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ORIGINAL RESEARCH

Empirical analysis of the differences in the drivers of fertility between CEE countries and the rest of the EU

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Abstract

Our research aims to reveal the key social, economic, and other factors behind the common fertility trends of the CEE countries compared to the rest of Europe over the past decades. A panel analysis was conducted to examine the main (social and economic) determinants of the total fertility rate using the fixed-effect method. The study employs macro-level data from the 27 countries of the European Union with special attention to the 11 CEE countries; the analysed period lasts from 1990 to 2021. The results demonstrate that fertility in the CEE countries is significantly more sensitive to changes in the economic situation, and demographic and social variables related to childbirth have a more pronounced effect on the TFR. In contrast, variables related to the ageing of society seem to be less decisive. Our main academic contribution is to extend the empirical literature on fertility rates in Central and Eastern Europe. There are indeed differences in the determinants of the TFR in Central and Eastern Europe compared to the rest of Europe over the past decades, which allows policymakers to respond more efficiently to changes in the fertility patterns of the region.

Keywords Fertility · TFR · Central and Eastern European countries · Demographic economics · Socio-economic uncertainty · Panel data methods

JEL Classification C33 · J11 · J13 · J18

Introduction

Besides the prevailing trend of population ageing, there are significant variations in the development of fertility rates across European countries over the past few decades. Many researchers have focused their attention on analysing the fertility trends according to the different regions of Europe (among others, see Frejka et al., 2008;

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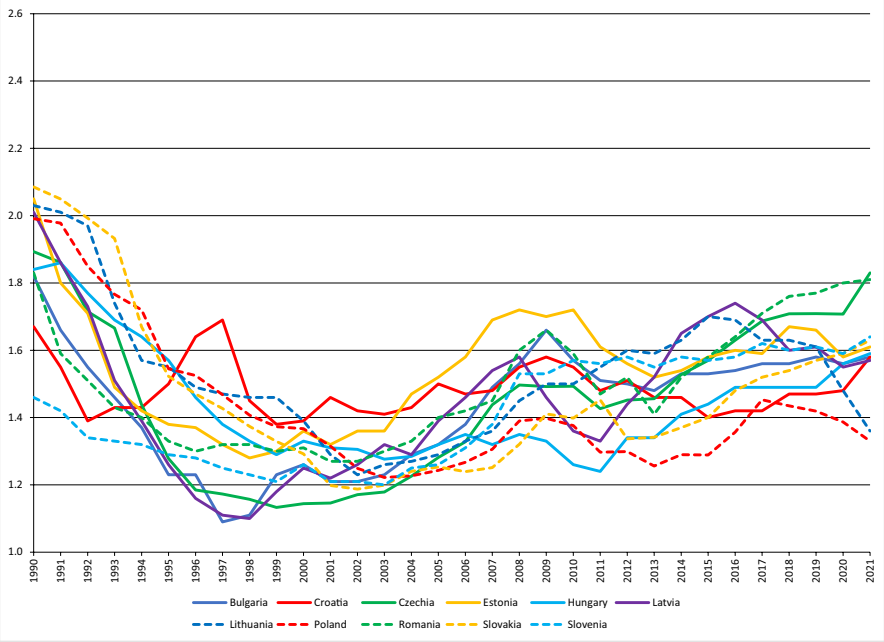

Fig. 1 Total fertility rates in CEE countries, 1990–2021. *Source*: Authors' graph based on the OECD Family Database (2023), SF2.1 Fertility rates. (Excel)

Goldstein et al., 2009; Luci-Greulich & Thévenon, 2013; Bongaarts & Sobotka, 2012). As can be observed, the fertility trends in Western, Southern, and Central European countries (in some time periods, specifically the German-speaking countries) have exhibited marked contrasts when compared to those in Central and Eastern European (henceforth, CEE) countries over the past few decades (see Fig. 1 and Appendix Fig. 2). Accordingly, this paper focuses primarily on the CEE countries within the European Union, namely Bulgaria, Croatia, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia. Based on the availability of data, the analysed period lasts from 1990 to 2021.

One of the most striking features of the fertility progression of the CEE region is the rapid transformation from the highest-fertility region of Europe to the lowest-fertility one, occurring within a single decade during the 1990s, measured by the total fertility rate[1] (TFR) (Sobotka, 2011). The lowest recorded total fertility rates in the CEE region during the analysed period occurred between 1997 and 2003 (see Fig. 1 and Appendix Table 4). Another remarkable similarity in the fertility trends of CEE countries is the gradual recovery after 2000, which persisted until 2009 (Sobotka, 2011). The global financial crisis of 2007–2009 resulted in a stalling or decline in the total fertility rates in the CEE region after 2009. The characteristics of the fertility trends were not significantly different from those observed in the Southern and

[1] "Total fertility rate (TFR) expresses to how many children a woman would give birth during her life at the birth frequency by age of the given year" (HCSO, 2023).

some other European countries between 2010 and 2013 (see Appendix Fig. 2). Following the relapse, TFR demonstrated a clear upward trend until 2016 in the majority of CEE countries. However, this common trend seems to dissipate by the second half of the 2010s (see Fig. 1).

Our main research objective is to reveal the common driving forces that have played a role in the evolution of TFR in CEE countries from 1990 to the present. What specific economic, demographic, social, and labour market factors, if any, can contribute to the similarity of fertility development at the macro level compared to the rest of Europe?

Our results suggest that fertility in the CEE countries is much more sensitive to economic factors—both to the general economic situation, as measured by the European Commission's economic sentiment indicator, and to more specific economic factors, such as the annual inflation rate of food and non-alcoholic beverages, or the construction cost index—than in other European countries. In addition, some demographic and social variables related to childbirth (such as the crude marriage rate and tertiary educational enrolment) have a more pronounced effect on the TFR than in other parts of Europe. Meanwhile, variables related to the ageing of society (such as the old-age dependency ratio and life expectancy) seem to be less decisive in the evolution of the TFR in Central and Eastern Europe.

The remainder of this paper is organised as follows. Sect. "The commonalities of fertility patterns in the CEE countries" describes the common characteristics of fertility patterns in the CEE countries. Sect. "Empirical literature review" presents an empirical literature review focusing on the explanation of the TFR evolution in the CEE region. Sect. "Data and methodology" describes the data used in detail and presents the methodology. Sect. "Results" discusses the results, and finally, Sect. "Conclusions" draws conclusions.

