sciendo

Zagreb International Review of Economics & Business, Vol. 27, No. 2, pp. 153-176, 2024

Faculty of Economics and Business, University of Zagreb and Sciendo. Printed in Croatia.
ISSN 1331-5609; UDC: 33+65
DOI: 10.2478/zireb-2024-0021

Perfect Competition and Competitive Dynamics in Europe; Analysing the Gap Between Theory and Reality

Daniel Tomić *

Abstract: *While the construct of market is one of the basic concepts in Economics, the term competition became the elemental paradigm in apprehending the organisation of markets. For economic assessment, it is crucial to understand how markets are organized, how they function, and how firms operating within them behave. Economists remain interested in how different market structures and the concentration of sellers affect market prices and quantities. Long before the advent of neoclassical economics and its equilibrium in a perfectly competitive economy, Adam Smith advocated for competitive markets as the preferred market structure because they lead to socially optimal economic outcomes. This concept essentially encapsulates the entire theoretical background of microeconomics. There are numerous arguments for clarification of the EU competitions rules as some of them are pointed at improving market efficiency for the benefit of consumers while others are driven by purely political and/or competitiveness scrutiny. Hence, the goal of this study is to test perfect competition conditions and therefore the competitive dynamics among European countries, as to analyse the disparity between the theoretical positions and empirical reality. Evaluation is based on testing the equality of prices and marginal cost in the long run, as well as in the short run within a panel structured sample of 38 European countries for the period of 1960-2022. Various estimation methods indicated the absence of the equality between prices and marginal costs across the panel sample and different sub-samples, but with the presence of long term cointegration between these variables, indicating that these variables share a common long run trend.*

Keywords: perfect competition; market efficiency; short vs. long run; panel sample; European countries

JEL Classification: A11, B10, D41, E01

* Faculty of Economics and Tourism „Dr. Mijo Mirković“, Pula, Croatia. Corresponding Author E-Mail: dtomic@unipu.hr

Introduction

While the market construct is one of the foundational concepts in Economics, competition has become the fundamental paradigm for understanding market organization. For economic assessment, it is crucial to comprehend how markets are organized, how they function, and how firms within them behave. If consumers do not perceive the products of certain firms as perfect substitutes, the possibility of non-price competition arises. In such cases, price competition may play only a secondary role in market competition compared to other competitive instruments such as product quality and design, advertising, and expenditures on research and development, which become more prominent. Nevertheless, economists are particularly interested in how various market structures and the concentration of sellers influence market prices and quantities. Adam Smith (1776), long before the emergence of neoclassical economics and its notion of equilibrium in a perfectly competitive economy, advocated for competitive markets as the ideal market structure, given their ability to produce socially optimal economic outcomes. Empirical observation indicates that many real-world markets deviate significantly from the ideal of perfect competition. Market participants, both sellers and buyers, often possess varying degrees of market power; products are seldom perfectly homogeneous, and information asymmetries are prevalent among market participants. Despite these deviations, the concept of perfect competition remains a cornerstone in economic theory. The significance of perfect competition lies in its ability to provide a benchmark for analysing market outcomes. By studying the theoretical outcomes of a perfectly competitive market, economists can compare these idealized results with those observed in more realistic market structures. This comparative analysis enables the assessment of different market allocations and the formulation of policy recommendations aimed at enhancing market efficiency.

While Europe strives to promote competitive markets, the reality shows significant deviations from perfect competition. Market concentration (telecommunications and energy), product differentiation (branding unique consumer goods), barriers to entry (high sunk cost), and regulatory environments all contribute to these deviations. Understanding these factors is crucial for policymakers aiming to enhance competition and for firms navigating the European market landscape. The European Union (EU) and national governments heavily regulate markets to prevent monopolistic practices and promote competition through antitrust laws, merger control, and state aid regulations. While these interventions aim to enhance competition, they can also introduce distortions and protect certain sectors from competitive pressures. Numerous arguments exist regarding the clarification of EU competition rules (Gunther, 2021). Some are directed at enhancing market efficiency for consumer benefit, while others are driven by political and/or competitive considerations.

Consequently, the objective of this study is to evaluate the conditions of perfect competition and the competitive dynamics among European countries by analysing

the gap between theoretical positions and factual reality. The study is focused on testing the equality of prices and marginal cost in the long run, as well as in the short run, following the methodology introduced by Razzak (2024) but with a difference of using a panel structured sample of 38 European countries for the period of 1960-2022. Additional estimation methods (panel cointegration tests, tests of equality, granger-causality tests, cross-correlations) indicated the absence of the equality between prices and marginal costs in its weaker and a stronger form across the panel sample and different sub-samples, but with the presence of long term cointegration between these variables, indicating that these variables share a common long run trend.

The theory behind perfect competition construct

The cornerstone of microeconomics

In economic theory, perfect competition characterizes a market structure where numerous buyers and sellers engage in the exchange of a homogeneous good, with no single participant able to influence the market price, hence all participants are price takers. In such a market, total welfare, defined as the sum of consumer and producer surplus, is maximized. The absence of deadweight loss makes the equilibrium allocation under perfect competition a standard benchmark for assessing welfare losses in market structures that deviate from perfect competition, such as those where one party possesses market power. We identify four standard assumptions that characterize the model of perfect competition (Katz and Rosen, 1994):

1) *Negligible Economies of Scale Relative to Market Size*: This condition implies that the average total cost will significantly increase if a firm substantially raises its production quantity beyond a marginal amount. Consequently, a perfectly competitive market features a large number of sellers. Similarly, the market consists of numerous buyers, each representing only a small fraction of total demand. As a result, neither sellers nor buyers can influence market prices.
2) *Product Homogeneity*: This assumption states that consumers cannot differentiate between products produced by different firms, which prevents any discrimination in the purchasing process. Under such conditions, firms cannot raise their prices above the competition without experiencing a significant drop in sales.
3) *Perfect Information*: This assumption ensures that all firms are fully aware of their production capabilities, and consumers are entirely informed about their alternatives in the decision-making process.
4) *Free Entry and Exit*: This condition indicates that the number of firms in the market will adjust over time so that all firms earn zero economic profit or a competitive rate of return. Positive and negative profits incentivize changes in

the number of firms in the market. Firms earn profits when their revenues exceed the opportunity costs (the value of inputs in their next best alternative use) of production factors. Without entry restrictions, entrepreneurs are motivated to enter a market by reallocating resources from other activities. Similarly, in the absence of exit barriers, economic losses prompt firms to leave the market as soon as their production factors can be more profitably redirected to other activities.

Next, the profit maximizing production rule applies to all firms. In case of a price taking firm (Church and Ware, 2000):

$$R(q) = pq \tag{1}$$

where in a perfectly competitive market, the firm's revenue is linear in output because the firm assumes that the price (p) remains constant and is independent of its output level (q). Consequently, if the firm sells an additional unit of output, its revenue increases by p. This holds true irrespective of the current output level, leading to the conclusion that the marginal revenue (MR) function for a price-taking firm is equivalent to the market price

$$MR(q) = p. \tag{2}$$

By substituting (2) into the profit maximizing production rule we derive the equation that defines the profit maximizing choice of the price taking firm:

$$p = MC\ (q^c)p. \tag{3}$$

The quantity q^c that equates price and MC is the profit maximizing output. The relationship between price and profit maximizing output is the *supply function* or $q^c = S(p)$. Market supply is the total amount firms in the industry would like to sell at the prevailing price. For any price p the market supply function gives the output that all of the firms industry would like to supply (Kristek and Tomić, 2019). Since it is just a sum, we find the market supply function by summing up the individual supply function of each firm:

$$Q^s(p) = \sum_{i=1}^{n} S_i p \tag{4}$$

where $S_i(p)$ is the supply function of firm i and $Q^s(p)$ is the market supply function.

