural competitiveness or without regional agreements. In contrast, the object of this study is the EU, which has regional trade agreements that support trade among member states. Effective EU regional collaboration can support economic progress and strategic infrastructure investments for landlocked countries in the region (Chaudhary and Paudel, 2024). In this way, this regional policy can potentially change landlockedness to land-linkedness. Hence, landlocked European countries have a much lower share of maritime transport, as substantial trade flows convey commodities over very short distances via road, rail, and inland waterways (Verschuur et al., 2022). The question naturally arises: is it true that agricultural competitiveness in EU landlocked countries is not affected by geographical disadvantages?

Theoretically, this study contributes to the Diamond Porter's and the New Trade Theories. Diamond Porter's theory shows that the competitiveness of a product can be created by considering several aspects, namely factor conditions, demand conditions, related and supporting industries, and firm strategy, structure and rivalry (Porter, 1990). However, international trade is complex, so production factors and efficiency do not always determine a commodity's competitiveness. According to the New Trade Theory, economies of scale are crucial because, even without a production factor advantage, a country's ability to produce on a large scale is necessary for its commodities to dominate the market (Krugman and Obstfeld, 2003). According to both theories, landlocked areas may present challenges or growth opportunities. Being landlocked poses challenges, as it forces a country to depend on other countries for economic activity, particularly in logistics and distribution. However, when a country can optimise its economic size through numerous technologies, landlocked countries also have a lot of promising thing. This theoretical gap serves as a foundation for the study, which aims to demonstrate the effects of a landlocked position on a country and solutions to address this detrimental circumstance.

Material and methods

Data source

This study used panel data that combines cross-sectional and time-series data. These data were obtained from the FAO, the Federal Reserve, the World Bank, the ILO, the OECD, and CEPII. Cross-sectional data from 27 EU Member States were used in this study, and the time-series data covered the years 2000–2022. Fourteen variables were analysed in this study (Table 1).

The selection of explanatory variables in Table 1 was based on the findings of other researchers. Agricultural competitiveness in a country is influenced by production (Rumankova et al., 2022), value added (Jung and Park, 2014), capital (Kozelský et al., 2024), exchange rate (Kozelský et al., 2024), education (Nugroho et al., 2023), labor (Rumankova et al., 2022), policies or political conditions (Rumankova et al., 2022), temperature change (Nugroho et al., 2023), bioenergy (Waldenström et al., 2016), research and development (Jung and Park, 2014) and geographical position/landlocked (Sharma, 2020).

Variable	Symbol	Source	Expected sign.
Agricultural Trade Comparative Advantage	TCA	Calculated by authors from FAO data	
Gross Production Index	GPI	FAO	+
Agricultural Value Added (million USD)	AVA	FAO	+
Agricultural Gross Fixed Capital Formation (million USD)	CAP	FAO	+
Real Effective Exchange Rates: CPI Based (%)	RER	Federal Reserve Economic	+
School Enrollment, Secondary (% gross)	SCH	World Bank	+
Employment in Agriculture, Female (% of female employment)	FEMA	ILO	+
Employment in Agriculture, Male (% of male employment)	MALE	ILO	+
Youth Unemployment Rate (%)	YOU	OECD	-
Political Instability	POL	World Bank	-
Temperature Change (0C)	TEMP	FAO	-
Total Bioenergy Consumption (TJ)	BIO	World Bank	-
Research and Development Expenditure (% of GDP)	RES	World Bank	+
Landlocked Country0 = no landlocked1 = landlocked	LOCK	CEPII	-

Source: Authors

Table 1: Variable in this study.

Data analysis

The Revealed Comparative Advantage (RCA) index can be used to quantify TCA. This method computes comparative advantage by analysing a country's export trade flow for specific products in specific markets. RCA measures the agricultural export performance of 27 EU Member States (Balassa, 1965):

$$RCA_{ij} = \left(\frac{X_{ij}}{X_{it}}\right) / \left(\frac{X_{ej}}{X_{et}}\right) \quad (1)$$

where: X_{ij} = the current year's total value of agricultural exports of a country (US dollars), X_{it} = the current year's total value of exports of a country (US dollars), X_{ej} = the current year's total value of EU agricultural exports (US Dollars) and X_{et} = the current year's total value of EU exports (US dollars). The formula produces the following results: 1) a country has a comparative advantage if the index generated by the RCA calculation is greater than 1 and 2) a country has a comparative disadvantage if the RCA value is less than 1.

