“Price convergence on the national gas markets of the Eastern European region”

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PRICE CONVERGENCE ON THE NATIONAL GAS MARKETS OF THE EASTERN EUROPEAN REGION

Abstract

Establishing institutional arrangements for regulating gas markets toward price convergence is one of the crucial integrational factors. The strategy of the firm and economic development management depends on it. The paper aims to assess the characteristics of price convergence on the natural gas markets of the Eastern European region. This region is relevant for Ukraine in a number of parameters. The assessment was made based on Eurostat data for different groups of consumers, excluding taxes, using the standard deviation detection method of price convergence for 15 countries in 2007–2020.

Despite the revealed generally positive price convergence on the natural gas markets in the considered countries after 2014, obtained results showed three points that highlight the heterogeneous structure of the process. First, an even movement toward a single price is detected in groups of large households (the standard price deviation of the price decreased in 2014–2020 from 2.7 to 1.9 euro per Giga Joule or 1.5 times) and medium industrial enterprises (the standard deviation decreased from 1.0-1.7 to 0.6-1.1 or 1.5-1.8 times). Second, the prices for the largest industrial enterprises in considered countries approached the fastest (the deviation decreased from 2.0 to 0.5). Third, in the segment of small enterprises, the deviation even increased from 2.1 to 2.2 (1.05 times). This result highlights the gap in the institutional mechanisms of European integration and sources of uncertainty for the small firms' management.

Keywords economic development, institutional arrangements, natural gas, trading hubs, contracts, taxes

JEL Classification F14, F15, F31, O24

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INTRODUCTION

Improving connected gas markets in the EU using gas hubs is one of the critical measures of institutional arrangement, which significantly determines firms' strategies and the behavior of market participants. A vital feature of the successful integration of gas markets is the convergence of prices. Determining the progress of convergence development simplifies forecasting indicators of gas market development and the corresponding increase in management efficiency.

Convergence of the economic environment of the EU countries, in addition to the harmonization of the institutional environment and the introduction of uniform market rules, also involves the achievement of price convergence for basic resource goods. One of the basic goods is natural gas, which is essential in the EU energy sector. Therefore, a convergence of the price of natural gas should be the final consequence of EU policy in gas markets.

The national natural gas markets of the EU countries over the past 20 years have gone through a complex stage of transformation. Its main

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content was the harmonization of the internal environment to uniform pan-European rules, the liberalization of economic relations, and, as a result, the further intra-European integration of energy markets. Adoption and implementation of the norms of the Second Energy Package and then the Third Energy Package (TEP) led to significant changes of the national gas markets in the EU countries. Furthermore, the expansion of the infrastructural capacities of the EU countries made it possible to first form integrated regional natural gas markets, which are often linked to developed regional trading platforms – hubs, and later – to create a pan-European natural gas market.

At the same time, countries from the Eastern European region (EER) that have recently become members of the EU need additional efforts to harmonize the institutional environment and create single markets (Jiroudková et al., 2015). This makes it appropriate to analyze convergence in key integration aspects, such as gas price convergence, focusing on these countries. In this regard, the analysis of the natural gas pricing process in the EER countries is vital for the further process of European integration both for the EU members and for the countries that plan to join it, particularly Ukraine. However, at the same time, the conducted scientific studies show rather contradictory results regarding the assessment of price convergence processes on the gas markets of different regions worldwide.

1. LITERATURE REVIEW

The scientific literature widely illustrates the approach to assessing the markets based on price convergence. The theoretical explanation of market mechanisms leads to the inevitability of price convergence in market deregulation. In the scientific literature, this is described as the "Law of one price," formalized in the models of spatial market equilibria presented by Enke (1951) and later reviewed by Takayama and Judge (1964). The "Law of one price" means that in free market conditions with price flexibility and the absence of friction in the form of transport costs and tariffs, goods with the same properties in different places will be sold at the same price. As an essential consequence of this law, Stigler and Sherwin (1985) defined price convergence as a sign of a full-fledged market for a certain good.

The issue of assessing price convergence on gas markets opened up after the 1970s in the USA and the 1980s in Europe when deregulation occurred. Different studies recorded that more accessible markets pushed close changes in prices of natural gas in the United States and other regions (De Vany & Walls, 1993; Doane & Spulber, 1994). In light of the debate on the emergence of the world market of natural gas, Neumann (2009) added empirical evidence on the move toward the law of one price in formerly regionally segmented markets in the Atlantic Basin. However, price changes in the 1990s were limited due to low production volatility and declining global commodity prices. By 2000, natural gas markets had changed significantly and were not the same as in the 1980s, and prices became more volatile (Brown & Yücel, 2008).