The market demand function $Q^d(p)$ represents the relationship between price and the total quantity demanded. It indicates the aggregate quantity that all utility-maximizing consumers are willing to purchase at various price levels. This function is

derived by summing the individual demand curves of all consumers in the market. At the equilibrium price both firms and consumers are able to fulfil their desired transactions. Therefore, the equilibrium price P is that equates the quantity supplied with the quantity demanded:

$$Q^S(p) = Q^d(p). \quad (5)$$

To sum it up, a perfect competitor is defined as one who faces a constant price and demand for their good, implying that they are a price taker and cannot influence the market price. This competitor can produce unlimited quantities of their goods and sell them at the same price as other market participants. So, profit is maximized at the output level where marginal cost equals marginal revenue. For a price-taking firm, this condition implies that both marginal cost and marginal revenue are equal to the constant market price or simply ***MC = MR = p***.

The relevance of the concept

The model of perfect competition is one of the most renowned, significant, and frequently misunderstood concepts in economics (Budzinski and Stöhr, 2024). It is not intended to provide an empirically-supported, realistic depiction of competitive markets in their entirety. Instead, it isolates a specific aspect of competition - its decentralized coordination function which cannot be observed without the abstraction offered by this model. By deliberately removing many elements of reality, the model highlights the pure coordination effect that would otherwise be obscured by the complexities of actual markets. This approach, while often criticized for its unrealistic assumptions, serves to elucidate fundamental economic principles. The fundamental concept is that a set of markets is the most effective mechanism for aggregating individual information to coordinate the behavior of decentralized agents. As Carbonnier (2023) pointed well, the assertion that perfect competition is efficient is based on the interpretation of willingness to pay as a proxy for individual welfare. This interpretation is significantly biased, even within the neoclassical framework. Consequently, market competition, even in its idealized form, is not inherently efficient from a political and social perspective. It is efficient only in terms of trade value, and asserting that market competition is beneficial for trade is somewhat tautological. The coordination of individual behaviors through a pure market system effectively corresponds to a decision-making process that weights individual preferences by purchasing power. Despite these limitations, an increasing number of public policies are predicated on the belief in market efficiency, aiming to replace restrictive regulations with a broader range of market-based regulatory mechanisms (Carbonnier, 2023).

The broad consensus on the importance of competition diminishes when discussing its idealization as perfect competition. This dissatisfaction is often encapsulated

in the assertion that "perfect competition is such a special case" (Makowski and Ostroy, 2001). While any model has inherent limitations, the primary objection is that the constraints of the perfect competition model disconnect it from broader, more significant concerns.

The abstract model of perfect competition represents an inescapable contribution to economic theory, elucidating the coordination mechanism within competitive markets and illustrating how individual actions aimed at maximizing utility contribute to aligning supply and demand. However, it is not an empirical depiction of real-world competition. Budzinski and Stöhr (2024) suggested that while all markets with effective competition inherently possess elements akin to perfect competition, which facilitate decentralized coordination of supply and demand, real-world competition encompasses complexities beyond the scope of this abstract model. Dynamic aspects of competition, such as innovation and imitation incentives, strategic interdependencies among rival firms, and other nuanced dynamics, are disregarded by the assumptions inherent in the model of perfect competition. Overall, while the abstract model of perfect competition holds significant importance in economic theory, its relevance to antitrust analysis, policy, and legal frameworks is limited. Its primary contribution lies in emphasizing the necessity of coordinating supply and demand for social welfare, affirming that competition remains the most effective mechanism that we are aware of.

Nonetheless, evaluation of perfect competition as full appropriation is to maintain its status as, not the primary model economists use for achieving efficiency, but because perfect competition holds substantial relevance in economic theory and its application to real-life scenarios due to several key factors. Namely, perfect competition serves as a benchmark for efficiency in markets. Under this model, resources are allocated optimally because firms produce at the lowest possible cost and consumers pay the lowest possible prices. This provides insight into how market structures can lead to the best possible outcomes for society as a whole maximizing social welfare, given certain assumptions. The mechanism of price adjustment facilitates efficient allocation of resources without the need for centralized planning. In a perfectly competitive market firms can freely enter and exit the market which promotes economic dynamism. Despite its limited usage for policy planning, analysis of such perfect model/condition informs antitrust policies by illustrating conditions necessary for competitive markets to function effectively and identifying deviations from these conditions that may harm consumers or distort market outcomes.

Lebourges (2019) implied that the primary objective of European competition policy is not to maximize social surplus, and consequently overall economic growth and wealth, but rather to protect various segments of consumers. Dominant market players bear a particular responsibility to sustain a competitive market structure, thereby restricting the extent to which they can leverage their efficiencies. It is important to note that when EU competition policy bases its decisions on criteria

other than the maximization of European social surplus, it inherently compromises the potential for maximizing that surplus, which in turn hinders economic growth and wealth accumulation in Europe. This consequence, although evident, is seldom highlighted. Furthermore, the inconsistency in the application of competition rules at the global level places European companies at a significant competitive disadvantage in the international market (Gunther, 2021). Following some stances about 'uncompetitive European economy within seemingly competitive markets', the purpose of this study is to test how much economies in Europe deviate and have deviated in the past from so-called perfect state of the market by confronting microeconomic theory with macroeconomic data and the sample of relatively homogeneous economic area.

Methodology and data

The methodology

The goal of this study is to evaluate the conditions of perfect competition among European countries by analysing the gap between theory and reality i.e. testing the equality of prices and marginal cost in the short and long run, following the methodology introduced by Razzak (2024) but with a distinction of using different estimations (panel data), different sample of countries (only European countries) and different time span (longer time series with additional sub-sample analysis). In his study, Razzak (2024) utilized aggregated macroeconomic data spanning from 1970 to 2022 for 43 countries, as well as the EU19 and EU27, to examine the microeconomic condition of perfect competition, characterized by the price level equating to the marginal cost in the long run. Author introduced two forms of perfect competition within the macroeconomic context: a weaker form and a stronger form. The weaker form is identified if the price level and the marginal cost exhibit a common long-run trend, indicating cointegration. The stronger form is observed if the market price and the marginal cost converge to equality in the long run. His findings suggested that evidence for weaker form competition is more prevalent than for stronger form of competition. Interesting literature related to our study can be found through theoretical discussions in Hall (1986) Makowski and Ostroy (2001), Dardi (2012), Gunther (2021) and Carbonnier (2023) and within empirical testing in Fama (1972), Hall (1988) Loecker, Eeckhort and Unger (2020).

Similar to Razzak (2024) we will use aggregated macroeconomic data for selected countries as to evaluate the possible equality between price and marginal cost i.e. $P = MC$. For microeconomic variable price (P) we will use macroeconomic variable consumer price index CPI_t, while the total cost curve TC_t is assumed to be a quadratic function of national output, so that the marginal cost MC_t is the derivative of the total cost with respect to output:

$$TC_t = \alpha y_t + \beta y_t^2 \tag{6}$$

$$MC_t = \alpha + 2\beta y_t = \frac{\Delta TC_t}{Dy_t} \tag{7}$$

The value α has no significant effect on the calculation because y_t is a large number so we will set it up equal to 1, and 1 plus a large number is again the large number. Therefore, the magnitude of β becomes irrelevant to the estimations because we can convert MC_t to an index MCI_t, as to compare it with the *CPI*, so it implies that we have to set β equal to 1 (see Razzak, 2024).