The empirical analysis begins with the Levin-Lin-Chu (LLC) unit root test before the estimation (Levin et al., 2002). The unit root test reveals that TCA, AVA, CAP, RER, SCH, FEMA, MALE, YOU, and POL are stationary at the level, but the other variables are not stationary at the level (Table 2). GPI, TEMP, BIO and RES are stationary at the first-difference level. The analysis's findings also indicate that TCA is a significant dependent variable at this level, suggesting that the Error Correction Model (ECM) is the model that best fits this study. This is because most dynamic models require the dependent variable to be significant at the first difference. Meanwhile, static analysis could not be used because some variables in this study are significant at the first difference (Wooldridge, 2016).

Variable	Level	Sign.
TCA	At level	-3.779***
GPI	1st difference	-11.629***
AVA	At level	-4.388***
CAP	At level	-4.110***
RER	At level	-2.345***
SCH	At level	-2.693***
FEMA	At level	-8.636***
MALE	At level	-4.460***
YOU	At level	-3.691***
POL	At level	-7.126***
TEMP	1st difference	-11.229***
BIO	1st difference	-3.876***
RES	1st difference	-6.246***

Note: ***: sig 0.01
Source: Own elaboration (2025)

Table 2: LLC unit root test.

The results of the cointegration test indicate that the variables in the models have a long-term relationship (Wooldridge, 2016). The TCA, GPI, AVA, CAP, RER, SCH, FEMA, MALE, YOU, POL, TEMP, BIO and RES variables are cointegrated (Table 3). The trace statistics value is higher than the critical value at the 1% confidence level, indicating that ECM is the appropriate analysis model for this study.

Hypothesized No. of CE (s)	Trace statistics
None	318.221***
At most 1	236.549***
At most 2	124.146***
At most 3	49.228***

Note: ***: sig 0.01
Source: Own elaboration (2025)

Table 3: Cointegration test.

The dependent and explanatory variables are rarely in equilibrium, so it is necessary to observe the disequilibrium relationship:

$$\begin{aligned} \Delta TCA_{it} = {} & b_0 + b_1 \Delta GPI_{it} + (b_1 + b_2) GPI_{it\text{-}1} + \\ & + b_3 \Delta AVA_{it} + (b_3 + b_4) AVA_{it\text{-}1} + b_5 \Delta CAP_{it} + \\ & + (b_5 + b_6) CAP_{it\text{-}1} + b_7 \Delta RER_{it} + (b_7 + b_8) RER_{it\text{-}1} + \\ & + b_9 \Delta SCH_{it} + (b_9 + b_{10}) SCH_{it\text{-}1} + b_{11} \Delta FEMA_{it} + \\ & + (b_{11} + b_{12}) FEMA_{it\text{-}1} + b_{13} \Delta MALE_{it} + \\ & + (b_{13} + b_{14}) MALE_{it\text{-}1} + b_{15} \Delta YOU_{it} + \\ & + (b_{15} + b_{16}) YOU_{it\text{-}1} + b_{17} \Delta POL_{it} + \\ & + (b_{17} + b_{18}) POL_{it\text{-}1} + b_{19} \Delta TEMP_{it} + \\ & + (b_{19} + b_{20}) TEMP_{it\text{-}1} + b_{21} \Delta BIO_{it} + \\ & + (b_{21} + b_{22}) BIO_{it\text{-}1} + b_{23} \Delta RES_{it} + \\ & + (b_{23} + b_{24}) RES_{it\text{-}1} + D_{LOCK} - \omega TCA_{it\text{-}1} + \varepsilon_i \end{aligned} \quad (2)$$

Δ = first difference and $\lambda = 1 - \Phi$.

Propensity Score Matching (PSM) is an additional instrument used in this study to investigate how the landlocked dummy (LOCK) affects trade comparative advantage. PSM can be carried out using several stages of analysis. First, determine the control and treatment groups. Second, an effect evaluation study should identify which outcomes can be measured. Third, carry out a characteristic matching process between the treatment group (a landlocked country) and the control group (a non-landlocked country) to determine the effect of the treatment on the predefined outcomes (Kuss et al., 2016):

$$ATT = E(R_1 | I = 1) - E(R_0 | I = 0) \quad (3)$$

$$ATT = E\{R_1 \mid I = 1, p(Z)\} - E\{R_0 | I = 0, p(Z)\} \quad (4)$$

Where *ATT* (Average Treatment effect of the Treated group) is the value of the impact of treatment on outcomes based on all the data used, I denotes the treatment indicator used in the study ($I = 0$ for the control group's outcome, $I = 1$ for the treatment group), R_0 for the control group's value, R_1 for the treatment group's value, and $p(Z)$ denotes the propensity score obtained from the PSM analysis. p(Z) is calculated using the LOCK dummy variable's probit estimate results. Two assumptions must be met for the PSM's findings to be valid: conditional independence and overlapping.