The commonalities of fertility patterns in the CEE countries

According to Frejka and Gietel-Basten (2016), the demographic, social, and economic traits of the CEE countries are influenced by the common influence of communism and subsequent transformation. We need to be aware of these important aspects when analysing and interpreting the fertility and family trends of the region. Until 1990, the countries of the Eastern bloc remained immune to the massive family transformation taking place in the West. This stability can be explained by a mix of institutional and cultural factors. During the 1990s, however, fertility behaviour in the CEE countries also underwent a major transformation. We will examine the cultural, demographic, institutional and economic factors that are thought to have influenced these fertility changes.

At the beginning of the 1990s, the mean age at birth[2] (MAB) in the CEE countries was still low compared to other European countries (see Appendix Table 4).[3] Furthermore, births out of marriage and childlessness were marginal, while abortion rates were high (Frejka & Sobotka, 2008; Sobotka, Skirbekk & Philipov, 2011). CEE countries typically had full employment before the regime change and low tertiary enrolment rates, both of which implied that most young adults were full-time earners by the age of 18, and cumulative teenage fertility was significant (Sobotka, 2011).

However, the change of the political regime between 1989 and 1991 led to a massive decline in the TFR, which lasted for most of the 1990s. Several theories have been proposed to explain this phenomenon. Some authors pointed out that in periods when the MAB increases significantly, TFR decreases sharply because of the so-called 'tempo effect'. This is the postponement transition, which was decisive in the CEE countries (Bongaarts & Sobotka, 2012; Frejka et al., 2011; Goldstein et al., 2009; Kohler et al., 2002; Philipov & Kohler, 2001; Sobotka & Lutz, 2011). According to the results of Sobotka (2017), in numerous European countries, the sustained tendency towards postponed parenthood—that is to say, the shift towards later childbearing—has exerted a detrimental impact on total fertility rate for over four decades. Another theory, that of the 'second demographic transition', finds the central factor and driving force of the above phenomena in the change of norms, values, attitudes and culture (van de Kaa, 1987, 2004; Frejka et al., 2008; Spéder, 2019). According to Lesthaeghe (2010), this theory also applies to CEE countries. Frejka (2008) considers social and economic transformation as the root cause of the demographic transition. Other important factors include educational expansion (Frejka, 2008; Sobotka et al., 2011), the rise in female employment (Wesolowski & Ferrarini, 2018), and the increasing prevalence of contraception (Sobotka, 2011). The economic transition was accompanied by severe economic downturns and transformations, with high inflation, rapidly increasing structural unemployment, falling real wages and the collapse of inefficient industries (Billingsley, 2010; Sobotka, 2011). According to the findings of Jemna and David (2022), the introduction of uncertainty in the CEE region after 1990 has resulted in a rise in unemployment rates and a significant decrease in fertility rates. It is important to take into consideration that the real value of family allowances has declined, and family policy institutions have been modified or abolished. These factors have contributed, to varying degrees in different countries, to the decline in the total fertility rate. (Macura, 2000; Sobotka, 2011).

As a result of the rapid transformation in the level and timing of fertility, Central and Eastern Europe had extremely low fertility rates by around 2000 (Sobotka, 2011). Except for Croatia, the TFR of all CEE countries fell to a level below 1.3, the so-called

[2] "Mean age of child-bearing women: the mean age is indicated with a weighted arithmetic mean calculated on the basis of the age-specific live birth data of the women giving birth to children in the given calendar period." (HCSO, 2023).

[3] The average of the MAB was 28.3 years in the EU15 countries and 25.5 years in the CEE countries in 1990 (own calculation based on data of Eurostat, 2023; Human Fertility Database, 2023; Human Fertility Collection, 2023; OECD Family Database, 2023).

'lowest-low fertility' category (see Appendix Table 4) (Goldstein et al., 2009; Kohler et al., 2002). However, younger women in the 1990s did not all give up, but mainly postponed their childbirths. At older ages, they attempt to realize at least some of their childbearing intentions; this is the period of recuperation (Bongaarts & Sobotka, 2012; Frejka et al., 2011). When these children were born, the TFR may have risen again. Although the postponement of childbearing still continued in almost all developed countries during the 2000s, according to Goldstein et al. (2009), the slowdown in the pace of postponement had a TFR-increasing effect in itself in the CEE countries. The authors also argue that in post-communist countries, the recovery from the serious economic and social crises of the 1990s also had a fertility-enhancing effect (Goldstein et al., 2009). According to Bergsvik et al. (2021), the fertility recuperation in Central Europe is to some extent related to the expansion of such family policies that support dual-earner families (regarding Eastern Europe, there are no studies on this topic). However, Frejka and Gietel-Basten (2016) found that family policy may have had a positive impact on cohort fertility rates only in Slovenia and Estonia.

Numerous authors have discovered a significant negative relationship between fertility and unemployment rates across Europe during the financial crisis (among others, Comolli, 2017; Goldstein et al., 2013; Matysiak et al., 2021). Moreover, Matysiak et al. (2021) pointed out that the economic downturn was indeed associated with a stronger decline in fertility rates compared to the pre-recession period. According to them, the most severe decline in fertility was observed in countries and regions where labour market conditions deteriorated most during the recession, such as Southern Europe, Ireland, and parts of Central and Eastern Europe. All in all, according to the authors, TFR in CEE countries shows a procyclical tendency, i.e., TFR increases during economic boom and decreasing unemployment and falls during economic recession, as in most developed countries (Matysiak et al., 2021).

By the end of the analysed period, the common trend in the TFR values of CEE countries seems to have disappeared. In Latvia, Lithuania, and Poland, the TFR has definitely started to decrease, while in Bulgaria, Czechia, Croatia, Hungary, Romania, and Slovakia, TFR has had an uninterrupted growth trend since the trough caused by the financial crisis until 2021. In brief, it can be observed that in certain Central and Eastern European countries, such as Czechia, Hungary, Romania, Slovakia, and Slovenia, the TFR has surpassed its previous peak around 2009 by a significant margin, as of 2021. In the rest of the group, however, TFR was almost the same (Bulgaria, Croatia, Latvia) or lower (Estonia, Lithuania, Poland) than its maximum before or around the crisis (see more details in Appendix Table 4). The divergence in fertility trends between CEE countries can be attributed to the COVID-19 pandemic and its economic aftermath. However, a longer observation period would be needed to fully analyse this topic.