Siliverstovs et al. (2005) explored gas prices in the USA, Canada, Japan, and Europe from the mid-1990s until the 2000s. They confirmed that gas markets could not be classified as integrated. More likely, they were divided between the US, Canadian, and European markets in the 1990s. Despite, in some cases, significant connectedness in the commodity market that could be pointed out after the crisis of 2008 (Zhang & Broadstock, 2020), natural gas prices left highly volatile. Sebastian and Tischler (2014) estimated that prices on natural gas across the Atlantic have become significantly different in the 2000s because of rising impediments to arbitrage (i.e., transaction costs).

The development of gas markets in the EU has been heterogeneous. For example, the Netherlands or the United Kingdom provided liberalization process faster than Italy or Germany. That is why institutional arrangements of gas market regulation were aimed at accelerating market integration (Miriello & Polo, 2015). However, even supply expansions in 2010s had a weak effect on gas price convergence. For instance, the shale gas developments in the USA have virtually eliminated the move toward integration across the Atlantic (Li et al., 2014). Furthermore, Núñez et al. (2022) analyzed the prices in 48 countries. They found two

directions of integration after the spreading of shale gas production: decreasing integration of regional gas markets in the US until 2016 and stabilized level of integration after that year.

At the same time, the moving process to one price in the EU region has more evidence. Chiappini et al. (2019) confirmed a strong trend of gas price convergence in most EU markets and weak integration of European markets with American. Evidence of price convergence, mostly in Western EU member states, is also confirmed (Asche et al., 2002; Robinson, 2007; Bastianin et al., 2019; Broadstock et al., 2020; Loureiro et al., 2022). When prices of gas are close in regions, it becomes more valuable to prioritize inner supply or trade in the region (Tsafos, 2020).

The reason why price integration in the EU region can be tighter than between different regions lies in the general convergence of regulatory requirements (Funke & Koske, 2008). In an effort to build a common gas market in the 2000s, the EU adopted European Gas Directives of 1998, 2003, and 2009 to develop competition policies and increased interconnections, subject to some natural limitations (Heather & Petrovich, 2017). These reforms in the natural gas industry affected consumer prices by strengthening the process of emerging gas prices in Western Europe since 2001 between the industrial enterprises of EU (Renou-Maissant, 2012).

The EU gas markets have developed more integrated with the northwestern part of Europe. It has diverse supplies, better trade connections, and liquidity. In contrast, southern parts were less developed (Boersma, 2015). There needs to be more investment in infrastructure, interconnectors, reverse flow options, and storage in these parts of Europe (Brau et al., 2010). Cassetta et al. (2022) analyzed the price dynamics of natural gas and electricity in the EU-28. They convinced weak convergence, even though a lot of regulatory directives for integration and harmonization were applied in the EU.

Generally, the convergence in natural gas prices depends on three main forces: supply, demand, and external shocks (including regulation). Hailemariam and Smyth (2019) and Broadstock et al. (2020) noted that in the price dynamics of natural gas, the role of regulatory policy outweighs the influence of changes in supply (Loureiro et al., 2022) or weather factors (Mu, 2007). This causes the need to separate the tax component from the gas price dynamics in cross-country comparisons.

To define price convergence, it is necessary to determine the dynamics of the difference in normalized indicators between the objects of comparison. For this, the researchers used various methods of cointegration analysis (De Vany & Walls, 1993), Augmented Dickey-Fuller test (Engle & Granger, 1987), Hodrick-Prescott (Bastianin et al., 2019) or Kalman (Neumann et al., 2005) filters, dispersion (Cassetta et al., 2022) or other tests (Robinson, 2007; Zachmann, 2008). In addition, the assessment of the integration of the EU markets was carried out using the standard deviation (Lutz, 2004), which allows the studies to simplify the comparison of a large number of series.

Overall, assessing price convergence in gas markets has some unfilled gaps in the existing literature. For example, different consumer groups have an indefinite role, excluding the impact of tax regulation as a friction factor. In addition, there is a limited representation of new EU members. Therefore, the purpose of this study is to assess the characteristics of the dynamics of price convergence on the gas markets of the Eastern European region as initial data for planning regulatory policy and firm development strategy.

