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European Housing Prices Through the Lens of Trends*

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Abstract

We study convergence and club formation of housing prices in European countries using several measures of housing prices. We employ correlations, innovative trend and gap approaches, and cointegration analysis to study the long-term development of housing prices and their reactions to crises. We find that housing prices in European countries do not converge and their development since the creation of the monetary union has differed. The most prominent examples are the differences between Southern European countries heavily affected by the Global Financial Crisis and the rest of the countries. Our analysis reveals several country clubs with similar growth patterns and reaction to crises which do not necessarily follow the traditional division between old and new EU member states. Our findings are in line with the literature, which finds that housing prices in the EU do not converge overall, and housing prices do not co-move in general, but only within smaller subgroups, which may be regionally dispersed.

Keywords: convergence, correlation, cointegration, EU, housing prices, trends

JEL Codes: E31, G01, R31

1. Introduction

Some countries in Europe are experiencing unprecedented housing price growth that did not end even with the onset of the COVID-19 pandemic, while others were severely hit by the Global Financial Crisis (GFC). The question is whether this development will endanger

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future prospects. Housing prices are a component of financial stability monitored by central banks, as well as a real-life problem for many households. Still, some authors assume that housing price development is cointegrated within larger groups of European countries (Euro Area, old member states) and reflect this idea in panel model analysis via dummy variables or subsample analysis. Even though housing prices could be perceived as continuously rising across many countries, our aim is to provide more complex evidence on trends across the sample of European countries in the period from 2000 to 2020, thus basically covering the entire history of the Euro Area (EA). This not only gives us an opportunity to compare development in EA member states versus non-members, but also shows that the use of a single currency has not created groups with homogenous development (EA vs. the rest) within the EU when it comes to housing markets.

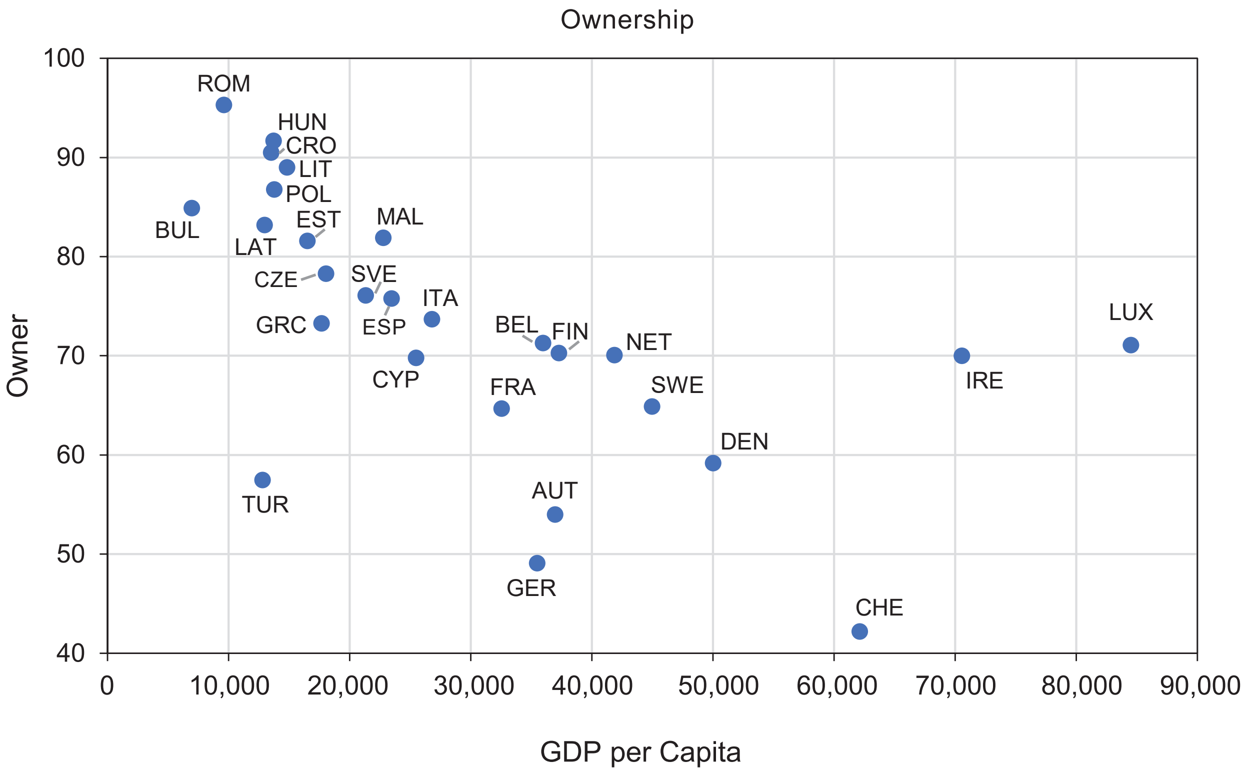
There has been some literature on housing price convergence and partial trends, but deeper analysis of housing price dynamics for European countries that would compare the developments at country level and analyse the differences in relation to crises in these countries is missing. Our paper aims to fill this gap.