A ***weaker form of competition*** exists when the price and the marginal cost are cointegrated, meaning they share a long run common trend. For the purpose of the analysis which is based on a panel sample of countries (see Tomić, Šimurina and Jovanov (2020), we will evaluate panel cointegration tests according to Pedroni (1999, 2004), Kao (1999) and Maddala and Wu (1999).[1] Determining the order of integration of a time series is crucial to avoid spurious results, particularly given that macroeconomic variables frequently exhibit non-stationarity. If the series are integrated (non-stationary), the analysis continues with testing for the panel cointegration. Therefore, to test the order of integration following panel unit root tests are considered: LLC test (Levin, Lin and Chu, 2002), Breitung test (Breitung, 2000), IPS test (Im, Pesaran and Shin, 2003) and Fisher-type tests using ADF and PP tests (Maddala and Wu, 1999 and Choi, 2001).

In order to test ***a stronger form of competition*** or to test if the price and marginal cost are equal in the long run, we have to extract long term trends from the data. For that purpose, we will use STL decomposition which is a seasonal adjustment method that decomposes a series into seasonal, trend and remainder components using a filtering algorithm based upon LOESS regressions. STL has two main advantages (Cleveland et al., 1990) over other methods; it works on any frequency of data, hence can be calculated on time series data with irregular patterns and missing values, which is one of characteristics of our panel sample, and in addition it can be estimated on a whole set of panel countries rather than on individual country only. To determine the nature of the nexus between the trend data i.e. to *test the stronger form of competition* ***in the long run*** we will evaluate the trend of the variables through graphical analysis, panel test of equality of mean, median and variance and in addition through Granger causality test. To further improve the comprehension between price and marginal cost, we opted to additionally *test the stronger form of competition* ***in the so-called short run*** by examining cyclical variations which could expose disparity between the observed variables (see Hall, 1988). Here we will evaluate the cyclical components of the variables through graphical analysis, again panel test of equality of mean, median and variance and cross-correlation analysis.

Data

Annual panel data on the observed variables, covering the period 1960-2022 for 38 European countries, are taken from the World Bank database (World Development Indicators – WDI). These countries are: Belgium, Bulgaria, Czechia (Czech Republic), Denmark, Estonia, Germany, Greece, Ireland, Spain, France, Croatia, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Malta, Netherlands, Austria, Poland, Portugal, Romania, Slovenia, Slovak Republic, Finland, Sweden, United Kingdom, Iceland, Norway, North Macedonia, Albania, Serbia, Turkey, Moldova, Russia, Switzerland and Ukraine. Data (un)availability is a major obstacle in achieving more (time) extensive research on a cross-country base therefore we will be dealing with an unbalanced panel data set[2]. Any biased estimations due to missing values are aligned through a sub-sample analysis (full sample: 1960 – 2022, sub-sample: 1960 – 1990, sub-sample: 1991 – 2022). Data are expressed in logarithms and presented as an index (2010 = 100): real gross domestic product is used for calculating marginal cost index[3] - $\boldsymbol{MCI}_t$, whereas we used consumer price index - $\boldsymbol{CPI}_t$ to express a price level variable[4].

Empirical analysis of conditions for perfect competition model

Testing the weaker form of perfect competition

As we previously illustrated, a weaker form of competition occurs when price and marginal cost are cointegrated, indicating they share a common long-term trend. Regarding the order of integration of our time series, unit root tests generally indicated that the variables are integrated of I(1), i.e. they are non-stationary in level and stationary in first differences (*Table 1*). Variable *CPI* displayed some ambiguous conclusion about its stationarity, especially when testing it in level with intercept and trend. This problem is also evident when we tested unit root across different time samples (*Table 2*) and we got inconclusive results for the period 1960 – 1990. Regardless of this, most of the unit root tests as well as graphical display of the variables suggested that we are dealing with time series that are stationary in their first differences. Therefore, a panel cointegration tests can be implemented.

Table 3 presents the results of Pedroni, Kao and Johansen Fisher panel cointegration tests between the *CPI* and *MCI*. When only intercept is included, almost all of Pedroni's statistics reject the null hypothesis of no cointegration between variables indicating the existence of long run panel cointegration relationship between the observed variables. We could conclude that there exists a long-run relationship, however, results and conclusions regarding these relationships slightly differ when intercept and trend are included. On the other hand, Kao's panel cointegration test strongly rejects the null hypothesis of no cointegration between variables indicating

the existence of long run panel cointegration relationship between the observed variables. Next, we evaluated the results of the combined cointegration test i.e. Johansen - Fisher trace and maximum eigenvalue cointegration tests reject the null hypothesis of no cointegration (in restricted constant case) between variables indicating the existence of a long run panel cointegration relationship. When observing individual cross section results (available upon request) from Johansen - Fisher trace and maximum eigenvalue cointegration tests, we can see that one cointegration relation is present in almost all countries, either in the case with restricted constant or in the case with no deterministic trend (except for Ireland, Lithuania, Luxembourg, Hungary, Poland, Romania, North Macedonia, Albania, Serbia). This evidence serves as a confirmation of the homogeneity of the sample. *Table 4* displays cointegration tests across different samples, indicating stable cointegration relationship across full sample and sub-sample 1991 – 2022, but with some ambiguous and inconclusive results for sub-sample 1960 – 1990. According to all residual cointegration tests, we can conclude that there exists a long cointegration relationship between the CPI and MCI variables.

Table 1: Panel unit root tests (1960-2022)

Variable and test	**Level**		**First difference**	
	Intercept	**Intercept and trend**	**Intercept**	**Intercept and trend**
Levin, Lin and Chu t	*Prob.*			
CPI	0.00	0.00	0.00	0.01
MCI	0.00	0.00	0.00	0.00
Breitung t-stat	*Prob.*			
CPI	-	0.00	-	0.00
MCI	-	0.99	-	0.00
Im, Pesaran and Shin W-stat	*Prob.*			
CPI	0.26	0.00	0.00	0.00
MCI	0.05	0.10	0.00	0.00
ADF - Fisher Chi-square	*Prob.*			
CPI	0.05	0.00	0.00	0.00
MCI	0.00	0.26	0.00	0.00
ADF - Choi Z-stat	*Prob.*			
CPI	0.06	0.15	0.00	0.00
MCI	0.05	0.29	0.00	0.00
PP - Fisher Chi-square	*Prob.*			
CPI	0.00	0.00	0.00	0.00
MCI	0.00	0.06	0.00	0.00
PP - Choi Z-stat	*Prob.*			
CPI	0.00	0.00	0.00	0.00
MCI	0.05	0.13	0.00	0.00

Source: Author's calculations.

Table 2: Unit root tests across different samples

Panel unit root tests	Full sample: 1960-2022	Sub sample: 1960-1990	Sub sample: 1991-2022
CPI	I(1)	Inconclusive	I(1)
MCI	I(1)	I(1)	I(1)

Source: Author's calculations.