This task corresponds to the interests of the regulators and the business of the three parties. First, the analysis of the process of price convergence for gas is useful at the EU level for evaluating the integration process of new members. Second, it corresponds to the interests of the EER countries for forecasting, based on the identified trends, directions of changes in natural gas prices for different groups of consumers. Third, in addition to the above, this is of interest to Ukraine within the framework of the European integration process.

2. METHODOLOGY

The analysis of gas price dynamics and their convergence consists of two main parts. The first contains a comparative analysis of gas price general

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dynamics for groups of final consumers of households and industrial enterprises excluding taxes in 2010–2020. The second is an assessment of the price convergence of each group separately over a wider time range, 2007–2020, which includes the TEP introduction.

To assess price convergence, the method of sample standard deviation was used:

$$s = \sqrt{\frac{\sum_{i=1}^{n}\left(x-\bar{x}\right)^2}{\left(n-1\right)}}, \quad (1)$$

where s = sample standard deviation; x = annual average price of gas on the national market for a group, in Euro for a Giga Joule, n = the sample – includes 15 countries: 3 developed EU countries (France, Germany, Italy) and 12 developing countries from EER (Latvia, Estonia, Lithuania, Bulgaria, Romania, Czech Republic, Hungary, Poland, Slovenia, Slovakia, Croatia, Serbia), mostly new EU-members or Energy Community (EC). Although the assessment is carried out primarily for the countries of the Eastern European region, the inclusion in the analysis of three developed countries of Western Europe makes it possible to assess the conformity of the convergence trend in the countries of the Eastern region with the general trends of the EU.

Eurostat data on energy statistics regarding natural gas and electricity prices have been used as a dataset for analyses. Gas prices for households/non-household consumers were taken in bi-annual data (average for the year). Gas price is an indicator that shows the price of gas for consumers: national price average for a year in Euro for Giga Joule (GJ), including or excluding taxes.

3. RESULTS

To analyze the convergence of natural gas prices, it is necessary to consider a feature of the development of gas markets in the countries considered. Such features include the countries' differences in the state of development of energy markets and the rate of liberalization of pricing for natural gas as a commodity and related services for different groups of consumers. In general, countries divide tariffs for households and industrial enterprises. Therefore, depending on the volume of natural gas consumption in Giga Joules, five to six subgroups with different final tariffs are distinguished (see Table 1).

The sixth group of industrial consumers among the analyzed countries with a consumption volume of more than 4,000,000 GJ is distinguished only in Germany, Italy, Hungary, and Romania. In Germany, such a group was distinguished until 2016, and then official statistics do not distinguish such a separate group for industrial consumers.

There are other regional differences. For example, although tariffs for industrial consumers are usually lower than tariffs for households, in most of the studied countries, group I1 tariffs (< 1,000 GJ) are higher than the tariffs of households of group D3 (> 200 GJ).

Table 1. Groups of natural gas consumers

Source: Authors' compilations based on the Eurostat data.

Group/Country	FRA	DE	IT	BG	CZ	HUN	RO	POL	SLO	SK	EST	LVA	LTU	CRO	SRB
Households															
Band D1 (< 20 GJ)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Band D2 (20 – 200 GJ)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Band D3 (> 200 GJ)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Industrial enterprises															
Band I1 (< 1000 GJ)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Band I2 (1000 - 10000 GJ)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Band I3 (10000 - 100000 GJ)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Band I4 (100000 -1000000 GJ)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Band I5 (1000000 - 4000000 GJ)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Band I6 (> 4 000 000 GJ)	-	+	+	-	-	+	+	-	-	-	-	-	-	-	-

Note: "+" – group is present in country; "–" – absent.

In all countries from 2000 to 2020, there was an increase in tariffs for various categories of consumers, but the increase in tariffs was different. In the countries that were pioneers in the liberalization of their own national markets, the smallest tariff increase is observed for all categories of consumers. On average across the EU-27, the tariff in 2020, compared to 2000, increased by 60% for households and 18% for industrial enterprises.

At the same time, for French households of category D1 (< 20 GJ), it increased by 77%, and in Germany – by 68%. For households in the D2 category (< 200 GJ), the increase over the reporting period was even greater, 98% for France and 73% for Germany. However, the situation in the countries that later joined the EU and began to liberalize their national gas markets was different, and the tariff for natural gas increased much more. Thus, in the Czech Republic (group D1) in 2018, compared to 2000, the tariff increased by 494%, in Poland by 219%, and in Hungary by 241%.