Our research reveals similarities across groups of countries and provides evidence that application of principles motivated by technical analysis of housing markets can bring interesting results. We find that our sample of countries can be divided into four groups with respect to housing price trends and reaction to shocks, such as the GFC. These groups do not correspond to traditional divisions. For instance, countries in one group experienced only a slowdown or minor reduction in reaction to the GFC, followed by long, rapid growth of housing prices (Austria, Germany, Norway, Switzerland,), whereas the other group of countries experienced a long and painful correction (Greece, Ireland, the Netherlands, Spain). We find that housing prices in old member states and among EA countries are still not synchronized, and they differ in their reaction to crises. To test the division into the four groups further, we apply Johansen cointegration tests to alternative housing prices measures (real housing prices, price to rent ratio, price to income ratio) that in general confirm our results. Moreover, we analyse cointegration of GDP per capita within our country groups, and we find that this indicator is cointegrated only in one of the four groups. Furthermore, we show that the owner-tenant occupation of dwellings differs significantly in Europe, which may be another reason why the housing prices may not necessarily converge in larger groups.

Our relatively simpler approach enables us to get results similar to those of more sophisticated studies that worked with older data with the following advantages. We receive even more complex results, e.g., compared to cointegration tests. We employ a less demanding technique that may be used in practice by a broader group of users, including investors in real estate who need to analyse markets and diversify risk, academics interested in analyses of housing markets, and policy makers to identify proper policy reaction. It allows us to evaluate different quantitative reactions to crises as well as the course of reaction that varies among older EU states. Nevertheless, we employ cointegration tests to validate our results.

Moreover, it may be used as a cheap early warning system of overheating of housing markets at various levels of aggregation. The identified groups may help investors diversify risk connected with co-movements of house prices among countries, especially when a crisis emerges. We illustrate this with the example of the GFC. The identified groups held during the first wave of the COVID-19 crisis, which is covered in our sample.

Figure 1: Relationship between housing ownership and GDP per capita



Source: authors' calculations

Housing prices have multiple impacts on the population since housing is one of the most essential needs for individuals. Apart from the general trends in movements of the housing prices in the European space, there are also differences in the ownership rates in individual countries. We can see that in Europe, not only do housing prices not converge, but also ownership of dwellings differs significantly. Firstly, the higher the GDP per capita, the lower the share of owner-occupied housing. Secondly, the CEE countries have a significantly higher share of owner-occupied housing and tend to have lower GDP per capita compared with older member states. There are some outliers, namely Ireland and Luxembourg, possibly due to specific tax policies. Given the core differences in the ownership structure in Europe, one might expect this to be one of the various factors contributing to heterogenous development of housing prices in Europe.

Furthermore, contrary to some other studies, we incorporate as many European countries as possible, the only limitation being data availability, since we do not want to start our analysis during the GFC and data for some European states are not available.

The rest of the paper is organized as follows: Section 2 presents a literature review focused on housing prices, their convergence across countries and trends in housing prices with special attention to the situation in the EU. Section 3 describes the data and empirical methodology employed. Section 4 discusses the results of correlation analysis and analysis of trends and gaps. Section 5 concludes.

2 Literature Review

There has been extensive research and discussion on the topic of housing prices, which further intensified after the GFC. European housing prices are driven by both common factors, such as trends in macroeconomic factors due to deepening European integration – monetary integration, adoption of the common currency and to a lesser extent fiscal integration – and country-specific factors (ECB, 2003). Maynou et al. (2021) argued that even if housing is not a tradable good, and therefore arbitrage is not possible, economic and financial integration leads to similar shocks and prices among countries may co-move at least among some smaller groups of countries. Policy integration in Europe and the common currency ensure similar economic conditions among EA members, which helps to reduce differences in housing price development as housing prices are not changing due to differences in policies and exchange rate development. In this sense, Duca (2019) found correlated movements in long-term interest rates and macroeconomic cycles driven by trends in globalization and international portfolio diversification.

There is a broad spectrum of economic factors that may contribute to country-specific development of housing prices. Based on a 200-year-long dataset, Droes and van de Minne (2017) found that the supply-side determinants dominated demand-side factors before 1900 and again after WW2, especially construction costs and new housing supply. However, later demand-side factors dominated and became the core of housing price models. Therefore, some authors have considered various measures of the output of the economy together with labour market conditions, which are represented by the unemployment rate and wages in the economy (see, e.g., Cunha and Lobao, 2021; Maynou et al., 2021; Geng, 2018). Moreover, housing prices are closely related not only to monetary policy but also to financial stability. Therefore, several authors consider credit conditions and macroprudential policy factors on top of interest rates while modelling housing prices (see, e.g., Robstad, 2018; Nocera and Roma, 2018; Hanck and Prüser, 2016). Furthermore, systemic crises, such as the GFC, influence housing prices and should be included in the models (see, e.g., Maynou et al., 2021; Agnello and Schuknecht, 2011).

Some authors have considered macroprudential factors and credit conditions to be determinants of housing prices (see, e.g., Cerutti et al., 2017; Kuttner and Shim, 2016; Kelly et al., 2018; Shi et al., 2014). Cerutti et al. (2017) found that the employment of macroprudential policies may lead to lower credit growth, especially in household credit. Shi et al. (2014) found that controlling for household mortgage choices and other economic conditions may influence the effect of interest rates on housing prices. Specifically, housing prices and credit are sensitive to the setting of macroprudential tools, such as LTV and LTI (Kelly et al., 2018) as well as DSTI ratio and housing-related taxes (Kuttner and Shim, 2016).