Results and discussion

Most EU Member States are included in the agricultural competitiveness category since their value is more than 1 (Table 4a-4c). Austria, Portugal and Romania have become highly competitive in the agricultural sector compared to 2 decades ago. Czech, Finland, Germany, Malta, Slovakia, Slovenia and Sweden are among the countries that fall into the category of not having competitiveness because their competitiveness value has been less than 1 for the previous 20 years. EU Member States' agricultural competitiveness fluctuates over time and between countries. Austria, Croatia, Finland, France, Germany, Italy, Lithuania, Malta, Slovakia, Slovenia, Spain and Sweden are among the countries that have seen a marginal gain in agricultural competitiveness.

In the meantime, countries such as Bulgaria, Latvia, Luxembourg, Poland, Portugal and Romania have seen a notable rise in competitiveness. However, certain countries—such as Belgium, Hungary, Ireland and the Netherlands—have seen a decline in competitiveness. Greece, Denmark and Cyprus saw a sharp drop in competitiveness. Estonia is the only EU Member States whose agricultural competitiveness has stagnated over the last twenty years.

The probability of ECT is less than 0.01, indicating that the model is valid (Table 5). According to the ECT, the error term from the prior year was adjusted at a convergence speed of 0.099 during the current year. The first explanatory factor that has a significant impact on agricultural trade competitiveness (TCA) is gross production (GPI). GPI raises TCA by 0.00003 in the short term and 0.00008 in the long term. The increasingly high and stable GPI value can be interpreted as evidence that the agricultural production process in the EU Member States is efficient and conducted on a large scale. Production cost efficiency drives cheaper products, creating a comparative advantage (Kuzmenko et al., 2022). The high GPI of the European Union is supported by implementing policies to increase agricultural production. These policies include subsidies and production incentives through the Common Agricultural Policy (CAP) scheme (Garrone et al., 2019) and precision

Year	Austria	Belgium	Bulgaria	Croatia	Cyprus	Czech	Denmark	Estonia	Finland	France	Germany	Greece
2000	0.79	1.42	1.53	1.32	6.81	0.67	2.57	1.05	0.27	1.58	0.68	3.40
2001	0.80	1.34	1.68	1.29	6.13	0.58	2.55	1.11	0.28	1.45	0.64	3.47
2002	0.78	1.26	1.86	1.48	4.24	0.52	2.39	1.33	0.29	1.55	0.62	3.50
2003	0.84	1.27	1.52	1.56	4.05	0.51	2.36	1.50	0.28	1.56	0.63	3.15
2004	0.96	1.29	1.61	1.22	3.57	0.56	2.45	1.00	0.29	1.57	0.65	3.01
2005	1.11	1.30	1.71	1.52	2.45	0.67	2.41	1.00	0.29	1.63	0.70	3.35
2006	1.21	1.33	1.65	1.68	2.79	0.62	2.51	0.99	0.30	1.72	0.71	3.31
2007	1.05	1.30	1.41	1.52	3.00	0.63	2.47	1.31	0.30	1.73	0.70	3.00
2008	1.05	1.32	1.91	1.37	2.64	0.65	2.31	1.28	0.30	1.69	0.75	2.95
2009	1.04	1.29	2.20	1.53	2.66	0.62	2.21	1.18	0.32	1.58	0.75	3.15
2010	1.04	1.28	2.40	1.47	2.65	0.58	2.30	1.17	0.34	1.68	0.75	3.34
2011	1.02	1.26	2.17	1.46	2.37	0.58	2.21	1.05	0.37	1.74	0.76	2.23
2012	1.04	1.30	2.17	1.62	2.30	0.66	2.25	1.13	0.37	1.72	0.78	2.31
2013	1.03	1.28	2.42	1.56	2.40	0.67	2.22	1.11	0.38	1.77	0.79	2.36
2014	1.00	1.26	2.18	1.56	1.46	0.64	2.25	1.09	0.47	1.64	0.76	2.23
2015	0.98	1.28	2.05	1.63	1.17	0.66	2.17	1.00	0.49	1.59	0.71	2.56
2016	0.97	1.26	2.01	1.71	1.46	0.62	2.02	0.93	0.40	1.49	0.69	2.66
2017	0.97	1.27	1.77	1.64	1.50	0.56	2.08	0.96	0.39	1.50	0.69	2.35
2018	1.01	1.29	1.93	1.82	1.23	0.55	2.08	0.89	0.35	1.57	0.69	2.31
2019	1.01	1.28	1.98	1.75	1.73	0.55	1.95	1.01	0.36	1.52	0.68	2.25
2020	1.02	1.26	1.92	1.76	1.90	0.55	1.81	0.96	0.34	1.59	0.68	2.45
2021	1.02	1.20	2.12	1.73	1.70	0.56	1.82	0.85	0.36	1.67	0.68	2.37
2022	1.04	1.13	2.13	1.78	1.52	0.61	1.81	1.04	0.36	1.75	0.72	2.07