Empirical literature review

There is a rich empirical literature on the development of TFR, especially for European countries and regions, with a special focus on specific periods such as the 1990s or the years following the financial crisis. This summary aims to outline the

key findings of such empirical papers that cover multiple European countries, at least partly including the CEEs, during a period that extends beyond 1990. These studies primarily focus on examining the impact of different family policies and demographic, social or economic variables on fertility.

The purpose of Billingsley's (2010) econometric analysis is to find an empirical explanation for fertility trends in post-communist countries. The findings show that no single theoretical explanation alone could adequately account for the complex fertility decline, although the author emphasizes that the economic downturn has significant explanatory power in the decreasing TFR. According to the author, a great part of the fertility decline occurred before significant childbearing postponement began, and that GDP growth was positively correlated with fertility postponement (Billingsley, 2010).

Goldstein et al. (2013) have posited that deep economic crises are associated with fertility decline in Western European countries. However, the authors still assume that the market mechanism in this region is more stable and predictable than in post-communist economies during their transition periods. The unemployment rate was used as an indicator of the economic crisis in their analysis. The results of fixed-effects modelling controlling for differences across countries and time periods showed that the unemployment rate is closely related to the evolution of fertility (Goldstein et al., 2013). Furthermore, Spéder (2019) speculates that high rates of inflation may lead individuals to perceive the living conditions as less predictable and thus to revise their plans and abandon their short-term intentions to have children.

Wesolowski and Ferrarini (2018) empirically tested the effects of different family policy settings on fertility in 33 industrialized countries (including Bulgaria, Czechia, Lithuania, Hungary, Romania, Slovakia, and Slovenia) using a pooled time-series analysis with country-fixed effects and stepwise controls for female labour force participation, unemployment rates and GDP between 1995 and 2011. Their results indicate that earner–carer support is associated with higher fertility, while traditional family support is not. Moreover, higher female labour force participation is associated with higher fertility when GDP is not controlled for. Meanwhile, as many other authors, they also verified the result that higher unemployment is associated with lower fertility levels (Wesolowski & Ferrarini, 2018).

Szabó-Morvai et al. (2019) mainly focused on the effect of social expenditure variables on fertility, among other demographic and economic variables. They investigated the TFR development of 19 European countries (including Czechia, Estonia, Hungary, and Slovakia) for the time period 2001–2014. According to their estimates, the total fertility rate is mostly influenced by economic and employment conditions and the old-age dependency ratio. A 1 percentage point reduction in the female unemployment rate would increase the TFR by 0.6%, and a 1 percentage point reduction in the old-age dependency ratio would increase the TFR by 1.6%. Their analysis confirms the view that cash benefits have no significant impact on fertility (Szabó-Morvai et al., 2019).

A study was conducted by Jemna and David (2022) to investigate the relationship between socio-economic uncertainty and fertility in countries throughout Central and Eastern Europe. The study utilized multiple measures of uncertainty and

controlled for social and demographic factors. The findings revealed that high unemployment rates in the area and a high level of female tertiary enrolment could lead to a decrease in fertility, while the marriage rate can increase it. Furthermore, the research demonstrated a significant positive correlation between female employment and fertility. However, the study suggests that economic uncertainty, as measured by growth volatility, may not play a significant role in determining fertility decisions and may not be the primary explanation for the decline in fertility rates in these countries since 1990 (Jemna & David, 2022).

In conclusion, it can be stated that no single theoretical explanation is sufficient to account for the observed decline in fertility rates in post-communist countries. However, numerous scholars contend that in Central and Eastern European countries, as in the majority of developed nations, there is a procyclical tendency. An increase in the total fertility rate is observed during periods of economic growth and periods of severe economic crisis correlate with a decline in fertility. Furthermore, numerous authors have posited a correlation between elevated unemployment and diminished fertility rates. However, there is no consensus regarding the importance of economic uncertainty in influencing the observed decline in fertility rates since 1990. Whether family subsidies have a strong positive effect on fertility is also debated in the literature. With respect to other non-economic factors, some authors have found that rising female tertiary enrolment and higher old-age dependency ratios in CEE countries have been linked to a reduction in fertility, while higher marriage rates have been observed to increase it.

Data and methodology

Data

We use macro-level data from the 27 countries of the European Union with special attention to the CEE countries. Our regression models cover the period from 1990 to 2021 in Specifications 1 and 2 and from 2000 to 2021 in Specification 3 (see in detail in Sect. "Results"). Table 1 below shows the list of the variables we use, the exact data source, and the most important descriptive statistics. The data come mostly from the Eurostat (2023), OECD (2023) and the World Bank (2023) online databases with a few exceptions (see Table 1).

Methodology

In order to measure the effect of potential influential factors on fertility, we estimate a panel regression using the fixed-effect method. Since most of the variables used in the regressions are non-stationary by nature, the first differences are applied to avoid spurious regression. The left-hand-side variable is the change in the total fertility rate, while the right-hand-side variables are the lagged changes in the potential influential factors. Except for the percentage change in MAB, all the potential influential factors are included with two-period lags. The use of two-period lags of the

Table 1 Description and summary statistics of the data, 1990–2021 and 2000–2021

Variables (notation)	Source and availability	Definition	Mean and standard error (in parentheses)	
			1990–2021	2000–2021
Dependent variable				
Total fertility rate (TFR)	OECD Family Database (SF2.1 Fertility rates) 1990–2021	"Average number of children born per woman over a lifetime given current age-specific fertility rates and assuming no female mortality during reproductive years." (OECD, 2023)	1.531 (0.204)	1.551 (0.207)
Demographic and social variables				
Percentage change of mean age of women at childbirth (MAB), %	Eurostat (demo_find) 1990–2021. The missing data is replaced by MAB values from the Human Fertility Database for Germany (1990–1999), and by MAB values from the Human Fertility Collection for Croatia (1990–2000) and Latvia (1990–1999)	"MAB: the mean age is indicated with a weighted arithmetic mean calculated on the basis of the age-specific live birth data of the women giving birth to children in the given calendar period." (HCSO, 2023)	0.004 (0.004)	0.004 (0.003)
Old-age dependency ratio	World Bank World Development Indicators 1990–2021	"The ratio of older dependents—people older than 64—to the working-age population—those ages 15–64." (World Bank, 2023)	26.068 (4.717)	27.299 (4.423)
Life expectancy	World Bank World Development Indicators 1990–2021	"The number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life." (World Bank, 2023)	78.495 (3.230)	78.936 (3.215)
Crude marriage rate	Eurostat (demo_nind) 1990–2021	"The ratio of the number of marriages during the year to the average population in that year. The value is expressed per 1000 inhabitants." (Eurostat, 2023)	4.799 (1.277)	4.635 (1.176)