Adopting the Third Energy Package (TEP) was an important step in integrating EU gas markets. It aimed to overcome the concentration of national markets and entered into force in September 2009. Therefore, it is advisable to conduct a convergence analysis from 2010 (the base period with which tariff changes were compared and from which the implementation of TEP norms began). This makes it possible to single out differences in tariffs for different groups (households and industrial enterprises) within the framework of the current EU policy on the integration of gas markets.

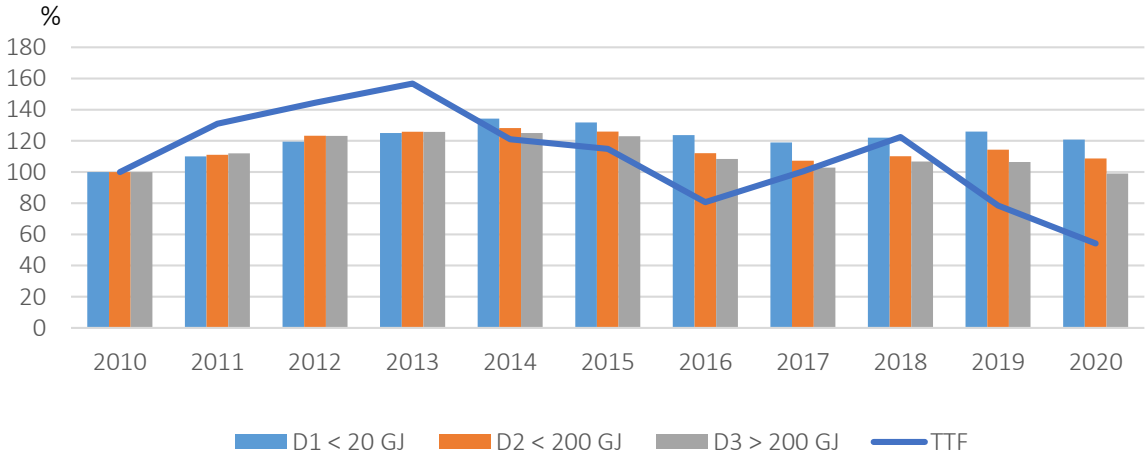
3.1. Tariffs for households

Of the analyzed countries for the period from 2010 to 2020, in five countries (Germany, Bulgaria, Slovakia, Estonia, and Latvia), tariff increases for D1 households (< 20 GJ) occurred within 20%; in Romania, Italy, and the Czech Republic – within 40%. The increase occurred within 60% in France, and in all others, the tariff decreased (Hungary, Poland, Slovenia, Lithuania, Croatia, and Serbia). In general, the tariff for the East European countries increased by 50.3% from 2010 to 2020.

Comparing the dynamics of changes in tariffs for different categories of households since 2010 (the first year of the TEP norms implementation) across EER countries, the preservation of price volatility is notable compared to the base year of 2010 (Figures 1-2).

The tax policy in EER countries regarding final prices for natural gas as a commodity for different categories of households is characterized by the following features. In Bulgaria, Slovakia, as well as Ukraine during 2010–2020, the tax rate for gas as a commodity was stable and amounted to about 20%; in Serbia and Romania, the tax rate was less than 20%. In all other countries analyzed, taxation was either above 20% or the share of taxes and fees in the final price of natural gas for dif-

Source: Authors' compilations based on the Eurostat data.



Note: 2010 = 100%.

Figure 1. Change in the tariff for natural gas by category of households, excluding taxation in the EER countries