Source: Own elaboration (2025)

Table 4: Agricultural trade competitiveness of EU member states. (to be continued).

Year	Hungary	Ireland	Italy	Latvia	Lithuania	Luxembourg	Malta	Netherland	Poland	Portugal	Romania
2000	1.22	1.40	1.02	1.12	1.85	0.88	0.37	1.88	1.17	0.91	0.54
2001	1.18	1.05	0.96	1.33	1.73	0.79	0.53	1.80	1.14	0.90	0.57
2002	1.13	1.02	1.00	1.67	1.46	0.81	0.65	1.96	1.06	0.94	0.48
2003	1.09	1.17	0.99	1.67	1.57	0.77	0.65	2.04	1.10	0.94	0.49
2004	0.97	1.34	1.04	1.14	1.62	0.68	0.47	2.02	1.34	1.02	0.49
2005	1.02	1.46	1.08	1.47	1.84	0.69	0.49	2.00	1.52	1.12	0.50
2006	0.97	1.72	1.13	1.65	2.03	0.62	0.48	2.00	1.54	1.18	0.63
2007	1.02	1.53	1.03	1.89	2.37	0.68	0.34	1.97	1.47	1.25	0.62
2008	1.07	1.41	1.04	2.14	2.23	0.68	0.48	1.88	1.38	1.28	0.98
2009	1.01	1.11	1.09	2.08	2.28	0.69	0.38	1.98	1.44	1.32	1.00
2010	1.10	1.24	1.14	2.21	2.25	1.00	0.35	1.91	1.45	1.40	1.17
2011	1.15	1.32	1.09	1.89	2.06	1.09	0.35	1.87	1.44	1.31	1.22
2012	1.29	1.37	1.11	2.52	2.33	0.89	0.45	1.83	1.63	1.37	1.22
2013	1.23	1.52	1.14	2.44	2.31	1.09	0.54	1.83	1.67	1.38	1.42
2014	1.15	1.49	1.12	2.31	2.27	1.16	0.66	1.69	1.63	1.43	1.38
2015	1.07	1.26	1.13	2.18	2.20	1.08	0.66	1.67	1.61	1.40	1.37
2016	0.99	1.18	1.11	2.17	2.05	1.00	0.45	1.72	1.51	1.36	1.29
2017	1.02	1.28	1.12	2.40	1.95	1.12	0.57	1.85	1.57	1.33	1.25
2018	0.99	1.17	1.19	2.34	1.97	1.26	0.52	1.85	1.64	1.39	1.29
2019	0.99	1.11	1.18	2.62	2.03	1.10	0.49	1.80	1.59	1.35	1.35
2020	0.97	0.94	1.22	2.48	2.17	1.22	0.48	1.76	1.54	1.43	1.32
2021	1.01	1.06	1.24	2.17	1.91	1.20	0.43	1.74	1.53	1.46	1.63
2022	1.07	1.06	1.21	2.50	2.01	1.22	0.49	1.62	1.67	1.47	1.57

Source: Own elaboration (2025)

Table 4: Agricultural trade competitiveness of EU member states (Continuation + to be continued).