Table 1 (continued)

Variables (notation)	Source and availability	Definition	Mean and standard error (in parentheses)	
			1990–2021	2000–2021
Proportion of live births outside marriage	Eurostat (demo_find) 1990–2021	"The proportion of live births where the mother's marital status at the time of birth is other than married." (%) (Eurostat, 2023)	36.247 (14.829)	40.385 (13.172)
Economic variables				
GDP per capita growth	World Bank World Development Indicators 1990–2021	"Annual percentage growth rate of GDP per capita based on constant local currency (annual %)" (World Bank, 2023)	2.106 (3.937)	–
Inflation rate	World Bank World Development Indicators 1990–2021	Inflation, consumer prices (annual %) (World Bank, 2023)	2.416 (3.326)	–
Unemployment rate	World Bank World Development Indicators 1990–2021	Unemployment, total (% of total labour force) (national estimate) (World Bank, 2023)	8.493 (4.203)	8.504 (4.214)
Economic sentiment indicator	Eurostat (ei_bssi_m_r2) 2000–2021. Croatian data is available from 2008	"The economic sentiment indicator is calculated by the DG ECFIN of the European Commission based on business and consumer surveys. Seasonally adjusted, but not calendar adjusted monthly data" (Eurostat, 2023)	–	99.900 (8.564)
Food inflation rate	Eurostat (prc_hicp_aind) 2000–2021	Harmonised Index of Consumer Prices—Annual average rate of change in the prices of food and non-alcoholic beverages (annual %) (Eurostat, 2023)	–	2.199 (2.843)

Table 1 (continued)

Variables (notation)	Source and availability	Definition	Mean and standard error (in parentheses)	
			1990–2021	2000–2021
Construction cost index	Eurostat (sts_copi_a) 2000–2021	Construction producer prices or costs, new residential buildings, except residences for communities. Unadjusted annual data, index (2015 = 100) (Eurostat, 2023)	–	98.617 (13.560)
Labour market indicators				
Female to male labour force participation rate	World Bank World Development Indicators 1990–2021	Ratio of female to male labour force participation rate (%)	0.837 (0.090)	0.860 (0.073)
Part-time employment rate of women 25–49 years old	Eurostat (lfsa_eppga) 1990–2021. Data available completely from 2002 to 2021	Part-time employment as percentage of the total employment among women aged 25–49 years (Eurostat, 2023)	21.458 (16.598)	21.801 (16.539)
Tertiary education indicators				
Tertiary educational attainment	Eurostat (edat_lfse_03) 1992–2021	Population by tertiary education (levels 5–8) aged 25–34 (%) (Eurostat, 2023)	34.761 (11.236)	–
Tertiary educational enrolment	Eurostat (educ_ipart_s) 2000–2012 Eurostat (educ_uoe_enrt08) 2013–2021	Students in tertiary education aged 20–24—as % of corresponding age population (Eurostat, 2023)	–	33.255 (7.425)
Family policy variables				
Total general government expenditure on families and children	Eurostat (gov_10a_exp) 2000–2021. Data available completely from 2001 to 2021	Total general government expenditure on families and children (COFOG GF1004), percentage of gross domestic product (Eurostat, 2023)	–	1.956 (0.959)
Family allowances	Eurostat (earn_nt_net) 2000–2021	Family allowances for a two-earner couple with two children, both earning the national average, as a ratio of their gross earning (Eurostat, 2023)	–	0.025 (0.020)

Table 1 (continued)

Variables (notation)	Source and availability	Definition	Mean and standard error (in parentheses)	
			1990–2021	2000–2021
Tax break for families with children	Eurostat (earn_nt_net) 2000–2021. Data available completely from 2013 to 2021	Difference between the average tax rates of a two-earner couple without children, both earning the national average and a two-earner couple with two children, both earning the national average (Eurostat, 2023)	–	0.017 (0.018)

right-hand-side variables partly reflects the fact that fertility decisions lag behind policy changes, i.e., it takes time for the population to realize that policy changes have been implemented, and also that fertility decisions are difficult to make and require a substantive consideration. Additionally, if a couple decides to have another child, that child will be born at least nine months later, and usually significantly later. So this assumption of our model can be interpreted as the following: if a change in a specific factor makes families more willing or able to have more children, then these children will be born on average two years later—maybe some of them earlier, but others later than that. However, we do not use lags in the case of the change in MAB, because the change in the mean age of mothers at childbirth automatically affects TFR, and not by changing families' incentives.

Different specifications of the following equation are used to estimate our models:

$$\Delta TFR_{i,t} = \alpha_i + \beta_1 \cdot \Delta MABchange_{i,t} + \underline{\beta} \cdot \Delta \underline{X}_{i,t-2} + u_{i,t} \quad (1)$$

where i is the index of countries, and t refers to time. *TFR* on the left-hand-side is the total fertility rate, while *MABchange* is the percentage change of the mean age of women at childbirth. Furthermore, X is the vector of the potential influential factors described in the previous section. Country-level fixed-effects are also included. Standard errors are corrected for country clustering.

A prominent issue addressed in this paper is whether there is heterogeneity in the effects of the potential influential factors between the two country groups, i.e., the 11 CEE countries and the rest of the EU. Instead of including interaction terms of the X variables and a CEE dummy variable in the regression models, all X variables were split into two other variables using the following technique:

- $X_{CEE,i} = X_i$ if the country belongs to the CEE group, and 0 otherwise;
- $X_{non-CEE,i} = X_i$ if the country belongs to the non-CEE group, and 0 otherwise.

So, practically, the X variables have been interacted with two dummy variables, a CEE dummy and a non-CEE dummy, and all these interactions are presented in the model. Thus, the $X_{CEE,i}$ and $X_{non-CEE,i}$ variables are included in the regressions, and this allows us to have interpretations that are more adequate from the point of view of our hypotheses.[4]

Three specifications of the model described by Eq. (1) were applied with different right-hand-side variables and different time frames:

- Specification 1: The time frame is 1990–2021, and all the right-hand-side variables are included without country grouping, so that the aggregate effects of the potential influential factors are measured.
- Specification 2: The time frame is also 1990–2021, and all the right-hand-side variables are included with country grouping (i.e., CEE and non-CEE interactions) so that the potential heterogeneity behind the aggregate effects is meas-

[4] A similar solution was used to the MAB change variable as well.

ured. This specification tries to capture whether there are differences in the effect of the potentially influential factors across the CEE and non-CEE countries.
- Specification 3: A set of potential influential factors is only available for a shorter time period, so in this specification, the time frame is 2000–2021, but a wider set of right-hand-side variables is used.