Table 3: Cointegration tests: CPI vs. MCI

Variables: CPI vs. MCI								
Pedroni test	**Intercept**				**Intercept and trend**			
	Stat.	**Prob.**	**Weight. Stat.**	**Prob.**	**Stat.**	**Prob.**	**Weigh. Stat.**	**Prob.**
Panel v-Stat.	-1.02	0.84	0.87	0.09	5.41	0.00	-2.76	0.99
Panel rho-Stat.	-1.53	0.06	-0.97	0.16	-0.05	0.47	2.87	0.99
Panel PP-Stat.	-8.96	0.00	-3.06	0.00	-3.72	0.00	0.38	0.65
Panel ADF-Stat.	-0.98	0.16	-0.49	0.31	3.52	0.99	1.92	0.97
Group rho-Stat.	-0.51	0.30			2.84	0.09		
Group PP-Stat.	-5.63	0.00			-1.05	0.14		
Group ADF-Stat.	-0.21	0.41			3.22	0.99		
Kao test	*t-Stat.*				*Prob.*			
ADF Stat.	-1.68				0.00			
John. - Fish. test Hypothesized CE(s)	**No deterministic trend**				**Restricted constant**			
	Fisher Stat.*	**Prob.**	**Fisher Stat.****	**Prob.**	**Fisher Stat.***	**Prob.**	**Fisher Stat.****	**Prob.**
None	428.8	0.00	397.8	0.00	309.0	0.00	241.8	0.00
At most 1	128.5	0.20	128.5	0.20	211.0	0.00	211.0	0.00

Source: Author's calculations.

Table 4: Cointegration tests across different samples: CPI vs. MCI

Panel coint. tests	Full sample: 1960-2022	Sub sample: 1960-1990	Sub sample: 1991-2022
Pedroni test	Cointegration	No cointegration	Cointegration
Kao test	Cointegration	No cointegration	Cointegration
John. - Fish. test	Cointegration	No evidence	Cointegration

Source: Author's calculations.

Our results indicated that there *exist a weaker form of perfect competition in many European countries* except in 8 countries which were characterized with shorter time series, either are out (North Macedonia, Serbia, Albania) or are relatively new EU members (Lithuania, Poland, Romania and Hungary) and have distinct story of economic growth such as Ireland and Luxembourg[5]. The results are expected considering relatively homogeneous economic area, territorially close and politically and socially linked countries.

Testing the stronger form of perfect competition

Stronger form of perfect competition in the long run

Testing the stronger form of perfect competition in the long run relies on extraction of the trend from the time series. For that purpose we used STL decomposition which extracted the trend of our variables, by using a filtering algorithm based upon LOESS regressions. We obtained the trend of the variables as *CPI_trend* and *MCI_trend*.

First, we evaluated the results from the *panel test of equality of mean* (t-test, Satterthwaite-Welch t-test, Anova F-test, Welch F-test), *median* (Wilcoxon/Mann-Whitney test, Med. Chi-square test, Kruskal-Wallis test, van der Waerden test) *and variance* (F-test, Siegel-Tukey test, Bartlett test, Levene test and Brown-Forsythe test). We found no evidence of equality of mean, median and variance between the observed trend variables across different samples (*Table 5*), with partial evidence of equality of variance for the sub-sample 1991-2022 with Siegel-Tukey test ($p = 0.49$), Levene test ($p = 0.24$) and Brown-Forsythe test ($p = 0.63$). Based on these results, we found no evidence of a stronger form of perfect competition in the long run.

Table 5: Test of equality: CPI_trend vs. MCI_trend

Tests equality of:	Full sample: 1960-2022	Sub sample: 1960-1990	Sub sample: 1991-2022
Mean	No evidence	No evidence	No evidence
Median	No evidence	No evidence	No evidence
Variance	No evidence	No evidence	Partial evidence

Source: Author's calculations.

Next, we wanted to see if one time series is useful in forecasting another, so we introduced *Granger causality test*. *Table 6* provides us with the information about Granger causality, but it does not suggest the direction of causality between variables. There are some indications of Granger causality between the observed trend variables, especially in the sub-sample 1960-1990, however general conclusion is that there is not enough evidence that that one variable is useful for forecasting the other variable, hence we can deduce that these tests too suggested the absence of the evidence of stronger form of perfect competition in the long run.

Table 6: Granger causality test: CPI_trend vs. MCI_trend

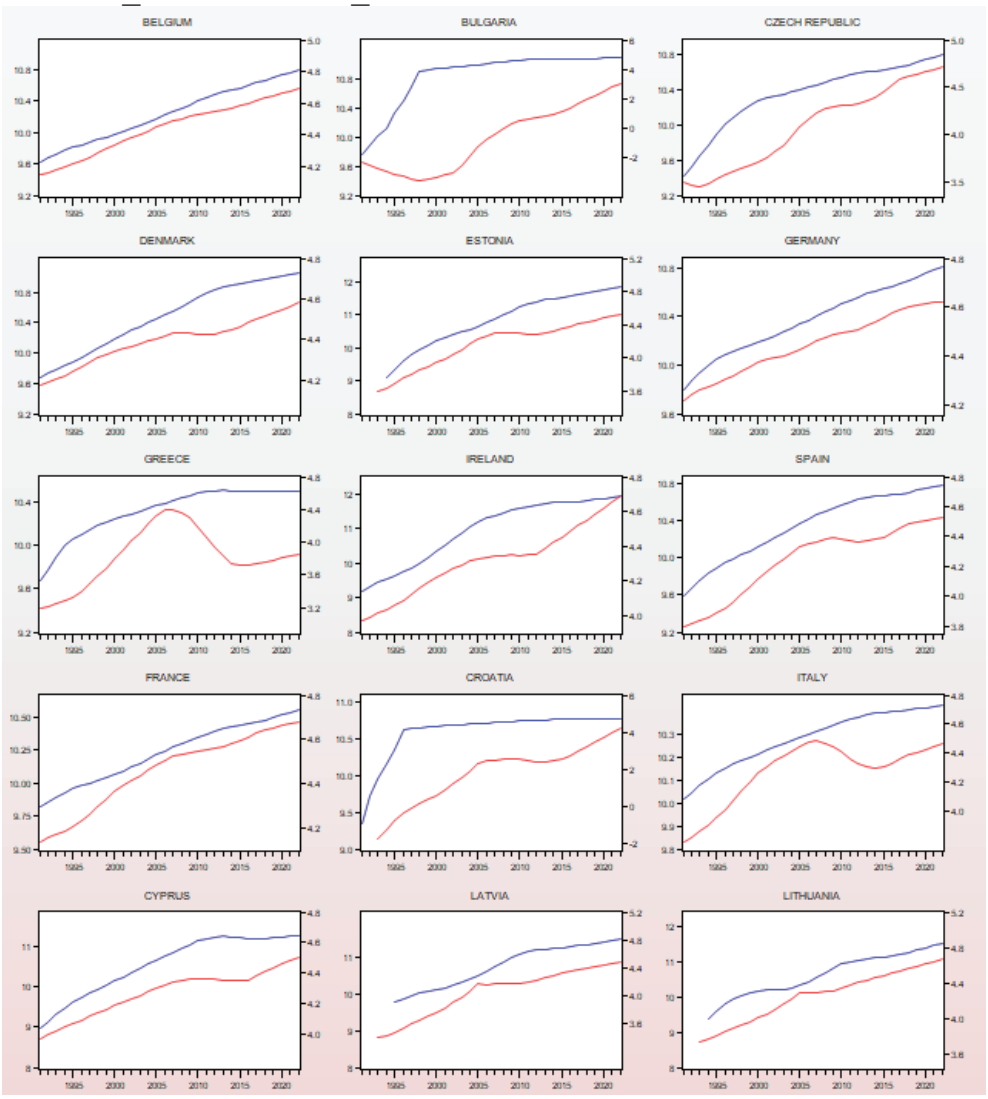
Granger causality	Full sample: 1960-2022	Sub sample: 1960-1990	Sub sample: 1991-2022
CPI_trend does not Granger cause MCI_trend	Granger causality F-stat.(44.80) Prob. (0.02)	Granger causality F-stat.(16.99) Prob. (0.00)	Granger causality F-stat.(86.01) Prob. (0.07)
MCI_trend does not Granger cause CPI_trend	Granger causality F-stat.(58.40) Prob. (0.50)	Granger causality F-stat.(95.62) Prob. (0.00)	Granger causality F-stat.(73.97) Prob. (0.06)