For the purpose of this paper, we further focus on reviewing literature on convergence, correlations and trends in housing price development. One strand of this literature has focused on trends in housing price development, with special attention to European countries (Knoll et al., 2017; Eichholtz et al., 2015). Knoll et al. (2017) analysed a time series of housing price indices for 14 advanced economies over the period 1870–2012. They concluded that housing prices in most developed countries were constant in real terms from the 19th to the mid-20th century, but experienced sharp growth in recent decades. Using a dataset for Melbourne and Sydney, Australia, Stapledon (2012) found no significant change in housing prices until the 1950s, but a significant growth trend thereafter. Eichholtz et al. (2015) examined housing prices on a long time series that covers prices along the Herengracht street in Amsterdam, the Netherlands. They analysed whether trends and fundamental factors (income, construction costs, employment, changes in housing stock, etc.) can explain housing prices and whether the explanatory power of such factors varies over time. They showed that agent expectations are driven more by fundamentals during economic slowdowns and more by momentum and recent trends during booms.

Another strand of literature has examined convergence patterns (Clark and Coggin, 2009; Abott and De Vita, 2013; Churchill et al., 2018). Clark and Coggin (2009) studied trends and cycles in regional housing prices in the USA over the period 1975–2005. They presented mixed evidence on regional price convergence. Using principal components factor analysis, they found that eight regional housing price indices can be grouped into two super-regional factors. They found evidence of absolute and relative convergence for some regions in those two factors, in both settings – with and without structural breaks. In the first factor, there is relative convergence for one pair and absolute convergence for two pairs of regions. In the second factor, relative convergence appears for five pairs and absolute convergence for two pairs of regions. Nevertheless, they found no evidence of absolute or relative convergence among these two super-regional factors, either before or after allowing for structural breaks. Abott and De Vita (2013) tested for stochastic convergence in the United Kingdom regional housing market using a pairwise approach. They found no evidence of long-run convergence in regional housing prices. There are only two subgroups of UK regions that display some evidence of partial convergence.

Churchill et al. (2018) examined the convergence pattern of residential housing prices across the capital cities of Australian states. They employed a non-linear model to allow for heterogeneity and transitional dynamics. They found no convergence across states, but they confirmed non-convergence in general, and they identified two sub-convergence groups.

In the European context, a significant portion of convergence research has examined convergence in EU and EA countries (Tsai, 2018; Miles, 2020; Maynou et al., 2021; Alvarez et al., 2010). Some authors have used panel unit root tests to identify convergence. Tsai (2018) presented results of panel root tests indicating that housing prices across EA countries are more correlated than those in non-EA countries. Furthermore, the results suggest that housing prices in various EU countries converged towards Germany's price level rather than the UK's. This indicates that the impact of the single currency on Germany is largely transmitted to other European housing markets. Their convergence test (log *t* regression model) indicates that housing prices in European countries were not converging until 1992 but started to converge afterwards. Miles (2020) added that the adoption of the euro as a common currency was expected to start convergence of various financial and economic variables across the continent, including housing prices. Nevertheless, using a probabilistic pairwise approach, Miles (2020) found only marginal evidence of housing price convergence, and further suggested that euro adoption played no role in this convergence process. Contrary to Tsai (2018), he found that Germany rarely converges with other economies in the block.

Gupta et al. (2015) used fractional integration and cointegration techniques to analyse co-movements of housing prices across eight EA countries over the period 1971–2012. They found that only three countries are significantly cointegrated with EA aggregate, and there is only a limited number of cointegrations across individual countries. Moreover, housing prices in Germany seem to move in the opposite direction compared to other countries. Vansteenkiste and Hiebert (2011) highlighted the relevance of co-movement in house prices across EA countries due to the effects of monetary union. They examined seven EA countries over the period 1971–2009. Their results from the global VAR model suggest limited and heterogenous house price spillover across analysed countries. Ferrara and Koopman (2010) employed an unobserved component model to analyse housing prices fluctuations and business cycles simultaneously. They focused on four EA members (Germany, France, Italy, and Spain) over the period 1981Q1–2008Q4. They found that house price cycles in France and Spain are strongly related, while the cycle in Germany follows its own dynamics. Furthermore, they concluded that GDP and house price cycles are related in the medium term and that the housing market supports long-run economic growth only in Spain and Germany.

Maynou et al. (2021) analysed convergence using a sample of EU countries (both within and outside the EA) over the period 2004Q2–2016Q3. They employed a Bayesian dynamic panel model to determine housing price drivers and dynamics. Their convergence tests identified five “clubs” – Norway and Sweden; Belgium, Finland, France, and Germany; Denmark and the United Kingdom; the Netherlands and Italy; and Ireland and Spain. These clubs reflect similarities among markets in terms of geographical proximity and market structure, but there is no evidence for a difference between EA and non-EA countries. These results indicate that the attempts to converge real economies before and after the formation of the EA have not significantly spread to housing prices.