Thus, Specifications 1 and 2 use the same sample, while Specification 3 is executed on a smaller sample (narrower time frame), but with more right-hand-side variables. The main descriptive statistics of the variables have been presented above in Table 1. Due to data limitations (i.e., missing values in the time series) the panels are not balanced, the number of observations (country-years) are 534 in Specifications 1 and 2, and 381 in Specification 3.

Results

Specifications 1 and 2

The panel regression results (based on Eq. (1)) of Specifications 1 and 2 are shown in Table 2. As discussed above, the difference between them lies in the use of country groupings. Specification 1 can be seen as the baseline model, assuming homogenous effects of the potential influentials for both country groups (i.e., CEE and non-CEE countries) in the sample. Specification 2, on the other hand, accounts for the potential heterogeneity of the effects between the CEE countries and the rest of the EU members.

It is evident at first sight that the baseline model (Specification 1) yields relatively weak results. One of the two main conclusions that can be drawn from the data is that the general economic situation has a significant effect on fertility rates when all EU countries are considered as a homogeneous group. This result is demonstrated by both the statistically significant, positive coefficient of the growth rate of per capita GDP and the also statistically significant, negative coefficient of the unemployment rate. These results are in line with the findings of Szabó-Morvay et al. (2019) and Wesolowski and Ferrarini (2018). Therefore, a better economic situation increases the willingness and ability of families to raise children. The negative coefficient of the old-age dependency ratio is statistically significant as well. This result is also consistent with that of Szabó-Morvai et al. (2019), and its possible explanation is that a larger proportion of elderly individuals necessitates the allocation of greater resources, including time, financial capital, and other resources, towards their support. Consequently, both the individuals and the society as a whole may have limited resources available for childbearing and childrearing. All the other (demographic, social, economic, or labour market) variables were found to be statistically insignificant in this model.

However, allowing for heterogeneity between non-CEE and CEE countries (Specification 2) yields different results. The influence of several variables on the TFR is not homogeneous in the two country groups. The following paragraphs present a detailed discussion of the model's findings.

Table 2 Regression results—specifications 1 and 2

	Specification 1	Specification 2	
Variables	Dependent variable: Δ TFR	Dependent variable: Δ TFR	
Δ MAB growth rate	−0.0894 (0.2363)	Non-CEE	−0.0725 (0.2540)
		CEE	−0.3512 (0.9897)
Δ old-age dependency ratio	−0.0173* (0.0091)	Non-CEE	−0.0287*** (0.0091)
		CEE	0.0078 (0.0204)
Δ life expectancy	−0.0008 (0.0078)	Non-CEE	0.0205** (0.0075)
		CEE	−0.0240* (0.0129)
Δ crude marriage rate	0.0087 (0.0062)	Non-CEE	0.0024 (0.0032)
		CEE	0.0294*** (0.0098)
Δ proportion of live births outside marriage	0.0020 (0.0029)	Non-CEE	0.0018 (0.0032)
		CEE	0.0062 (0.0044)
Δ GDP growth rate	0.0013* (0.0007)	Non-CEE	0.0006 (0.0009)
		CEE	0.0016 (0.0011)
Δ inflation rate	−0.0002 (0.0003)	Non-CEE	−0.0023 (0.0017)
		CEE	−0.0002 (0.0002)
Δ unemployment rate	−0.0057*** (0.0017)	Non-CEE	−0.0059*** (0.0018)
		CEE	−0.0028 (0.0037)
Δ relative labour force participation rate of women	−0.0100 (0.2042)	Non-CEE	−0.1771 (0.1993)
		CEE	0.2905 (0.3923)
Δ part-time employment rate of women 25–49 years old	0.0010 (0.0017)	Non-CEE	0.0019 (0.0016)
		CEE	−0.0008 (0.0053)
Δ tertiary educational attainment	0.0012 (0.0009)	Non-CEE	0.0000 (0.0012)
		CEE	0.0024 (0.0015)
Constant	0.0065 (0.0060)		0.0040 (0.0063)
Observations	534		534
R-squared	0.0865		0.1399

Regression results are estimated by Eq. (1). Clustered standard errors are presented in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

The list of variables in Table 2 begins with five demographic and social variables. The estimated coefficient of the growth rate of MAB is found to be statistically insignificant in both country groups. The interpretation of the lack of significance is that although a change in the growth rate of MAB has an impact on TFR (see Sect. "The commonalities of fertility patterns in the CEE countries" above), the former is not an independent driver of the latter, instead the social and economic factors that affect fertility decisions influence both MAB and TFR.

The old-age dependency ratio is estimated to have a negative coefficient in non-CEE countries, whereas life expectancy at birth is found to have a strong positive effect on the TFR in Western Europe. At first glance, the fertility-enhancing effect of longevity may seem somewhat contradictory, since higher life expectancy is typically accompanied by population ageing, i.e., an increasing share of elderly people within the society. However, life expectancy at birth measures the general health status of people. It is evident that a higher level of health status will lead to an increase in fertility, both directly and indirectly, through an improvement in welfare and greater resources available for raising children. In contrast, the old-age dependency ratio is found to be insignificant in the CEE countries, while the estimated coefficient of life expectancy at birth is significant but negative. This suggests that the increase in life expectancy may also exert a detrimental impact on fertility if the longer expected lifespan prompts individuals to delay childbearing, but either specific social factors (e.g., increased number of divorces), or the lack of adequately developed health services hamper the realization of these postponed intentions.

Two further demographic and social variables have been incorporated into our models: the crude marriage rate and the proportion of live births outside marriage. The two variables measure two different social aspects of having children. The crude marriage rate captures the intentions of individuals to formally start a family (although, having children is naturally not the only possible reason to get married). The proportion of live births outside marriage, on the other hand, provides insight into the social acceptability of having children without living in a legally formalized family structure. It is worth mentioning that these two variables are not entirely independent of one another, as a higher marriage rate typically correlates with a decline in the proportion of children born out of wedlock. However, if a higher marriage rate is accompanied by a higher frequency of divorces, it does not necessarily imply a larger proportion of people living (therefore, a larger proportion of children born) in marriage. Both of these variables are found to be statistically insignificant in the non-CEE country group, while only the crude marriage rate has a significant (positive) effect on TFR in Central and Eastern Europe. This indicates that—although more liberal norms may have also become socially acceptable in the region—the traditional values (e.g., the importance of families) still exert a strong influence on child-bearing decisions.