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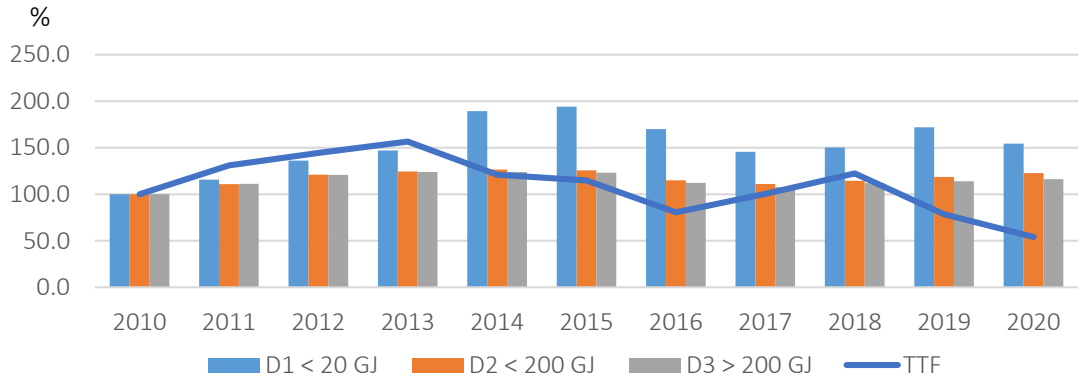


Note: 2010 = 100%.

Figure 2. Change in the tariff for natural gas by category of households, including taxation in the EER countries

ferent categories of households varied from year to year. Thus, in the final price of natural gas as a commodity, the share of taxes and duties was the highest in Italy (from 32.9% to 69.5%), Slovenia (40-45%), and Estonia (40-42%).

Analyzing the dynamics of changes in tariffs for different categories of households, including taxes and fees for the same period, in general for EER countries, it can be noted that the share of tax fees has increased in the final price for natural gas as a commodity.

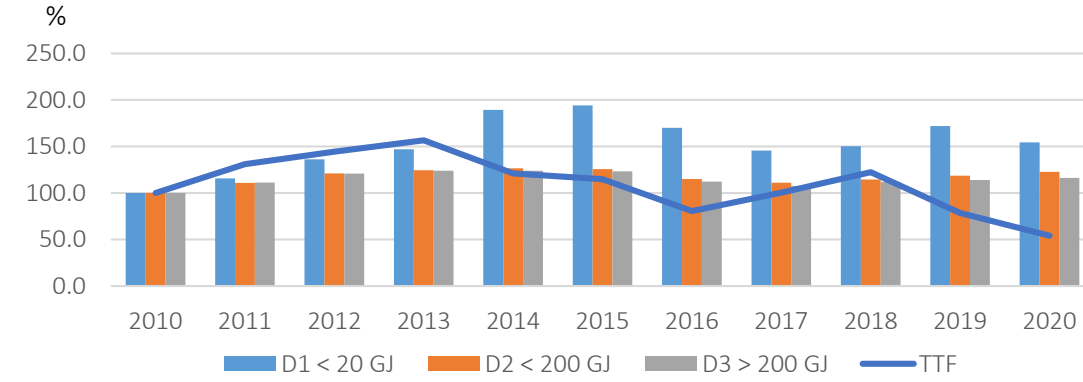
3.2. Tariffs for industrial enterprises

Based on the analysis of data on the dynamics of natural gas prices in EER countries for various groups of industrial consumers from 2010 to 2020, it can be seen that in 2020 the price of gas increased only slightly for two groups (I1 and I4), and for others of three groups even decreased by 4-7% (Figures 3-4).

The analysis of tariffs for different groups of industrial consumers, including taxes results, does not change much. Similarly, in two groups of industrial consumers, there is a slight increase in 2018 within the range of 2-9%, and in the third – a price decrease of 2-7%. The only difference is that an increase was observed in the final price, not in the first and fourth groups, but in the first and second. That is, the final price for the fourth group in 2020, compared to 2010, decreased by about 15%.