Year	Slovakia	Slovenia	Spain	Sweden
2000	0.50	0.57	1.91	0.32
2001	0.48	0.59	1.85	0.38
2002	0.52	0.55	1.91	0.39
2003	0.45	0.52	1.97	0.38
2004	0.54	0.49	2.00	0.39
2005	0.66	0.54	2.18	0.45
2006	0.66	0.68	2.16	0.44
2007	0.57	0.67	1.96	0.44
2008	0.54	0.71	1.96	0.46
2009	0.61	0.75	1.89	0.46
2010	0.62	0.83	1.95	0.44
2011	0.66	0.75	1.85	0.41
2012	0.79	0.89	1.99	0.46
2013	0.67	0.78	1.95	0.50
2014	0.55	0.70	1.97	0.51
2015	0.51	0.71	1.98	0.49
2016	0.50	0.69	1.95	0.46
2017	0.47	0.67	1.94	0.46
2018	0.46	0.72	2.00	0.46
2019	0.46	0.68	2.04	0.46
2020	0.48	0.64	2.16	0.47
2021	0.51	0.69	2.11	0.48
2022	0.61	0.65	2.01	0.49

Source: Own elaboration (2025)

Table 4: Agricultural trade competitiveness of EU member states (Continuation - the end).

agricultural technology (Barnes et al., 2019).

The following explanatory variable with a significant detrimental effect is Agricultural Value Added (AVA). In the long term, a 1% increase in AVA will result in a 0.00001 drop in TCA. Short-term changes in AVA do not affect TCA. Generally, countries with greater agricultural value added have greater comparative advantages (Török and Jámbor, 2013). EU agricultural products will compete with similar products from other countries with greater AVAs but at lower prices. This makes EU products less competitive by discouraging consumers from choosing them.

In the long term, a 1 million USD increase in agricultural gross fixed capital formation (CAP) results in a 0.0001 increase in TCA. In the short term, CAP has no impact on TCA. CAP increases productivity, efficiency and competitiveness. Increasing food crop yields is currently focused on efficiency, with output increasing with the same production factors (Iglesias et al., 2012). This way, food crop prices can be lowered and produce competitive advantages in the global agricultural market.

Youth Unemployment Rate (YOU) significantly impacts TCA. In the long term, a 1% drop in YOU causes TCA to drop by -0.007. YOU have no significant impact on TCA in the short term. Many countries' economic success is at risk due to YOU. The agricultural sectors of European economies saw significant structural labour reforms in the years following World War II. On the one hand, economic growth and rising agricultural productivity have led to a continuous net labour outflow from agriculture. On the other hand, specialisation and changes in the demand structure and the scale of production have led to structural quantity and skills shifts in the demand for agricultural labour (Dries et al., 2012).

Long-term political instability (POL) will cause TCA to fall by 0.835. Like YOU, though, the POL variable does not affect TCA in the short term. One of the biggest obstacles to the development of European agriculture is POL. Low productivity and farmer income, inefficient farming businesses and firms, deteriorating environmental conditions and risks to the competitiveness and sustainability of European agriculture are all results of geopolitical problems and inaccurate political policymaking (Kravčáková Vozárová and Kotulič, 2025).

The following explanatory factors have a long-term impact on TCA: temperature change (TEMP) and bioenergy usage (BIO). TCA will decrease by -0.121 for every 1 0C TEMP increase and -0.000003 for every 1 TJ increase in BIO. The rise in TEMP will exacerbate the imbalance in water availability for crop production, intensify pest and plant disease attacks and accelerate agricultural land degradation (Yuan et al., 2024). Soil respiration increases with temperature and reducing ecosystems' carbon uptake. All of this leads to a sharp decline in agricultural competitiveness and productivity. Meanwhile, BIO will increase its price relative to conventional energy, thereby reducing production efficiency in the agricultural sector (Estevez et al., 2022).

Variable	Short run		Long run	
	Coeff.	**Std. error**	**Coeff.**	**Std. error**
GPI	0.00003*** -3.433	0.00001	0.00008*** -3.715	0.00002
AVA	-0.000001 (-0.231)	0.000004	-0.00001* (-1.704)	0.000007
CAP	0.00001 -1.2	0.00001	0.0001*** -4.268	0.00002
RER	-0.00001 (-0.735)	0.00002	0.00003 -0.763	0.00004
SCH	0.00001 -0.525	0.00002	0.00002 -0.749	0.00002
FEMA	-0.016 (-1.228)	0.013	-0.012 (-1.520)	0.008
MALE	0.005 -0.328	0.014	0.0005 -0.056	0.008
YOU	0.0007 -0.364	0.002	-0.007** (-2.377)	0.003
POL	-0.004 (-0.086)	0.044	-0.835*** (-10.342)	0.081
TEMP	0.003 -0.336	0.01	-0.121** (-2.999)	0.04
BIO	0.00000008 -0.216	0.0000004	-0.000003*** (-7.740)	0.0000007
RES	-0.03 (-0.457)	0.066	-0.072 (-1.622)	0.045
LOCK	0.015 -0.88	0.017	-0.468*** (-6.272)	0.074
C	-0.01 (-1.234)	0.008	1.469** -2.727	0.539
ECT(-1)	-0.099*** (-8.720)	0.011	-	-
Adj R^2	0.117		0.397	
F-stat	6.589***		32.381***	