The next three variables in Table 2 try to capture different aspects of the general economic situation: the growth rate of per capita GDP, inflation rate, and unemployment rate. The results regarding these variables are different from those observed in Specification 1. Firstly, whereas in the baseline model, GDP growth was identified as one of the only three statistically significant variables, it is found to be insignificant in Specification 2 for both country groups. Secondly, the significant negative

impact of unemployment on fertility is found to be valid only for non-CEE countries. Regarding the third variable, Spéder (2019) posits that inflation rate seems to be the most important general economic factor affecting the TFR in Central and Eastern Europe, however, its variable is statistically insignificant in both country groups. This finding is in contrast with the results of our Specification 3 (discussed subsequently), which reinforce those of Spéder (2019) as well.

It is also worth noting that the labour market indicators we included in our models (apart from the previously discussed unemployment rate) all have statistically insignificant coefficients in both specifications as opposed to the papers of Wesolowski and Ferrarini (2018) and Jemna and David (2022). Naturally, the statistical insignificance of the coefficients does not necessarily mean that labour market conditions are irrelevant to fertility decisions, instead it may show that the effects of labour market indicators are already captured by other explanatory variables (either by the demographic and social variables or economic factors). Finally, tertiary educational attainment was also found statistically insignificant.

Specification 3

As discussed in Sect. "Results", we have also run a third regression (Specification 3), because we were interested in the potential effects of some other variables that were available only for a shorter time period (2000–2021 instead of 1990–2021). The results of this model are shown in Table 3.

The partial change in variables and the shorter time period naturally mean that the results regarding the variables included in all our specifications are also somewhat affected. For the non-CEE countries, the effects of demographic variables are very similar to what we saw in Specification 2: the old-age dependency ratio has a significant negative and life expectancy has a significant positive estimated coefficient. On the other hand, both life expectancy and old-age dependency ratio are found to be statistically insignificant in the CEE countries. Similar to Specification 2, the effect of the crude marriage rate is significantly positive only in the CEE countries, while the proportion of live births outside marriage is insignificant in both country groups.

An important difference compared to Specifications 1 and 2 lies in the variables characterising the economic situation. The results demonstrate that these variables are strong determinants of fertility trends in Central and Eastern Europe, while their effect is insignificant in the non-CEE countries. Firstly, the economic sentiment indicator (ESI), as calculated by the European Commission, has a significant and positive effect on the change in TFR in the CEE countries, thereby confirming the claims of Frejka (2008), Billingsley (2010) and Sobotka, Skirbekk and Philipov (2011). This indicator is based on business and consumer surveys and provides a general picture of how people assess the economic situation. Although it is not an objective measure of some aspect of the economy, such a sentiment indicator mirrors the economic situation. In a general sense, if the economy performs better, most of the respondents of such surveys will also perceive an improvement in their situation and market environment. A better economic situation can directly

increase fertility rates by providing individuals with greater resources, which may make them more able and willing to have children. However, an indirect effect may also be observed, which reinforces this direct effect: a favourable current economic situation may encourage people to adopt a more optimistic outlook regarding their future opportunities. This is naturally also very important since having children is an irreversible long-lasting investment (de la Croix & Pommeret, 2021), therefore, potential parents have to take into account not just their current ability to bear the costs of raising children, but also their future ability to do so.

A further economic variable newly included in our model is the harmonised index of consumer prices for food and non-alcoholic beverages. This measure is employed because it is one of the most direct ways in which people can feel the changes in their personal economic circumstances. If food prices increase significantly (as occurred in Europe in 2022, especially in Hungary), then people quickly and directly realise a reduction in their real income (or more generally: the purchasing power of their assets). It can therefore be anticipated that a higher inflation rate for food products leads to lower ability and willingness to have children. As evidenced in Table 3, the estimated coefficient for the non-CEE countries is insignificant, while it is negative and statistically significant in the case of the CEE countries.[5]

We have also assumed that construction costs may be another important factor affecting fertility rates (which is not generally investigated in the relevant literature), because having a home to live is an elementary prerequisite for starting a family and having children. Similarly to the previous two variables, the construction cost index is also found to be significant only in the case of Central and Eastern Europe: higher construction costs make it more challenging for people to start a family, and therefore decrease fertility rates.

The heterogeneity in the effects of these economic variables (ESI, food inflation rate, and construction cost index) means that people in the CEE countries react more strongly to changing economic situations, manifesting in altered child-bearing intentions. In other words, our results suggest that economic stability or uncertainty is an important explanatory variable for the movements in the TFR only in the CEE countries.

The labour market variables in Specification 3 (including the unemployment rate as well) are found to be statistically insignificant in both the CEE and non-CEE country groups. Regarding higher education, a different variable is employed in Specification 3 compared to Specifications 1 and 2. Instead of educational attainment, we have included higher educational enrolment into our model, as this is a more direct measure of the expansion of higher education, whose effects on fertility were found to be negative in the literature (see for example Sobotka et al., 2011; Spéder, 2019). However, our findings suggest that the expansion of higher education in the CEE countries had a positive effect on fertility rates contrary to the general

[5] It is also worth mentioning that food prices tend to have a higher rate of increase in Central and Eastern Europe than in the Western part of the continent. In the period between 1999 and 2022 (for which annual food inflation rates are available for all 27 member states in the Eurostat 2023 database), the unweighted average of the 11 CEE countries was higher than the unweighted average of the other 16 EU member states in 19 out of the 24 years. The difference was extraordinarily high in 2022: 19.2% compared to 10.3%.