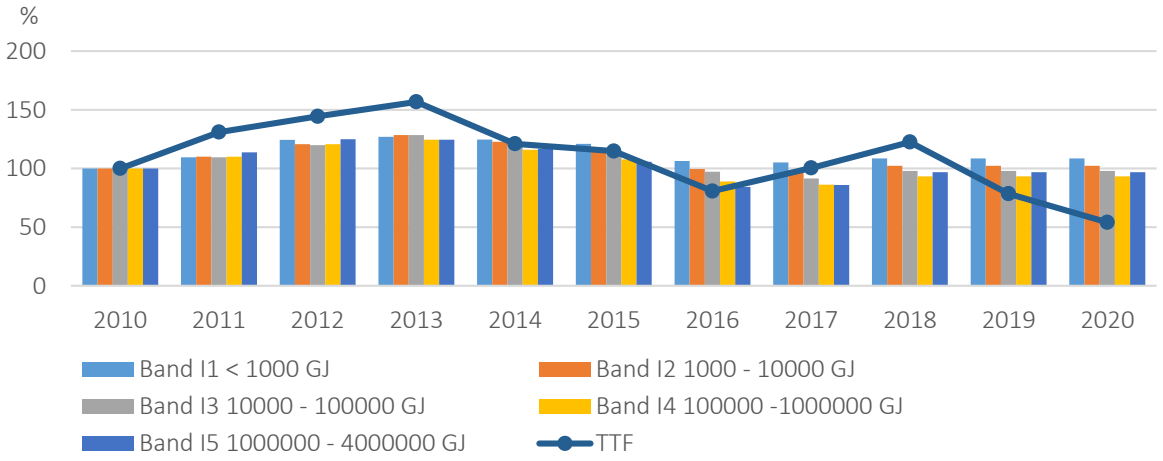
Assessing the level of taxation in the EU and EC countries, it can be noted that in almost all countries, taxes in the final price of the natural gas amount to more than 20%. Depending on the groups of industrial consumers by country, the specific weight

Source: Authors' compilations based on the Eurostat data.



Note: 2010 = 100%.

Figure 3. Change in the tariff for natural gas by category of industrial enterprises, excluding taxation in the EER countries



Note: 2010 = 100%.

Figure 4. Change in the tariff for natural gas by category of industrial enterprises, including taxation in the EER countries

of taxes in the final price usually varies, but the difference between the groups in the level of taxation is insignificant. The highest share of taxes in the final price of natural gas for industrial consumers is observed in Italy (up to 40% for the first and second groups), Hungary (about 34%), Slovenia (about 40%), Estonia (about 40-42%), Lithuania (35-37%), and Germany (30-40%). At the same time, the example of Italy demonstrates a significant reduction in taxation in groups that consume natural gas in volumes of more than 10,000 GJ (the third-fourth group of taxation in the range of 10-20%).

3.3. Convergence of gas prices by different consumption groups

For a wider sample and relevant analysis, the assessment of gas price convergence is carried out over a more comprehensive time range to reflect the possible impact of the TEP implementation. Its direct impact was not tested, but the obtained results show that if TEP's effect was, it was not instantaneous, but gradually, as the new members of EU implemented it. A graphic presentation of the price convergence in 12 EER plus three developed countries assessment based on the determination of the standard deviation is shown in Figure 5 (a-j) in Euro for GJ.

The graphically presented results of calculating the standard deviation of the price of gas tariffs for households and industrial enterprises excluding taxes show different results for different groups of consumers. Quantitative parameters of the price of gas convergence (rate of standard deviation from the average gas price in Euro for GJ) for different groups of consumers are presented in Table 2.

Table 2. Quantitative parameters of the price of gas convergence, Euro/GJ

Source: Authors' compilations based on the Eurostat data.

Group/Year	2007	2010	2014	2016	2020	2020/2010	2020/2014
Households							
Band D1 (< 20 GJ)	3.975	4.836	6.354	6.503	7.422	0.65	*0.86*
Band D2 (20 - 200 GJ)	2.148	2.345	3.213	2.908	2.604	0.90	*1.23*
Band D3 (> 200 GJ)	1.946	2.136	2.742	2.397	1.889	1.13	*1.45*
Industrial enterprises							
Band I1 (< 1000 GJ)	2.125	2.192	2.101	2.267	2.175	1.01	*0.97*
Band I2 (1000 - 10000 GJ)	1.748	1.976	1.672	1.539	1.143	1.73	*1.46*
Band I3 (10000 - 100000 GJ)	1.294	1.708	1.365	0.511	0.803	2.13	*1.70*
Band I4 (100000 -1000000 GJ)	0.958	1.388	0.985	0.784	0.636	2.18	*1.55*
Band I5 (1000000 - 4000000 GJ)	0.963	1.166	1.068	0.959	0.590	1.98	*1.81*
Band I6 (> 4 000 000 GJ)	1.213	1.862	2.001	1.125	0.530	3.51	*3.78*