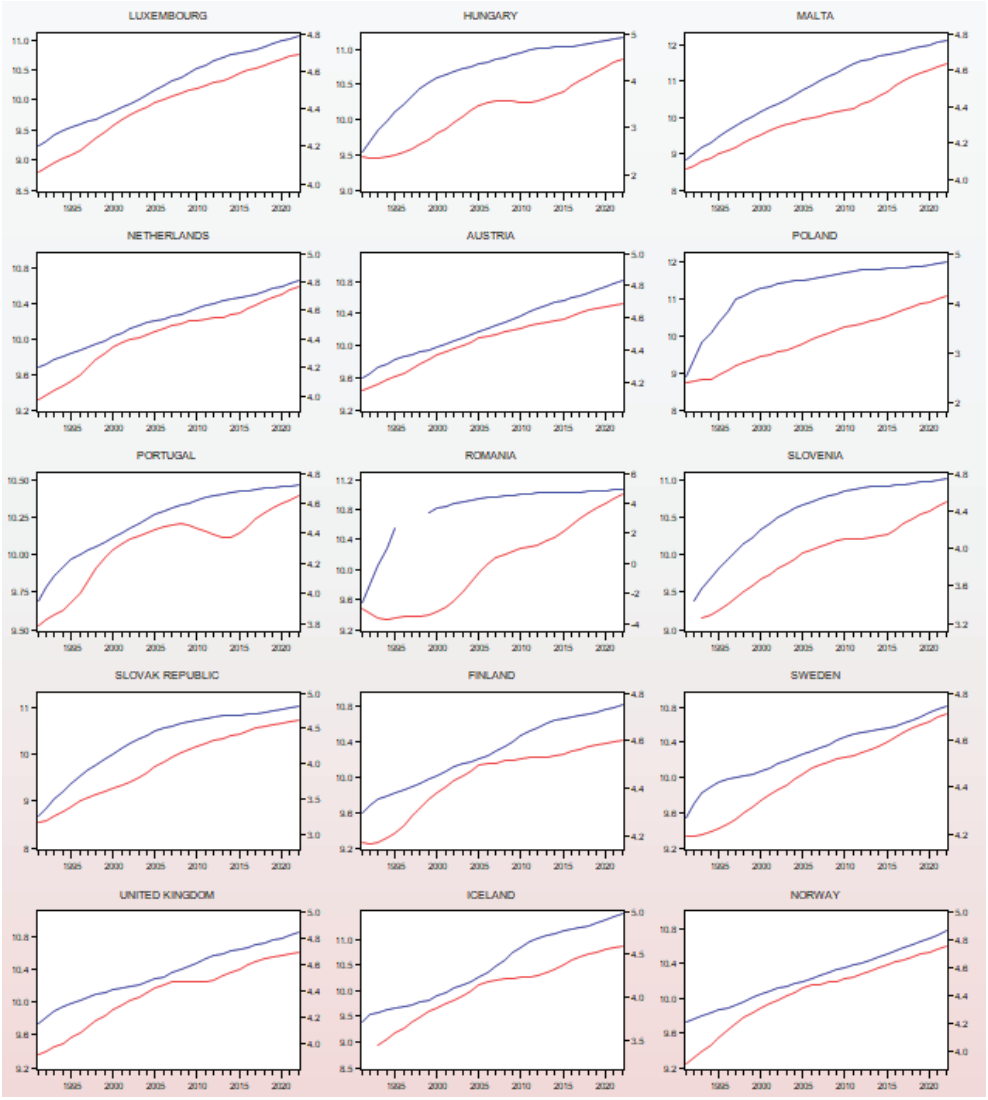
Source: Author's calculations.

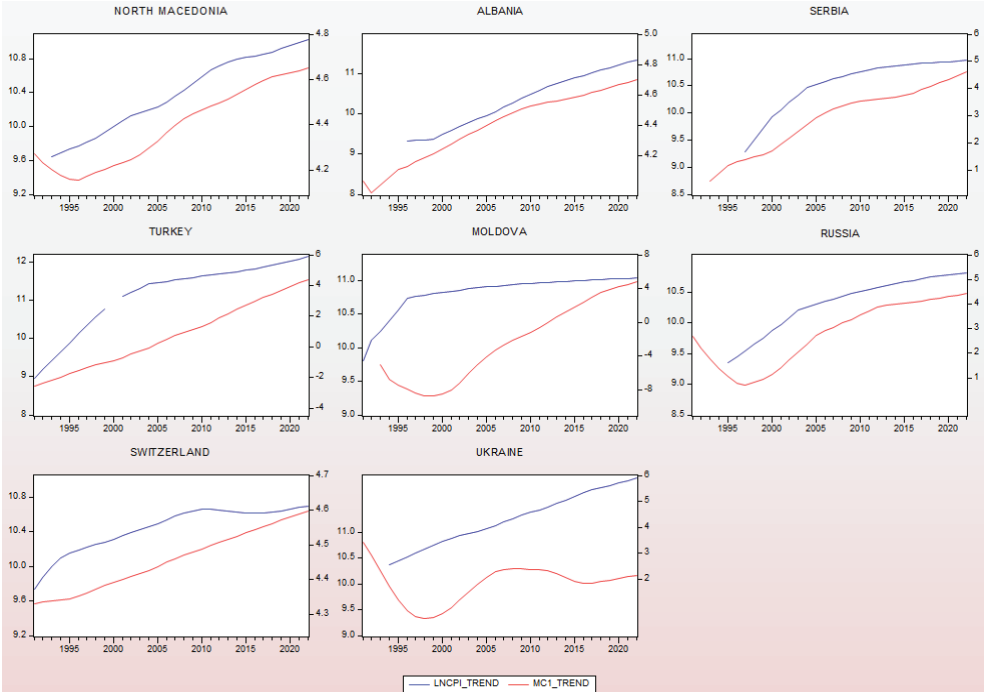
Finally, we evaluated the behavior of the trend variables through *graphical analysis*. Due to missing values within the unbalanced panel sample, we opted to display just the trend of the variables for the sub-sample 1991-2022, which generally represents the behavior of the whole sample (*Graph 1*). We found trends in all variables in all the countries. Most of the countries in the EU had relatively analogous trends with similar behavior of the movements of *CPI_trend* and *MCI_trend*. Resemblance is seen for Belgium, Denmark, Estonia, Germany, Spain, France, Latvia, Lithuania, Luxembourg, Netherlands, Austria, Slovak Republic, Finland, Sweden, United Kingdom, Iceland, Norway and interestingly Albania (but we should take it with caution due to relatively short time series included). Other countries, mostly out of the EU, experienced some phases of intense divergence between the observed variables. For most of these countries we have not found evidence of an even weaker form of perfect competition. Regardless of the similarities in trends from many countries, we found no evidence of the equality of *CPI_trend* and *MCI_trend* in the long run, hence no evidence of a stronger form of perfect competition.

Considering the (1) dissimilarity between the *CPI_trend* and *MCI_trend* variables across the whole sample 1960 – 2022 and evident difference in these variables in sub-samples, regardless of the similarities in trend, (2) absence of strong Granger causality and (3) no evidence of equality of mean, median and variance between the observed trend variables across different samples, we can say that we did not found evidence of stronger form of perfect competition in the long run for 38 European countries.