Alvarez et al. (2010) investigated relationships between GDP cycles and housing cycles in four major EA countries (Germany, Italy, France, and Spain) from 1980Q1 to 2008Q4. They documented a high level of co-movement of GDP cycles (possibly due to trade linkages), but the co-movements of housing prices are substantially weaker. Furthermore, they found that country-specific variables play a major role in the determination of housing prices. They identified strong linkages in the era of the European Monetary Union, both for GDP and residential investment variables, which may be a result of convergence in mortgage interest rates. On the contrary, co-movements in the housing sector remain much weaker for prices than for real variables. Eun et al. (2022) examined synchronization of housing prices in the USA and its connection to the business cycle alignment. They found a large cross-sectional dispersion in the degree of housing price growth synchronization among the states in the USA. They identified a significant upward trend in the synchronization of housing price growth in their sample. This trend development supports the findings of Cotter et al. (2011) and Landier et al. (2017) that housing prices across the USA co-move increasingly over time.

Ciarlone (2015) examined degrees of over- and undervaluation of housing prices in 16 emerging economies in the period 1995–2011. Six of them were from Asia and the rest from Central and Eastern Europe. The degree of housing price over- or undervaluation tends to remain relatively stable, in the interval of ±6% for most countries. There are a few exceptions, closely linked to the crises at the end of millennium (Hong Kong and Singapore). Larger deviations occurred in European countries and in the period before the GFC. Furthermore, changes in fundamentals do not seem to be the main reason for overvaluation of housing prices in CEE countries prior to the GFC. It seems that the housing prices in these countries were driven by overly optimistic expectations. Hejlova et al. (2017) employed four different methods to assess equilibrium property prices in the Czech Republic. Their methods complement each other and provide complex information regarding housing price sustainability assessment. They found that residential property prices in the Czech Republic were overvalued in the periods 2002Q1–2004Q1 and 2007Q3–2009Q2 and undervalued in the periods 2004Q4–2007Q1 and 2010Q3–2013Q2. Their analysis ends in 2014Q2, when housing prices were approximately at the equilibrium.

3 Data and Methodology

3.1 Data

We use the OECD database as a primary data source because it outperforms data available from Eurostat in terms of starting dates. For two non-EU countries, we obtained data from the Bank for International Settlement. We downloaded the housing price index (HPI) that measures the changes of the transaction prices of residential real estate purchased by households. We checked the data for all European countries. In order to analyse long-term patterns, we prefer to maximize the time span at the cost of a smaller sample. Finally, we work with quarterly data from 2000Q1 to 2020Q4. Our sample covers 18 European countries and two aggregate indicators for the OECD countries and for the Euro Area countries (EA17). The old EU member states (Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain and Sweden) represent most of the sample. Other countries with available data include the non-EU countries of Northern Macedonia, Norway, Serbia and Switzerland. We exclude the rest of the EU countries (mostly new member states) because of short time series. In robustness tests we use real housing prices, housing prices to rent, housing prices to income, and GDP per capita data from the OECD database and ownership data from Eurostat.

3.2 Methodology

In this article, we employ pairwise correlation analysis to identify the development of HPIs across countries.

The Pearson correlation coefficient *r* is calculated as follows:

$$r = \frac{n\sum xy - \sum x \sum y}{\sqrt{\left(n\sum x^2 - \left(\sum x\right)^2\right)\left(n\sum y^2 - \left(\sum y\right)^2\right)}} \tag{1}$$

where *x* and *y* are values of variables, and *n* is sample size.

Although correlation analysis can bring interesting information on co-movements of housing prices in general, it does not provide certain much-needed details. Therefore, in the second step, we analyse trends and gaps using HPI data. Specifically, we calculate the one-year moving average (1Y_MA) and the three-year moving average (3Y_MA), both as arithmetic means.

$$1Y\_MA = \frac{A_1 + A_2 + A_3 + A_4}{4} \tag{2}$$

$$3Y\_MA = \frac{A_1 + A_2 + \ldots + A_{12}}{12} \tag{3}$$

The moving averages and their crossing can indicate buy/sell signals and can bring interesting information. Therefore, we calculate the gap in percent as follows:

$$Gap\,in\ \% = \frac{1Y\_MA - 3Y\_MA}{3Y\_MA} \times 100 \tag{4}$$

The motivation for this approach comes from the technical analysis often employed to analyse stock market development. We apply this methodology to identify whether price growth will continue or whether we should expect a correction. We can expect a correction if 1Y_MA crosses 3Y_MA from above. Conversely, we can identify a buying signal for investors if 1Y_MA crosses 3Y_MA from below. This approach allows us to compare not only the trends, but also the size of the gaps across countries. Moreover, we search for any pattern, such as the size of the gap, which may serve as an early warning signal of future decrease in housing prices.

Johansen cointegration test

To formally test validity of the created country groups, we employ cointegration tests using the *vecrank* command in Stata. These tests are based on the Johansen cointegration method. We test whether the log likelihood of the unconstrained model, including the cointegrating equations, significantly differs from the log likelihood of the constrained model without the cointegrating equations. To confirm long-term association among housing prices in the group of countries, we have to reject the null hypothesis (StataCorp, 2021).