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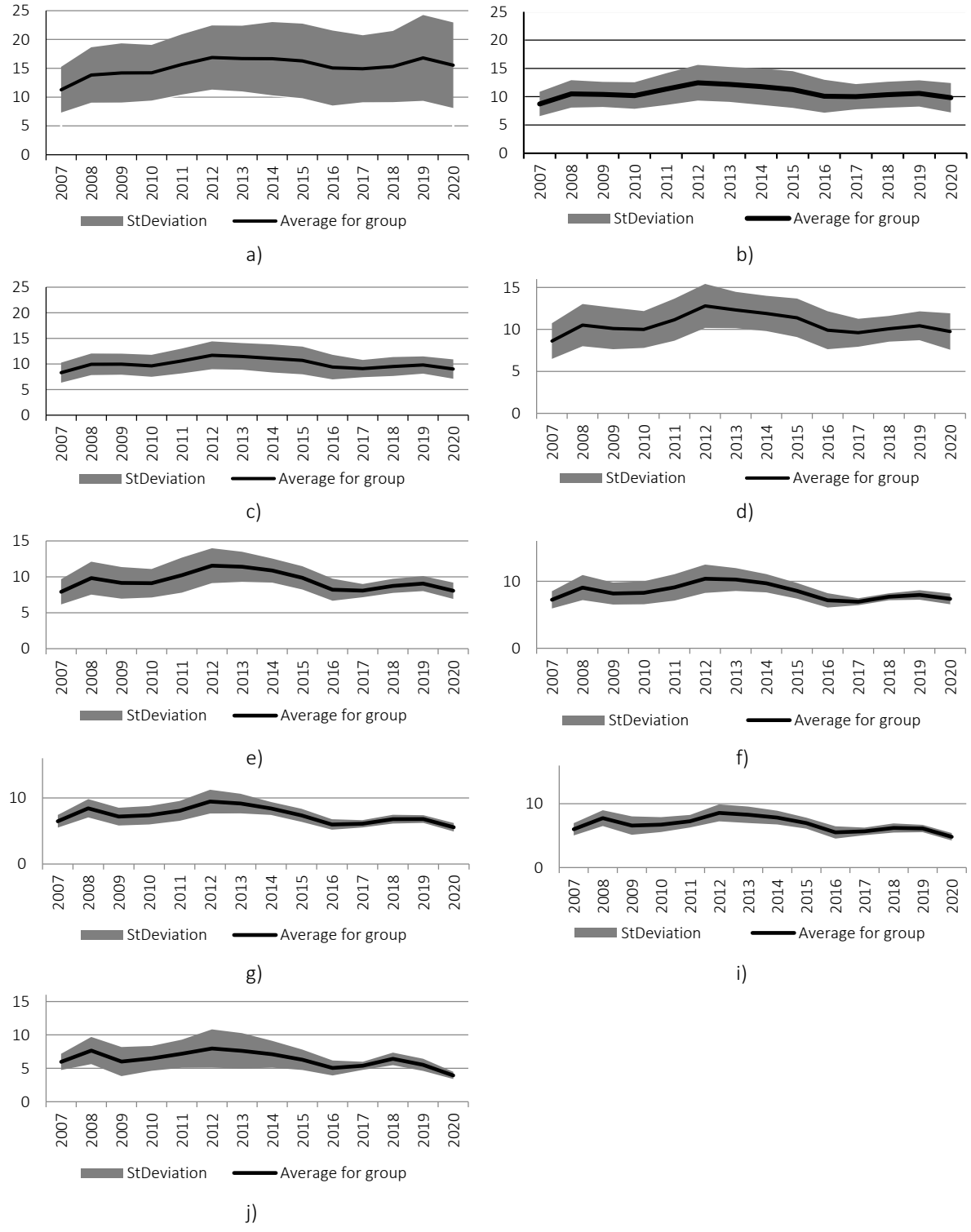
Source: Authors' compilations based on the Eurostat data.



Note: (a) Band D1; (b) Band D2; (c) Band D3; industrial enterprises: (d) Band I1; (e) Band I2; (f) Band I3; (g) Band I4; (i) Band I5; (j) Band I6.

Figure 5. Price convergence for households

There is noticeable price divergence for the subgroup of households D1 and limited convergence for the other two subgroups of households. For the D1 group, a trend toward convergence has been observed since 2019. At the same time, for the other two categories of household consumers (D2 < 200 GJ and D3 > 200 GJ), with an increase in consumption volumes, a moderate price convergence is observed after 2010. When analyzing the final price of natural gas, including taxes and fees for all categories of household consumers, insignificant price convergence is observed even in the first category of consumers (< 20 GJ).