Note: *** sig 0.01, ** sig 0.05 and * sig 0.1
Source: Own elaboration (2025)

Table 5: Determinant factors of EU member states' agricultural trade comparative advantage.

The primary variable in this study, landlocked (LOCK), significantly impacts TCA. The analysis's findings demonstrate that countries with seas are more competitive in the agricultural sector than landlocked countries. Next, a Propensity Score Matching (PSM) analysis was conducted to determine the differences of TCA value between landlocked and non-landlocked countries.

PSM requires a balancing test to ensure the model is consistent and does not introduce bias into the analysis results (Sseguya et al., 2021). The balancing test shows that the matching process has reduced bias by 86.41% (Table 6). Another indicator, pseudo R^2 after matching, is better than the pseudo R^2 value before the matching process.

Parameters	Value of Parameter
Pseudo R^2 Before Matching	0.14
Pseudo R^2 After Matching	0.47
Prob. LR chi^2 Before matching	0.00
Prob. LR chi^2 After matching	0.00
Mean Standardised Bias Before Matching	57.40
Mean Standardised Bias After Matching	7.80
Total % |Bias|Reduction	86.41

Source: Own elaboration (2025)

Table 6: Balancing test for matching based on the propensity score.

Impact evaluation analysis shows that LOCK harms agricultural trade competitiveness (Table 7). The landlocked decreased TCA value of 0.53. This is consistent with the ECM analysis, which indicates that LOCK reduces TCA.

Parameters	Value of Parameter
Treated	0.85
Control	1.38
Difference	-0.53
t-statistics	-3.19 ***

Note: *** Significant at 1% alpha (t-table = 2.33)
Source: Own elaboration (2025)

Table 7: Impact evaluation results.

The EU countries rely on cross-border maritime infrastructure to import and export commodities through ports in neighboring countries or to use transshipment services to send goods from the origin to the destination. Several European ports, such as Algeciras, Valencia and Marsaxlokk, have a high share of foreign throughout. In addition, the ports of Le Havre, Antwerp, Rotterdam, and Bremen handle the largest volumes of imports and exports, as they compete for trade to and from the Central European hinterland (Verschuur et al., 2022).

This study shows landlocked countries experience a decrease in competitiveness. Landlocked countries experience limited autonomy in their trade policies and are heavily influenced by neighboring countries with port access policies (Sharma, 2020). Meanwhile, countries with seaports tend to have lower trading costs. Trade costs have been shown to affect a country's export competitiveness and composition (Abdullahi et al., 2021). Landlocked countries face trade restrictions at their borders and must pay higher costs for loading, unloading, transportation, and other logistical costs (Chaudhary and Paudel, 2024). Landlocked countries have reported that uncertainty reduces agricultural competitiveness by forcing exporting firms to use more dependable but more costly forms of transportation, such as flights (Sharapiyeva et al., 2019). Consumers of imported goods must also pay higher prices due to higher land transportation costs from entering through alternative ports (Lane and Pretes, 2020). The higher trade costs reduce trade volumes and overall competitiveness, posing challenges to maintaining strong economic growth (Chaudhary and Paudel, 2024).

Additionally, all trade in goods will pass through customs at the border. When border customs are backed up due to increased product volume, this can lead to transport delays. These processes make the situation less predictable and delay the delivery of goods (Sharapiyeva et al., 2019). This will be a problem for perishable agricultural products, thereby reducing their competitiveness.

There is also evidence of the detrimental impact of permanent shocks on landlocked countries, including a decline in goods production by -2% annually, consumption and social welfare, and aggregate investment by -7% (Rivero et al., 2020). This situation can worsen when a landlocked country conflicts with a neighboring country. For instance, Nepal is a landlocked country that depends heavily on India for imports and exports because it can access only the seaport of Kolkata. Political concerns prevented Nepal from accessing ports in 1969, 1989, and 2015 due to India's monopoly over Nepal's maritime access (Adhikari and Ma, 2022).