The Johansen cointegration test is based on vector autoregression of the order p given by Equation (5).

$$y_t = \mu + A_1 y_{t-1} + \ldots + A_p y_{t-p} + \varepsilon_t \, . \tag{5}$$

where y_t denotes the $n \times 1$ vector of variables that are integrated of order one, commonly denoted as I(1), and ε_t is the $n \times 1$ vector of innovations. The vector autoregression (VAR) model can be re-written as in Equation (6).

$$\Delta y_t = \mu + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \varepsilon_t \tag{6}$$

where $\Pi = \sum_{i=1}^{p} A_i - I$ and $\Gamma_i = -\sum_{j=i+1}^{p} A_j$.

If the matrix Π has a reduced rank $r<n$, the nrx matrices α and β exist, each with the rank r such that Π is equal to $\alpha\beta'$ and $\beta y'$ is stationary. In this framework, r is the number of cointegrating relationships, the α elements are the adjustment parameters in the vector error correction model, and β denotes the cointegrating vector. For a given r, the maximum likelihood estimator of β defines the combination of y_{t-1} yielding the r largest canonical correlations of Δy_t with y_{t-1} after correction for lagged differences and deterministic variables when present (Johansen, 1995).

Multivariate GARCH models

We use the *dvech* Stata command[2] to estimate the parameters of multivariate generalized autoregressive conditional-heteroskedasticity (GARCH) models to assess the dynamic correlations. We take inspiration from Syllignakis and Kouretas (2011), who performed this method to assess the problem of time-varying conditional correlations to the weekly stock market index returns in CEE countries. These models allow the conditional covariance matrix of the dependent variables to follow a flexible dynamic structure and estimate the parameters of diagonal *vech* GARCH models, in which each element of the current conditional covariance matrix of the dependent variables depends only on their own lagged values and on past shocks (StataCorp, 2021).

2 Alternatively, the *mgarch* command can be used.

As proposed by Engle (2002), the GARCH model can be written as

$$y_t = Cx_t + \varepsilon_t$$

$$\varepsilon_t = H_t^{1/2} v_t$$

$$H_t = D_t^{1/2} R_t D_t^{1/2}$$

$$R_t = diag\left(Q_t\right)^{-1/2} Q_t diag\left(Q_t\right)^{-1/2}$$

$$Q_t = \left(1 - \lambda_1 - \lambda_2\right) R + \lambda_1 \tilde{\varepsilon}_{t-1} \tilde{\varepsilon}_{t-1}^{'} + \lambda_2 Q_{t-1} \quad (7)$$

where y_t is an m × 1 vector of dependent variables; C is an m × k matrix of parameters; x_t is a k × 1 vector of independent variables, which may contain lags of y_t; $H_t^{1/2}$ is the Cholesky factor of the time-varying conditional covariance matrix H_t; v_t is an m × 1 vector of normal, independent and identically distributed innovations; and D_t is a diagonal matrix of conditional variances. R_t is a matrix of conditional quasicorrelation, $\tilde{\varepsilon}_t$ is an m × 1 vector of standardized residuals, $D_t^{-1/2}\,\tilde{\varepsilon}_t$; and λ1 and λ2 are parameters that drive the dynamics of conditional quasicorrelations. λ1 and λ2 are nonnegative and satisfy 0 ≤ λ1 + λ2 < 1. When Q_t is stationary, the R matrix in is a weighted average of the unconditional covariance matrix of the standardized residuals $\tilde{\varepsilon}_t$, denoted by $\bar{R}$, and the unconditional mean of Q_t, denoted by $\bar{Q}$.

4 Results and Discussion

In this section we introduce and discuss our results. First, we focus on simple correlation of housing prices, and then we discuss housing price dynamics using analysis of trends and gaps, including identification of similarities across groups of countries.

4.1 Correlations across countries

Table A1 in the Appendix presents our initial correlation analysis of 18 European countries. As expected, we find high correlations among countries that were severely hit by the GFC and the consequent banking and debt crises (Greece, Italy, Spain, and Ireland). The correlation of their housing price development with other countries is relatively low. On the other hand, correlations across EA countries are weaker than expected, as can be seen in Table 1, which shows the five strongest correlations of each country with its counterparts. This supports findings in previous literature that the creation of the Eurozone and the common currency has thus far not led towards synchronization and/or convergence (Maynou et al., 2021; Miles, 2020). In most cases, we find Euro Area non-members and countries entirely outside the EU among the five closest correlates of Euro Area members. Quite surprisingly, Serbia serves as the most prominent case, with very strong correlations with Belgium, Finland, Sweden, Norway, and Switzerland. Looking at the five highest correlations with the EA17 average, three out of the five countries with highest correlations are not in the Eurozone, and the United Kingdom is not currently even a member of the EU. On the other hand, we find several negative correlations.