Graph 1: CPI_trend and MCI_trend




LUXEMBOURG
HUNGARY
MALTA
NETHERLANDS
AUSTRIA
POLAND
PORTUGAL
ROMANIA
SLOVENIA
SLOVAK REPUBLIC
FINLAND
SWEDEN
UNITED KINGDOM
ICELAND
NORWAY



Source: Author's calculations.

Stronger form of perfect competition in the short run

Testing the stronger form of perfect competition in the short run relies on extraction of the cyclical component from the time series. For that purpose we used First order differencing (FOD)[6] for differencing the variable can stabilise the mean of a time series by removing changes in the level of a time series, and therefore eliminating or reducing trend and seasonality, displaying the cyclical behaviour of the variable (see Tomić and Stjepanović, 2018). We obtained the cyclical components of variables as *CPI_cycle* and *MCI_cycle*.

Table 7: Test of equality: CPI_cycle vs. MCI_cycle

Tests equality of:	Full sample: 1960-2022	Sub sample: 1960-1990	Sub sample: 1991-2022
Mean	No evidence	No evidence	No evidence
Median	No evidence	No evidence	Partial evidence
Variance	No evidence	No evidence	No evidence

Source: Author's calculations.

As in the long run analysis, at first, we evaluated the results from the same *panel test of equality of mean, median and variance*. We found no evidence of equality of mean, median and variance between the observed cyclical components of the variables across different samples (*Table 7*), with partial evidence of equality of median for the sub-sample 1991-2022 with Med. Chi-square test (p = 0.26), and Adjusted Med. Chi-square test (p = 0.28). Based on these results, we found no evidence of a stronger form of perfect competition in the short run.

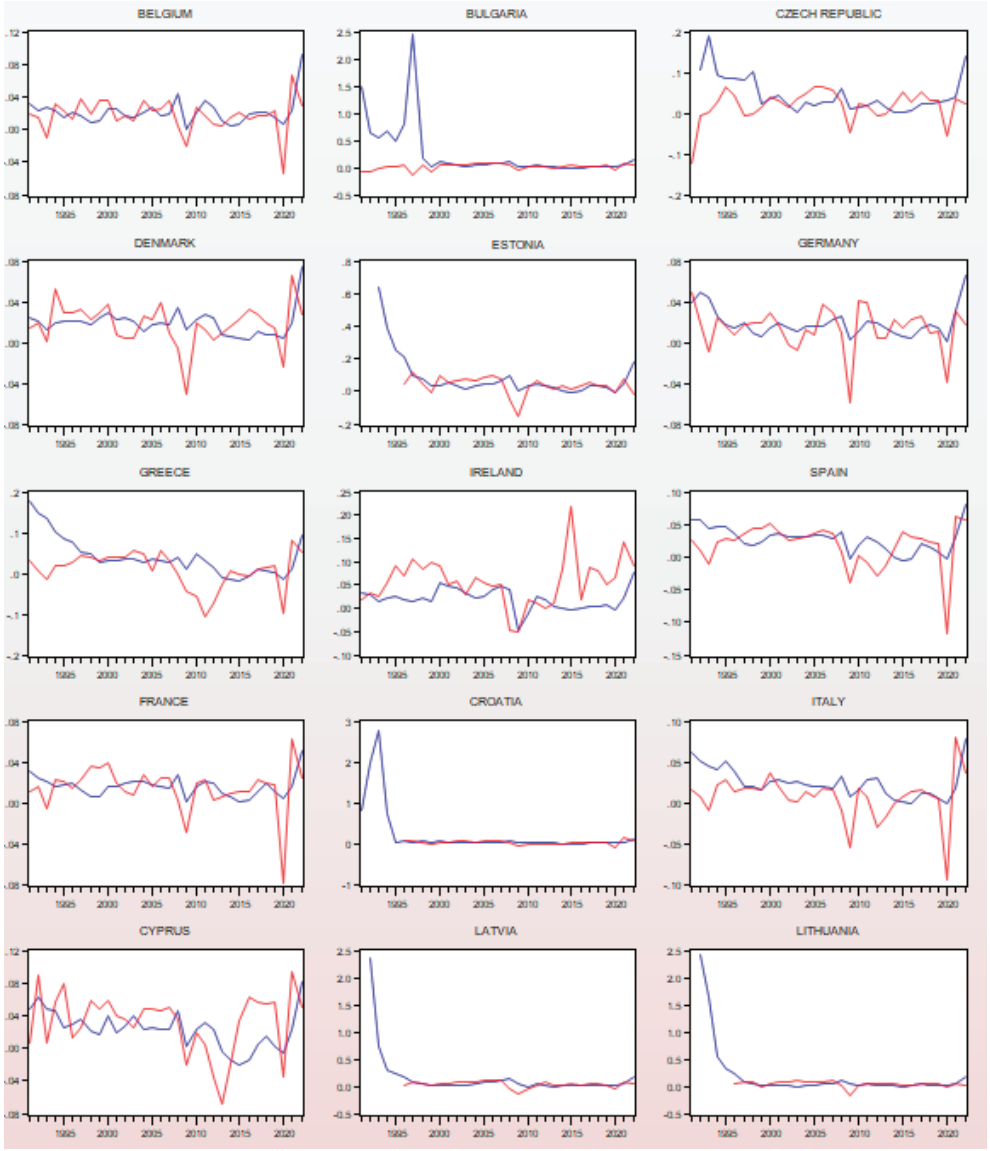
Next, we introduced *cross-correlation analysis* to estimate the degree to which two series are correlated as well as time lags/leads (up to 4 periods i.e. years) to evaluate time analogy between them[7]. If we observe cross-correlation coefficients (ranging from min. -0.02 to max -0.34) we can notice extremely weak, negative (counter-cyclical) and statistically insignificant relationship between the *CPI_cycle* and *MCI_cycle* variables both in leading and lagging patterns (*Table 8*). Interestingly, the relationship between the variables seems to be counter-cyclical, albeit statistically insignificant, it means that in their cycles these variables move in different directions. This analysis also indicated the absence of evidence of a stronger form of perfect competition in the short run.

Table 8: Cross-correlation CPI_cycle vs. MCI_cycle with lags and leads up to 4 periods

Cross-corr. matrix	Full sample: 1960-2022	Sub sample: 1960-1990	Sub sample: 1991-2022
t-4	-0.05	0.10	-0.06
t-3	-0.13	0.09	-0.14
t-2	-0.22	-0.04	-0.24
t-1	-0.23	-0.14	-0.25
t-0	-0.27	-0.34	-0.29
t+1	-0.20	-0.22	-0.20
t+2	-0.12	-0.12	-0.11
t+3	-0.05	-0.07	-0.04
t+4	-0.02	-0.05	-0.03

Source: Author's calculations.

Graph 2: CPI_cycle and MCI_cycle



Source: Author's calculations.

In the end, we again analysed the behaviour of the cyclical components of the variables through *graphical analysis*. Due to missing values within the unbalanced panel sample, we opted to display just the cyclical behaviour of the variables for the sub-sample 1991-2022, which generally represents the behaviour of the whole sample

(*Graph 2*). Though we can detect many points in time where variables *CPI_cycle* and *MCI_cycle* intercepted in many countries, there is not enough evidence to conclude there is constant equality of changes in price level and marginal cost. There is some odd resemblance of the cycles between countries outside of the EU or newer member countries, however this could be associated with shorter time series. Regardless of the similarities in cyclical behaviour for some countries, there is visible dissimilarity in the cyclical movements for most of the European countries, hence again we found no evidence of the equality of *CPI_cycle* and *MCI_cycle* in the short run, therefore is no evidence of a stronger form of perfect competition.