The landlocked position is also a barrier to economic integration and FDI entry. A study by Kasimov et al. (2024) shows that landlocked countries in the Commonwealth of Independent States have difficulty attracting FDI. These countries have a smaller FDI proportion of 56.8% than coastal countries in the same area. One obstacle to economic activity, including agriculture, is the difficulty of attracting FDI, which results in suboptimal production and low competitiveness. The study from Liu et al. (2023) suggests otherwise, China is more eager to deploy FDI to landlocked countries with underdeveloped infrastructure and logistics capabilities because these countries frequently face greater uncertainty. However, this context is not ideal in the EU, which is generally wealthy despite having little access to the sea.

The EU region can overcome the detrimental effects of landlocked conditions due to its strong institutional economics. Institutional economics focuses on how governance frameworks and institutional quality influence the economic results of landlocked countries (Chaudhary and Paudel, 2024). Institutional economics is the most effective means of mitigating various shocks in landlocked countries, reducing them by up to 68% and improving their economic performance (Rivero et al., 2020). Furthermore, strong institutional economics will promote trade relationships for landlocked countries. Initiatives to lower trade and market access restrictions are part of the deal, which will increase supply chains and competitiveness (Chaudhary and Paudel, 2024).

From the study findings, five explanatory variables—the real effective exchange rate (RER), school enrollment (SCH), female employment in agriculture (FEMA), male employment in agriculture (MALE) and research and development expenditure (RES)—do not significantly affect TCA in the short or long term.

Conclusion

Landlocked countries in the EU, such as Austria, the Czech Republic, Hungary, Luxembourg, and Slovakia, are less competitive than non-landlocked countries. This study's findings align with Porter's Diamond Theory, which holds that factor conditions influence competitiveness. Landlocked countries face unfavorable geographic conditions because their agricultural products must transit through other countries. This results in higher transportation costs and product prices. Meanwhile, this study shows the importance of more efficient economies of scale in landlocked countries to increase competitiveness, as the New Trade Theory expresses.

Landlocked conditions pose challenges for EU Member States and require tailored strategies. One of the main strategies is improving the supply chain. Based on Institutional Economics Theory, this strategy will be easy to implement in the EU, considering integration between member states already exists. The mobility of agricultural products should make it easier to enter and exit neighboring countries with seas. However, the EU must map the distribution flow of agricultural product supply chains between countries. This mapping needs to be complemented by additional intervention steps, such as identifying raw materials and consumer demand sources, distribution networks and logistics infrastructure.

Several factors in this study indicate the potential to increase agricultural competitiveness by boosting capital and production. However, this study also indicates that the EU Member States' agricultural competitiveness will be reduced due to temperature change, political instability and rising youth unemployment.

In general, EU Member States must also take several steps to improve agricultural competitiveness, including 1) increasing agricultural production through agricultural intensification and adoption of modern technology (precision farming, IoT and big data); 2) increasing agricultural investment by ensuring that the Common Agricultural Policy provides subsidies for innovation, farmer empowerment and research collaboration; 3) massive climate change mitigation and adaptation through the development of climate-resistant crop varieties, sustainable agricultural practices and optimisation of water use; 4) selection of bioenergy from non-agricultural raw materials, such as solar/wind-powered farms, which use clean energy for agricultural operations and reduce dependence on fossil fuels; 5) creating political stability within the EU Member States by strengthening EU cooperation, democracy and the rule of law and 6) increasing youth participation in agriculture through agricultural education and training in schools, access to land and capital and pro-young farmer EU policies.

Although this study can holistically capture several phenomena that affect agricultural competitiveness, it must be improved to capture current phenomena. This study did not examine differences across countries, so future studies can use FMOLS or DOLS to assess the influence of domestic factors on agricultural competitiveness. Further studies also need to address the development of information technology to improve agricultural competitiveness. The role of this technology is to facilitate coordination between actors engaged in farm businesses, thereby increasing their competitiveness. Another condition that other researchers should consider is the logistics infrastructure indicator, given its vital role in improving competitiveness. Further studies should expand their scope to include regions such as Africa, Asia, and the Americas to comprehensively examine the impact of landlockedness on agricultural competitiveness.

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