Table 1: Five highest correlations of nominal housing prices for each country

AUT	CHE	0.9713	NOR	0.9666	SWE	0.9641	DEU	0.9505	BEL	0.8888
BEL	FIN	0.9863	SER	0.9700	NOR	0.9656	SWE	0.9641	CHE	0.9612
DNK	GBR	0.9617	BEL	0.9187	FRA	0.9143	SWE	0.9043	FIN	0.8758
FIN	BEL	0.9863	SER	0.9639	FRA	0.9531	NOR	0.9445	CHE	0.9379
FRA	FIN	0.9531	BEL	0.9508	DNK	0.9143	GBR	0.8988	SER	0.8944
DEU	AUT	0.9505	SWE	0.8769	CHE	0.8604	NOR	0.8547	GBR	0.7928
GRC	ITA	0.7848	ESP	0.7154	IRL	0.4806	NLD	0.2232	FRA	0.2141
IRL	ESP	0.7397	NLD	0.6827	PRT	0.5844	DNK	0.5507	GRC	0.4806
ITA	ESP	0.8701	GRC	0.7848	FRA	0.7201	MKD	0.6111	FIN	0.5305
NLD	PRT	0.8548	DNK	0.8392	GBR	0.8007	ESP	0.7474	SWE	0.7384
PRT	NLD	0.8548	DEU	0.8026	AUT	0.6372	DNK	0.6235	GBR	0.6093
ESP	ITA	0.8701	FRA	0.7559	IRL	0.7397	GRC	0.7154	DNK	0.7153
SWE	NOR	0.9885	CHE	0.9793	AUT	0.9641	BEL	0.9600	GBR	0.9592
NOR	CHE	0.9942	AUT	0.9666	BEL	0.9656	SER	0.9501	FIN	0.9445
GBR	DNK	0.9618	SWE	0.9592	BEL	0.9479	NOR	0.9381	CHE	0.9161
SER	BEL	0.9700	FIN	0.9639	SWE	0.9506	NOR	0.9501	CHE	0.9407
MKD	SER	0.9004	FIN	0.8805	BEL	0.8787	FRA	0.8609	CHE	0.7925
CHE	NOR	0.9942	SWE	0.9793	AUT	0.9712	BEL	0.9612	SER	0.9407
EA17	DNK	0.9648	FRA	0.9562	GBR	0.9557	BEL	0.9498	FIN	0.9092
OECD	GBR	0.9781	SWE	0.9691	DNK	0.9485	NOR	0.9420	CHE	0.9308

Source: authors' calculations

Table 2 highlights the examples where housing prices depart the most from the European trend. Greece produces five lowest (even negative) correlations with Austria, Germany, Norway, Switzerland and Sweden. The causes include the GFC, the debt crisis, and the overall unfavourable development in Greece after 2010. In general, housing prices in Greece do not correlate much with those of other countries; the highest correlations are with the southern part of the EU and the EA respectively.

Table 2: Five lowest correlations

DEU	−0.5263	GRC
AUT	−0.4631	GRC
CHE	−0.3260	GRC
NOR	−0.3061	GRC
SWE	−0.2615	GRC

Source: authors' calculations

Our results do not support the rule of thumb that EA countries have the highest correlations with other EA members and non-EA countries with other EA non-members. These preliminary findings could indicate that there are other, substantially more important factors influencing development in the area of housing markets, and that the common currency has not caused housing markets to synchronize even after more than 20 years. Moreover, the old and new EU member countries often experience higher correlations across these groups than within them. To reveal more about dynamic patterns, we continue with an analysis of trends and gaps.