Table 3 Regression results—specification 3

Variables	Specification 3	
	Dependent variable: Δ TFR	
Δ MAB growth rate	Non-CEE	−0.4367 (0.6658)
	CEE	0.5090 (0.5661)
Δ old-age dependency ratio	Non-CEE	−0.0365*** (0.0105)
	CEE	0.0156 (0.0158)
Δ life expectancy	Non-CEE	0.0176** (0.0082)
	CEE	−0.0112 (0.0132)
Δ crude marriage rate	Non-CEE	0.0170 (0.0116)
	CEE	0.0301** (0.0129)
Δ proportion of live births outside marriage	Non-CEE	0.0051 (0.0036)
	CEE	0.0041 (0.0040)
Δ economic sentiment indicator	Non-CEE	−0.0003 (0.0003)
	CEE	0.0017*** (0.0005)
Δ food inflation rate	Non-CEE	0.0002 (0.0009)
	CEE	−0.0012** (0.0005)
Δ construction cost index	Non-CEE	0.0003 (0.0008)
	CEE	−0.0033*** (0.0011)
Δ unemployment rate	Non-CEE	−0.0019 (0.0018)
	CEE	−0.0051 (0.0037)
Δ relative labour force participation rate of women	Non-CEE	−0.2865 (0.2927)
	CEE	−0.0258 (0.4516)
Δ part-time employment rate of women 25–49 years old	non-CEE	0.0022 (0.0026)
	CEE	−0.0033 (0.0040)
Δ tertiary educational enrolment	Non-CEE	0.0017 (0.0027)
	CEE	0.0056** (0.0026)
Δ government expenditures on families and children	Non-CEE	−0.0224 (0.0194)
	CEE	0.0303 (0.0242)
Δ family allowances	Non-CEE	0.4803 (2.4976)
	CEE	−1.3130 (0.7819)
Δ tax rate difference	Non-CEE	0.6667 (0.5671)
	CEE	0.2857 (0.5714)
Constant		0.0059 (0.0063)
Observations		381
R-squared		0.2212

Regression results are estimated by Eq. (1). Clustered standard errors are presented in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

view in the literature, because a higher level of qualification is associated with significantly higher living standards on average, which increases the ability of families to have more children. The significant positive coefficient also suggests that the direct effect (that university students only rarely have children during their studies)

is more than compensated for by the higher willingness and ability of university graduates to raise more children later. A similar effect is not observed in the non-CEE countries, as the higher education expansion had already taken place earlier in most of these countries than in Central and Eastern Europe.[6]

Finally, we also aimed to ascertain whether family-related government policies have an effect on the TFR. Therefore, our model incorporates three policy variables: government expenditures on families and children as a percentage of GDP, family allowances as a ratio of gross earnings of families with two children if both members of the couple earn the national average, and a measure of tax allowances for children, namely, the difference between the tax burden of couples with no and with two children, if both members of the couple earn the national average. The coefficients of all three family-related policy variables are statistically insignificant in both country groups (in line with Szabó-Morvai et al., 2019), which implies that other social and economic factors exert a greater influence on child-bearing decisions.

As a robustness check, we have rerun the empirical analysis with the omission of the years 2020 and 2021 from our original sample period, as trends in fertility and its determinants may have been significantly impacted by the COVID-19 pandemic. The results of Specifications 1 and 2 are virtually unaffected by the omission of these two years. In the case of Specification 3, the main results also remain intact: the previously significant beta coefficients did not change their sign, although as the omission of two years decreases the number of observations in the already relatively short sample further, some of them lose their significance.

Conclusions

In this paper, we have conducted a panel analysis of the main (economic and social) determinants of the total fertility rate. In addition to presenting the general European situation, we have particularly focused on the Central and Eastern European region and analysed the main factors that can explain the significantly different picture in CEE countries with regard to the evolution of the TFR in the last few decades.

Our results indicate that there are indeed differences in the determinants of the TFR in Central and Eastern Europe compared to non-CEE members of the EU. Attitudes toward marriage (measured by the crude marriage rate) are more important in the CEE countries, while the general health status of the population (measured by life expectancy) and the ageing of the population (measured by the old-age dependency ratio) have a stronger impact on TFR in Western Europe. A key result of our analysis is that CEE countries seem to be significantly more sensitive to changes

[6] Also, the earning advantage of university graduates compared to those having only a secondary educational attainment tends to be somewhat higher in Central and Eastern Europe than in most Western European countries. The Eurostat (2023) database contains data for the mean net income by educational attainment, from which we can calculate the mean net income of those who have a higher education degree as a percentage of the mean net income of those who have only secondary qualification. In the period between 2010 and 2022 (for which the data are available for all 27 EU member states) the unweighted average of CEE countries was 149.0%, while the unweighted average of non-CEE countries was 133.7%.

in the economic situation. We observed this phenomenon in the case of all three economic variables used in Specification 3: the economic sentiment indicator, the inflation rate of food products, and the construction cost index. We believe that this finding is important as the economies of CEE countries tend to be more volatile and vulnerable than the more developed economies of Western Europe. The finding that the average willingness to childbearing is especially sensitive to the economic situation in the region may also be relevant for policymakers when designing family policies.

Our future research plans include the investigation of the fertility trend of the CEE countries over a longer time period after the COVID-19 pandemic. Also, we would try to incorporate a more detailed analysis of the possible effects of separate family policy elements on fertility. We expect the general findings to remain valid in this more detailed analysis. Additionally, we plan to explore the correlation of the tempo-adjusted TFR indicator (Human Fertility Database, 2023) with other factors in the case of those European countries where the data are available.

Appendix

See Fig. 2.