In all categories of industrial consumers, price convergence is observed for gas as a commodity during 2007–2020. Extensive dynamics of convergence are noted for the first three categories (I2 < 10000 GJ; I3 < 100000 GJ; I5 < 4000,000 GJ).

For three categories of industrial consumers (I1: < 1000 GJ; I4: 100000 -1000000 GJ; I6: > 4000000 GJ), price convergence is also observed; at the same time, despite the growth in consumption volumes, price convergence is slower. The convergence of the price of natural gas, including taxes and fees, is lower compared to the price convergence of the price of gas excluding taxes, although it is also typical for all categories of industrial consumers. The peculiarity of the analysis of the sixth group of industrial enterprises I6: > 4000000 GJ is a small sample – as mentioned, only a few countries single this group out within a short period.

4. DISCUSSION

This study analyzed price convergence on the European natural gas market in EER countries in different segments of these markets. The results revealed that at the current stage of the formation of a single integrated gas market of the EU, price convergence for natural gas can be observed. At the same time, some groups are characterized by a lower level of convergence. They mainly include groups of household consumers. At the same time, there is no price convergence for the D1 group of household consumers, excluding taxes. For the other two categories of household consumers (D2 and D3), price convergence was observed after 2010, when the TEP was adopted. In contrast to household consumers, there was a convergence of gas prices in the groups of industrial consumers during 2007-2020. Extensive dynamics of convergence are noted for the first three categories (I1, I2, and I3).

Thus, the results of the analysis of price convergence, taking into account consumer groups and tax regulation, on the one hand, confirm the results of Chiappini et al. (2019) on strengthening the integration of the gas markets of European countries. In contrast, the obtained results provide an opportunity to explain the negative result regarding the detection of convergence obtained by Cassetta et al. (2022) without distinguishing groups and taxes. It is due to various features of the development of gas markets in the regions of Europe, individual countries, and groups of consumers, which are affected by different regulatory approaches, in particular, a lower tax burden for target groups of economic development programs.

In general, the detection of price convergence on the EU gas market requires a diversified analysis of consumer groups and regions. Moreover, it is vital to consider regulatory policy. These findings confirmed the conclusions of Hailemariam and Smyth (2019) and Broadstock et al. (2020) that considering the price dynamics of natural gas, the role of regulatory policy outweighs the influence of changes in supply.

An attempt to explain the identified differences in the approximation of the gas price for different groups of consumers draws attention to the peculiarities of the tariff policy for the smallest consumers in the group of households and small consumers in the group of industrial enterprises. A unique pricing regime characterizes all these groups. In particular, the first subgroup of households in most countries pays an underpriced price offset by government spending. Accordingly, it is in these groups that pricing is more influenced by national regulators. As a result, when implementing the policy of gas market integration, EU regulators need to consider that certain consumer categories on national markets will have special pricing regimes. It may be appropriate to formalize and standardize such categories at the EU level.

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CONCLUSION

Provided assessment of price dynamics on gas markets of EER countries showed the generally heterogeneous nature of the development of price convergence for gas in these countries. Three points of gained results characterize the course of this process. First, an even movement toward a single price is detected in groups of large households – the standard price deviation of the price decreased in 2014–2020 from 2.7 to 1.9 euro per Giga Joule (or 1.5 times), as well as medium and large industrial enterprises – the standard deviation decreased from 1.0-1.7 to 0.6-1.1 (1.5-1.8 times). Second, the prices for the largest industrial enterprises that consume more than 1000 GJ in considered countries have the fastest convergence – the deviation decreased from 2.0 to 0.5 (almost 4 times). Third, the deviation in the price of gas for small enterprises remained almost unchanged or even had a moderate increase – 2.1 to 2.2 (1.05 times) and increased from 6.4 to 7.4 (1.15 times) among small households. Thus, against the general background of price convergence of the gas markets, the convergence process is not homogeneous. For the management of smaller enterprises, this makes it difficult to forecast price dynamics and develop an optimal strategy.

The obtained results make it possible to characterize the process of economic development and international institutional arrangements in the EU in terms of natural gas markets, identify bottlenecks and optimize regulatory policy to accelerate integration processes and increase economic efficiency. It is advisable to direct further research to assess price convergence at the level of the entire EU-27. This will contribute to expanding the information policy of the EU in the energy sector.

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Formal analysis: Roman Yukhymets.
Investigation: Oleksandra Kurbet.
Methodology: Roman Yukhymets.
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