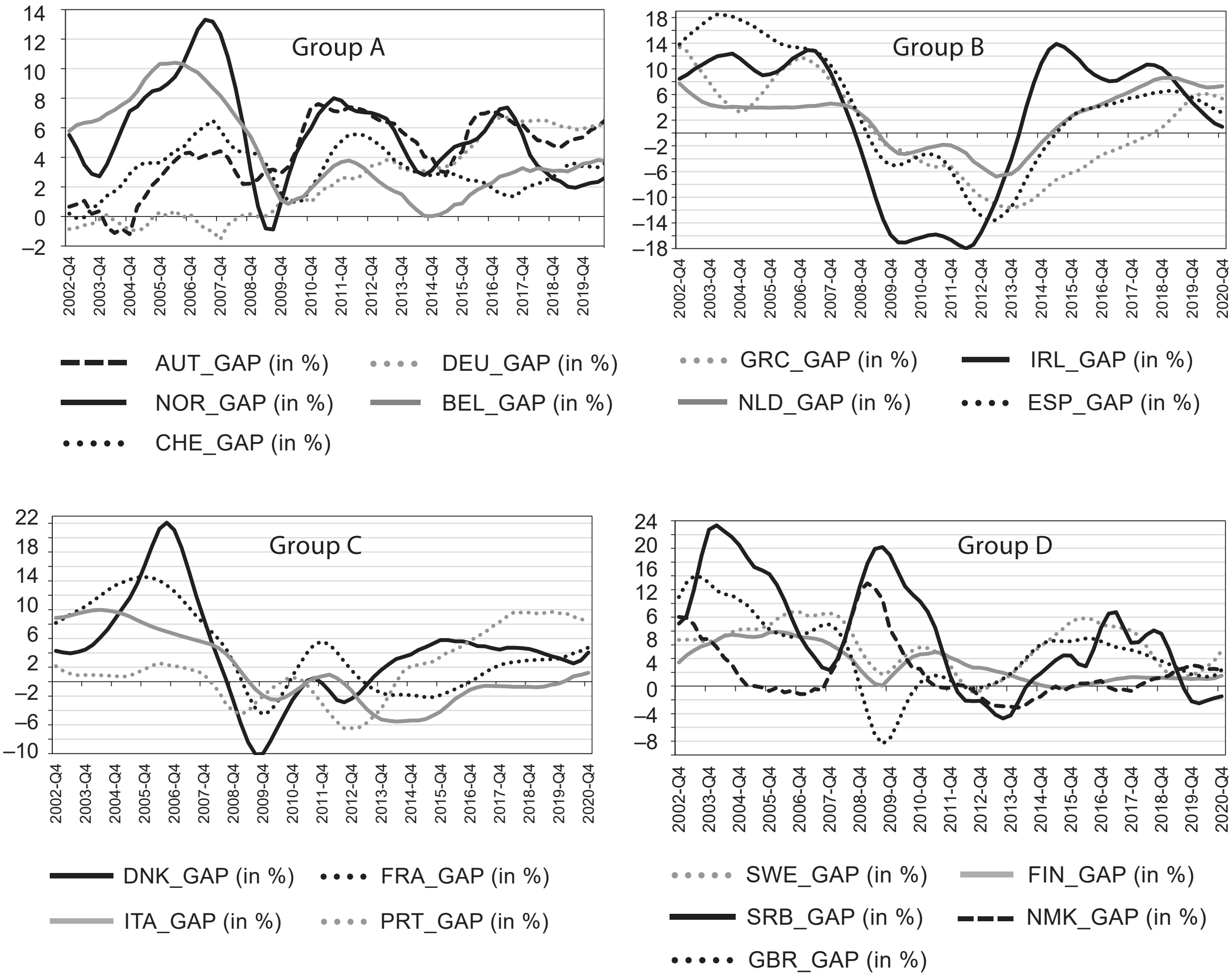
4.2 Trends and gaps

Figure A1 in the Appendix presents the one-year and three-year moving averages jointly with year-on-year growth rates of the housing price index across countries. The analysis of the trend reveals that the analysed countries did not experience similar housing price development over the last eighteen years, even within the EU17 and EA groups. Instead, they can be broadly divided into four groups that follow similar patterns. Firstly, some countries experienced only a small and rather short drop in reaction to the GFC, followed by a long period of fast housing price growth (Austria, Germany, Norway, and Switzerland). Norway experienced a slightly stronger correction, and the situation in Germany fluctuated before the GFC. Another group of countries experienced a long and painful correction of housing prices which began with the GFC (Greece, Ireland, the Netherlands, and Spain). Ireland is the most prominent example in this group, as the year-on-year price decrease reached over 21% after the GFC in the third quarter of 2009 and, after a small correction, registered another fall of almost 20% at the end of 2011. Thirdly, some countries affected by the GFC experienced, after a short recovery and growth of housing prices, a second wave of price decreases in reaction to the second recession in 2012 and to subsequent debt crises that emerged in some of these countries (Belgium, Denmark, Finland, France, Italy, Portugal, Sweden, and the United Kingdom). An interesting example in this group is Italy, which experienced a larger decrease in housing prices during the second wave (–7,11% in 2013Q1) than during the first wave (–4.16% in 2009Q3). Finally, the remaining countries (Serbia and North Macedonia) show an unstable development of housing prices after the GFC. This result points out that, even though the correlations of housing prices in Serbia with some other countries were high, a closer look reveals significant differences.

The moving averages provide some interesting information. We can expect a correction of housing prices if 1Y_MA crosses 3Y_MA from above. Conversely, we may expect boom if 1Y_MA crosses 3Y_MA from below. With this approach, we can compare both trends and the size of the gaps across countries. To highlight the differences, we continue with a graphical analysis of the gaps between the one-year moving average (1Y_MA) and the three-year moving average (3Y_MA) expressed as percentage deviations, i.e., we calculate the gap according to Equation (4) above.

For better visibility, we present the graphs of the gaps. As in the previous analysis, we can identify similar development across a group of countries. We create four groups of countries to illustrate this and present the results in Figure 1, i.e., Group A without a negative gap since at least 2009, Group B with a long negative gap, Group C with two negative gap periods, and Group D for other countries. We may interpret the results so that a positive gap indicates that property prices in the country are overvalued, while a negative gap suggests that the prices are undervalued. In most cases, a significant correction comes only once the gap reaches high values (around 10%); see, e.g., Greece, Ireland, and Spain in Group B, as well as France, Italy and Portugal in Group C. On the other hand, lower positive gaps, indicating a constant growth of housing prices, may last for quite a long time in some countries (see the panel for Group A), or the prices may almost stabilize, as in the case of Finland in Group D. Developing countries such as Serbia and Northern Macedonia may experience higher volatility of the gap, indicating fast housing price growth with only minor corrections.

Figure 2: Groups of countries by nominal housing price dynamics



Source: author's calculations

4.3 Johansen tests for cointegration

To enrich our trend and gap approach and formally test the division of countries into four groups, we employ the Johansen cointegration test, looking for cointegration within the created groups. The results confirm most of the initial findings. We identify cointegration equation for three out of four groups with the exception of Group D; see Tables A2 to A4 in the Appendix and following tables with Johansen cointegration tests results. This is not surprising since Group D was constructed as a residual group of countries that did not fit into any other category. It should be noted that the division into groups reflects not only co-movements in general but also the reaction of housing prices to the GFC and the magnitude of the reactions. Therefore, the proposed trend and gap analysis is more complex compared to the cointegration test and may lead to slightly different results.