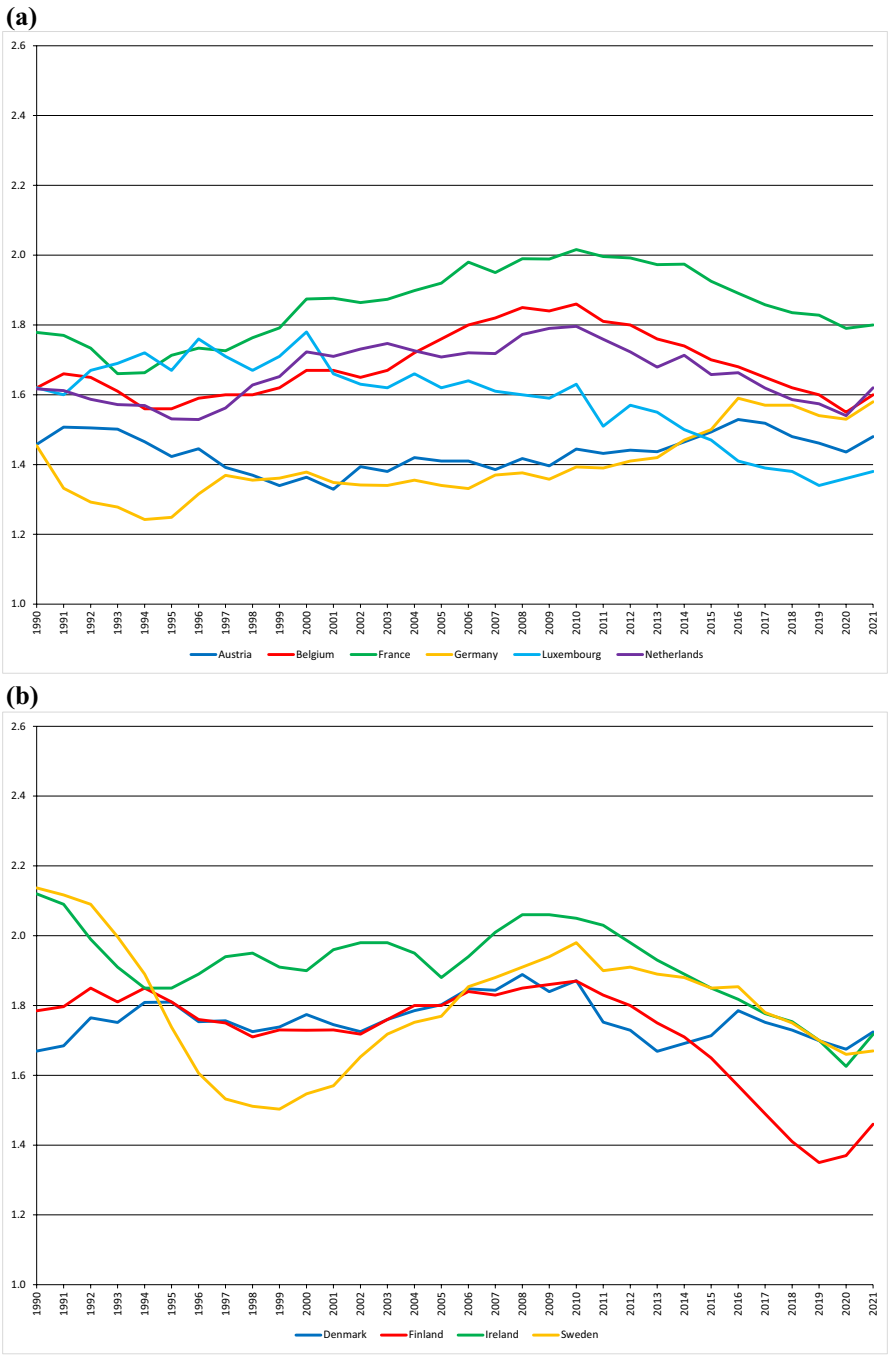

Fig. 2 Total fertility rates in Western (panel a), Northern (panel b), and Southern European (panel c) countries, 1990–2021. *Source*: Authors' graph based on the OECD Family Database, SF2.1 Fertility rates (2023). (Excel)

(c)

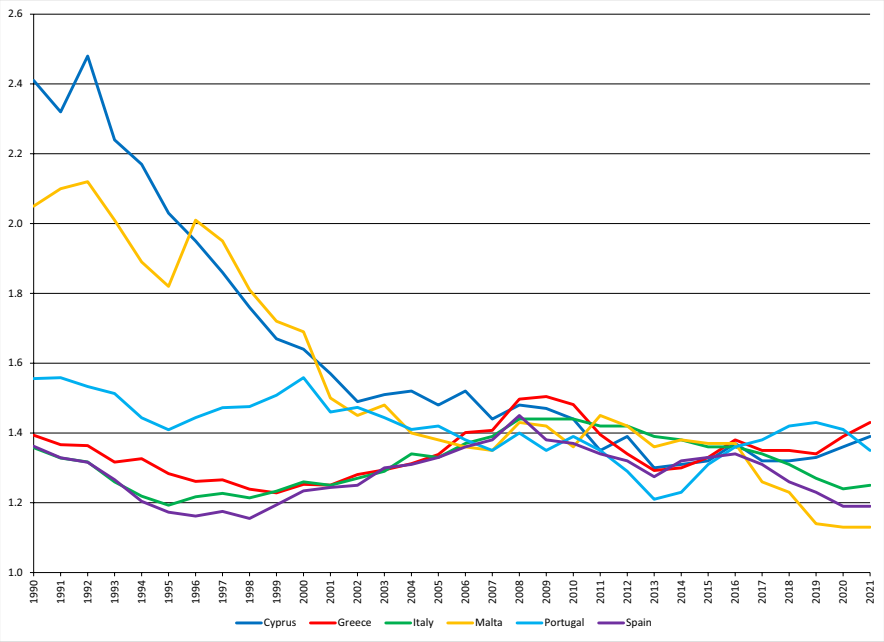

Fig. 2 (continued)

See Table 4.

Table 4 Trends in the TFR of CEE countries

CEE countries	TFR in 1990	MAB in 1990	Minimum TFR values around 2000		Maximum TFR values around the financial crisis		Minimum TFR values after the financial crisis		TFR in 2021	MAB in 2021
			year	value	year	value	year	value		
Bulgaria	1.82	23.9	1997	1.09	2009	1.66	2013	1.48	1.58	27.9
Croatia	1.67	26	1999	1.38	2009	1.58	2011	1.48	1.58	30.7
Czechia	1.9	24.8	1999	1.13	2009	1.51	2011	1.43	1.83	30.4
Estonia	2.05	25.6	1998	1.28	2010	1.72	2013	1.52	1.61	31
Latvia	2	25.7	1998	1.1	2008	1.58	2011	1.33	1.57	30.2
Lithuania	2.03	25.9	2002	1.23	2009	1.5	2013	1.59	1.36	30.4
Hungary	1.87	25.6	2003	1.27	2008	1.35	2011	1.23	1.59	30
Poland	2.06	26.2	2003	1.22	2011	1.41	2013	1.29	1.33	29.9
Romania	1.83	25.5	2002	1.27	2009	1.66	2013	1.46	1.81	28.2
Slovakia	2.09	25.1	2002	1.19	2011	1.45	2012	1.34	1.63	28.9
Slovenia	1.46	25.9	2003	1.2	2010	1.57	2013	1.55	1.64	30.5
CEE average	1.89	25.5	–	–	–	–	–	–	1.59	29.8

Eurostat Database (2023), Human Fertility Database (2023), Human Fertility Collection (2023), OECD Family Database (2023)

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Declarations

Conflicts of interest The authors report there are no competing interests (financial or non-financial) to declare.

Human or Animal Rights The authors report the research involves only Human Participants.

Informed consent The authors report that the consent has been informed to all of us.

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