All in all, (1) evident dissimilarity in the cyclical movements of the *CPI_cycle* and *MCI_cycle* variables across the whole sample 1960 – 2022 and evident difference in these variables in sub-samples, (2) weak, counter-cyclical and statistically insignificant cross-correlation coefficients and (3) no evidence of equality of mean, median and variance between the observed cyclical components across different samples, we can conclude that there is no evidence of a stronger form of perfect competition in the short run for our panel sample of European countries.

Beyond conclusion

A well-functioning competitive process is fundamental to driving investments, innovation, productivity growth, business dynamism, and employment across an economy. Competition is not only advantageous for consumers but also serves as a critical driver of long-term economic growth and the enhancement of living standards. When coupled with other policies, effective competition enhances an economy's growth potential and contributes to its resilience against shocks, which is crucial in an increasingly crisis-prone global environment. Conversely, insufficient competition can render an economy vulnerable and less resilient to external disturbances. Recognizing the vital role of competition, most of the European countries and especially the EU are committed to establishing an internal market characterized by a system that ensures undistorted competition. The EU aims to achieve a highly competitive social market economy, as articulated by the European Commission (2024).

The objective of this study was to evaluate the conditions of perfect competition and the competitive dynamics among European countries by testing the equality of prices and marginal cost in the long, as well as in the short run, following the methodology introduced by Razzak (2024) but with a distinction of using different estimations, different sample of countries and different time span. Taking into account the dissimilarity between the trends and cyclical behavior of the level of prices and marginal costs across the whole sample and evident difference in these variables in sub-samples, absence of causality and correlation, no evidence of equality of mean,

median and variance between the observed variables, we concluded that there exists no evidence of stronger form of perfect competition in the long run, as well in the short run. However, we found evidence of a weaker form of perfect competition in many European countries based on the fact that price and the marginal cost variables are cointegrated, meaning they share a long run common trend. These results are expected considering a relatively homogeneous economic area, but not enough proof that European markets 'work' on the conditions considered in the perfect competition model.

The model of perfect competition describes the 'world' in which competition between the firms is not impacted by changes in technology, trade patterns, business practices, customer preferences and public policies; factors that are mostly immanent to competitive markets of European countries. That said, perfect competition assumes that all firms produce identical products, which is rarely the case in real-world markets. In Europe, products often vary significantly in terms of quality, branding, and features. The model assumes that all consumers and producers have perfect knowledge of prices and products. In reality, information asymmetry is prevalent, with consumers and producers often having access to different levels of information. Perfect competition assumes no barriers to entry or exit. In the EU, various industries have significant barriers such as high capital requirements, regulatory hurdles, and strong incumbent firms. The model presupposes a large number of small firms, each with a negligible market share. However, many European markets are characterized by a few dominant players, which can influence prices and output. The model does not account for externalities, but European markets often deal with environmental regulations, social costs, and benefits that impact market outcomes.

This is not a modern situation. After World War II, many European economies (both market oriented and communist designed countries) underwent significant reconstruction with substantial government intervention, which deviates from the laissez-faire approach of perfect competition. The formation of the EU brought about a complex regulatory framework aimed at harmonizing economic policies across member states (whereas cross-border trade barriers still exist). Many European countries have a history of state-owned enterprises and publicly provided services. European governments have often engaged in industrial policies, including subsidies and support for certain industries (banking, car industry, telecommunications, pharmaceutical industry etc.). European markets are heavily influenced by social welfare policies aimed at reducing inequality and providing public goods. Labor markets in Europe are characterized by strong regulations, including minimum wage laws, worker protections, and collective bargaining. The EU's single market aims for economic integration, but member states still engage in protectionist measures to safeguard local industries (European Commission, 2023). Consequently, many European markets exhibit high levels of concentration, with a few firms dominating. On the contrary to the perfect competition model, extreme concentration is common and firms proactively influence prices.

The perfect competition model, while useful for theoretical exploration, fails to accurately represent the complex and nuanced realities of European markets. Historical factors, regulatory environments, market structures, and socio-economic policies all contribute to market dynamics that diverge significantly from the assumptions of perfect competition (Budzinski and Stöhr, 2024). Thus, alternative models that incorporate elements of imperfect competition, regulation, and market power should provide a more accurate and relevant framework for analyzing competitive markets in Europe and the EU. We hope that we manage to offer a modest contribution to the comprehension of the limitation of the model of perfect competition in explaining the market dynamics within the European countries. This approach and deductions made above are just our opinion and could/should be subject to revision in the future.

Declarations

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflicts of interest/Competing interests

There is no conflict of interest/Competing interests

Availability of data and material

Annual panel data are taken from the World Bank database (World Development Indicators - WDI); https://databank.worldbank.org/source/world-development-indicators.

Code Availability

The EViews 13 computer program results are shared through the tables in the manuscript..

Authors' Contributions

Not applicable.

NOTES

[1] Pedroni and Kao extend the two-step Engle-Granger framework to include tests involving panel data. Pedroni introduces several tests for cointegration that accommodate heterogeneous intercepts and trend coefficients across cross-sections, with two alternative hypotheses. In contrast, the Kao test employs the same methodological approach but assumes cross-section specific intercepts and homogeneous coefficients on the first-stage regressors. Maddala and Wu (1999) propose an alternative method for testing cointegration in panel data by applying Fisher's combined test (Fisher, 1932), which aggregates the results of individual independent tests, and Johansen's test methodology (Johansen, 1991, 1995). This approach combines tests from individual cross-sections to derive test statistics for the entire panel.

[2] Belgium (1960 – 2022), Bulgaria (1980 – 2022), Czechia (1990 – 2022), Denmark (1960 – 2022), Estonia (1992 – 2022), Germany (1960 – 2022), Greece (1960 – 2022), Ireland (1960 – 2022), Spain (1960 – 2022), France (1960 – 2022), Croatia (1995 – 2022), Italy (1960 – 2022), Cyprus (1960 – 2022), Latvia (1991 – 2022), Lithuania (1991 – 2022), Luxembourg (1960 – 2022), Hungary (1972 – 2022), Malta (1960 – 2022), Netherlands (1960 – 2022), Austria (1960 – 2022), Poland (1990 – 2022), Portugal (1960 – 2022), Romania (1990 – 2022), Slovenia (1995 – 2022), Slovak Republic (1991 – 2022), Finland (1960 – 2022), Sweden (1960 – 2022), United Kingdom (1960 – 2022), Iceland (1960 – 2022), Norway (1960 – 2022), North Macedonia (1993 – 2022), Albania (1991 – 2022), Serbia (1995 – 2022), Turkey (1960 – 2022), Moldova (1991 – 2022), Russia (1992 – 2022), Switzerland (1960 – 2022) and Ukraine (1992 – 2022).

[3] As to ensure supplementary evidence, we also used industrial production index for calculating marginal cost index, as industrial production could be generally used as an approximation of the national output, however we ended up with similar results to when we used GDP measure.

[4] *Gross domestic product* (*GDP*) is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources and data are in constant local currency. *Consumer price index* reflects changes in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly and data are period averages.

[5] Similar results were achieved when we focused only on EU27 countries, therefore we opted to stay with a larger sample of countries.

[6] Non-parametric methods, often referred to as 'ad hoc' filters, are commonly employed in detrending processes, primarily using band pass techniques. Despite their various technical and methodological limitations, they are favored for their ease of use. These methods include first-order differencing (FOD), the Hodrick-Prescott filter, the Baxter-King filter, the Christiano-Fitzgerald filter, and the phase average trend method, among others. We used the FOD approach because of its simplicity in calculation and because Tomić and Stjepanović (2018) suggested it is a good method for revealing strong cycles, but not weaker ones (which is preferable for our annually presented long time series).

[7] For deeper insight into this methodology see Stock and Watson (1998) and Napoletano, Roventini and Sapio (2005). To test the integration properties, we analysed graphical displays of the variables and applied three unit root tests; Augmented Dickey Fuller test, Phillips-Perron test and Kwiatkowski-Phillips-Schmidt-Shin test. Generally, graphs and tests confirmed the absence of unit root in the observed variables which is an important property of detrended variables (results available upon request).

REFERENCES

Breitung, J. (2000). The Local Power of Some Unit Root Tests for Panel Data. In B. Baltagi (ed.), Advances in Econometrics, Vol. 15: Nonstationary Panels, Panel Cointegration, and Dynamic Panels, Elsevier Science Inc., pp. 161–178.

Budzinski, O. and Stöhr, A (2024). Perfect competition, market power and contestability. Ilmenau Economic Discussion Papers, No. 189. Technische Universität Ilmenau, Institut für Volkswirtschaftslehre, Ilmenau.

Carbonnier, C. (2023). Welfare Economics and Neoliberalism: Interpreting the ideal type of perfect competition general equilibrium. Hal-04062786. Hal open science.

Choi, I. (2001). Unit Root Tests for Panel Data. Journal of International Money and Finance, 20(2), pp. 249–272.

Church, J.R. and Ware, R. (2000). Industrial Organization: A Strategic Approach. Irwin McGraw Hill.

Cleveland, R. B., Cleveland, W. S., McRae, J. E., & Terpenning, I. J. (1990). STL: A seasonal-trend decomposition procedure based on loess. *Journal of Official Statistics*, *6*(1), 3–33.

Dardi, M. (2012). The perfect competition paradigm: evolving from its ambiguities. Cahiers D'Economie Politique, 63(2), pp. 219-231.

European Commission (2023). Euro area competitiveness: State of play, challenges and trade-off for policy. European Commission, Directorate general, Economic and financial affairs.

European Commission (2024). Protecting competition in a changing world; Evidence on the evolution of competition in the EU during the past 25 years. European Commission, Directorate general for competition.

Fama, E.F. (1972). Perfect Competition and Optimal Production Decisions under Uncertainty. The Bell Journal of Economics and Management Science, 3(2), pp. 509-530.

Fisher, R. A. (1932). Statistical Methods for Research Workers, 4th Edition. Oliver & Boyd: Edinburgh.

Gunther, J-P. (2021). Seeking a Balance between Perfect Competition and the Fostering of European Industry, RED, 3(2), pp. 114-120.

Hall, R.E. (1986). Market Structure and Macroeconomic Fluctuations. Brooking Papers on Economic Activity, 17(2), pp. 285-338.

Hall, Robert. (1988). The Relation between Price and Marginal Cost in U.S. Industry. Journal of Political Economy, 96(5), 921-47.

Im, K.S., Pesaran, M.H. and Shin, Y. (2003) Testing for Unit Roots in Heterogeneous Panels. Journal of Econometrics, 115(1), pp. 53–74.

Johansen, S. (1991). Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models. Econometrica, 59(6), pp. 1551–1580.

Johansen, S. (1995). Likelihood-based Inference in Cointegrated Vector Autoregressive Models. Oxford: Oxford University Press.

Kao, C. (1999) Spurious Regression and Residual-Based Tests for Cointegration in Panel Data. Journal of Econometrics, 90(1), pp. 1–44.

Katz, M.L. and Rosen, H.S. (1994). Microeconomics. The Irwin Series in Economics.

Kristek, I. and Tomić, D. (2019). How to estimate technical efficiency? Interdisciplinary Management Research XV. Opatija, Croatia, May 16-18.

Lebourges, M. (2019). Four economic questions concerning European competition policy. Orange, Orange Group.

Levin, A., Lin, C. and Chu, C. (2002). Unit Root Tests in Panel Data: Asymptotic and Finite-Sample Properties. Journal of Econometrics, 108(1), pp. 1–24.

Loecker, J., Eeckhort, J. and Unger, G. (2020). The Rise of Market Power and the Macroeconomic Implications. Quarterly Journal of Economics, 135(2), 561-644.

Maddala, G. S. and Wu, S. (1999). A Comparative Study of Unit Root Tests with Panel Data and a New Simple Test. Oxford Bulletin of Economics and Statistics, 61(1), pp. 631-652.

Makowski, L. and Ostroy, J.M. (2001). Perfect Competition and the Creativity of the Market. Journal of Economic Literature, 39(2), pp. 479-535.

Napoletano, M., Roventini, A. and Sapio, S. (2005). Are Business Cycles All Alike? A Bandpass Filter Analysis of Italian and US Cycles. LEM Working Paper Series, No. 2004/25, pp. 1-36. Available at: http://www.lem.sssup.it/WPLem/files/2004-25.pdf.

Pedroni, P. (1999). Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors. Oxford Bulletin of Economics and Statistics, 61 (Special Issue), pp. 653–70. DOI: https://doi.org/10.1111/1468-0084.0610s1653.

Pedroni, P. (2000). Fully Modified OLS for Heterogeneous Cointegrated Panels In B. Baltagi (ed.), Advances in Econometrics, Vol. 15: Nonstationary Panels, Panel Cointegration, and Dynamic Panels, Elsevier Science Inc., pp. 93–130. DOI: https://doi.org/10.1016/S0731-9053(00)15004-2.

Pedroni, P. (2001). Purchasing Power Parity Tests in Cointegrated Panels. The Review of Economics and Statistics, 83(4), pp. 727–731.

Pedroni, P. (2004). Panel Cointegration; Asymptotic and Finite Sample Properties of Pooled Time Series Tests with an Application to the PPP Hypothesis. Econometric Theory, 20(3), pp. 597–625. DOI: https://doi.org/10.1017/S0266466604203073.

Pesaran, M. H., Shin, Y. and Smith, R. P. (1999). Pooled Mean Group Estimation of Dynamic Heterogeneous Panels. Journal of the American Statistical Association, 94(446), pp. 621-634.

Razzak, W. (2024). Measuring the Deviation from Perfect Competition: International Evidence. MPRA Paper No. 120200. Munich Personal RePEc Archive.

Smith, A. (1776). An Inquiry into the Nature and Causes of the Wealth of Nations. History of Economic Thought Books, McMaster University Archive for the History of Economic Thought, number smith1776.

Stock, J. H. and Watson, M. W. (1998). Business Cycle Fluctuations in U.S. Macroeconomic Time Series. NBER Working Paper Series, No. 6528, pp. 1-83.

Tomić, D. and Stjepanović, S. (2018). Empirical tests of various cycle extraction methods; GDP vs. industrial production in Croatia. 27th International Scientific Conference on Economic and Social Development. Rome, Italy, March 01-02.

Tomić, D., Šimurina, J. and Jovanov, L. (2020). The Nexus between Economic Sentiment Indicator and Gross Domestic Product; a Panel Cointegration Analysis. Zagreb International Review of Economics and Business, 23(1), pp. 121-140. https://doi.org/10.2478/zireb-2020-0008.

World Bank (2024). World bank database – World development indicators: https://databank.worldbank.org/source/world-development-indicators.