In the following step, we test for cointegration between country pairs that come from the same group. The number of significant pairwise cointegrations differs among these groups. Group A contains 3 out of 10 pairwise cointegrations, Group B has 6 out of 6, Group C has 3 out of 6 and the remaining Group D shows 0 out of 10. These results are not that surprising since we knew that Group D was quite heterogenous. Group A is a group of countries with quick and steady recovery from the GFC when taking mainly reaction to the crisis into consideration. Group B consists of severely affected countries and their trends as well as reactions to the GFC are similar. Group C is the middle ground with 3 out of 6 pairwise cointegrations. One might consider merging groups B and C, as the most severely affected countries, but their preliminary reaction to the crisis differs.

To conclude, the Johansen cointegration tests confirm most of our findings with exceptionally strong bonds among the countries severely hit by the GFC belonging to Group B.

4.4 GARCH model

On top of the existing analysis, we employ a GARCH-M(1,1) model to study dynamic correlations among countries in the identified groups of countries. Table 3 summarizes the results for each group and major countries[3].

Table 3: GARCH model estimations

Major country from group	Lagged variables from given group				
Group A, AUT	L1.AUT 0.842***	L1.DEU 0.114**	L1.NOR 0.037	L1.CHE 0.083	L1.BEL 0.019
Group B, ESP	L1.ESP 0.898***	L1.GRC 0.006	L1.IRL 0.141***	L1.NLD −0.077***	
Group C, ITA	L1.ITA 1.081***	L1.FRA −0.100***	L1.DNK −0.003	L1.PRT 0.072***	
Group D, GBR	L1.GBR 0.975***	L1.FIN 0.090***	L1.SWE 0.043***	L1.SERBIA −0.465***	L1.NMAC −0.109***

Source: authors' calculations

3 The full results are extensive and are therefore available upon request.

The GARCH model estimation for the 4 groups yields mixed results. The most significant relationships are proven in Group D, where the United Kingdom is the major country. In Group A, significance was proved only in the case of Austria and Germany, which is not surprising due to their economic similarities as well as geographical proximity. The majority of significant correlations also occur in Groups B and C.

4.5 Robustness tests

To validate the robustness of our results, we perform a trend and gap analysis using three alternative indicators of housing prices, namely real housing prices, housing prices to rent ratio, and housing prices to income ratio. Real housing prices consider the development of price levels, which varies across the countries. The housing prices to rent ratio may serve as an important indicator for investors, who consider further renting of the properties as well as for individuals deciding between renting and owning properties. Moreover, this ratio may serve as an indicator of fair value. Finally, the housing prices to income ratio is closely connected to affordability of housing, especially for domestic buyers. Therefore, the alternative indicators capture somewhat different things than the baseline indicator. All these indicators are expressed in index form and retrieved from the OECD database. As these data are not available for North Macedonia and Serbia, we exclude them from further the analysis.

Due to a large number of outputs, we will focus on a discussion of the gap analysis. Other results are available upon request. In general, our results are robust across different specifications of housing prices with just small deviations in specific cases. The results are visualised in Figures A2 to A4 in the Appendix. The results for real housing prices confirm long and serious declines of housing prices in Group 2 countries (Greece, Ireland, Spain, and the Netherlands) and a double-dip scenario for Group 3 countries (Denmark, France, Italy, and Portugal). The only visible changes compared to the nominal housing price measure are slightly negative gaps in Belgium in the period 2014–2015 and a little lower value of the gap in the GFC period for the remaining Group 4 countries (Finland, the United Kingdom and Sweden). We find similar results for the housing prices to rent ratio. In this specification, we do not find one long drop for Ireland but rather two significant decreases with bottom values of the gap in 2008Q3 at –18.6% and in 2012Q1 at striking –27.2%, which was followed by sharp growth of this indicator up to 14.1% in 2015Q2. As for the housing prices to income ratio, which reflects rather affordability of housing for domestic buyers, we find some differences in the development of gaps for Greece in Group 2 and Italy in Group 3. According to the housing prices to income ratio, Greece went through a double-dip scenario but with a more serious decline of the gap with the bottom at the beginning of 2015, when Greece struggled with the repayment of the IMF loan. In the case of Italy, we do not find significantly negative values of the gap for the GFC period but rather later as a reaction to the debt crisis in Europe.

As in the baseline scenario, we validate our results using cointegration analysis. The results are summarized in Table 4[4].

Table 4: Group cointegrations of selected variables

Group/Variables	Real housing prices	HP to rent	HP to income	GDP per capita
A	Yes	No	Yes	No
B	Yes	Yes	Yes	Yes
C	Yes	Yes	No	No
D	No	Yes	Yes	No

Source: authors' calculations

The results of the Johansen cointegration analysis on alternative housing price measures show that Group B is aligned in terms of all four variables. Given the fact that Group B are mostly countries severely hit by the GFC and debt crisis, this makes sense. The other three groups report group cointegration in two out of three instances. Moreover, the results for real housing prices precisely mirror the results for nominal housing prices. One might argue that cointegration of housing prices might be driven by economic development. Therefore, we also run cointegration analysis for GDP per capita. However, we find that GDP per capita within the country groups is cointegrated only in Group B and might not be the best variable for explaining similar price developments in European country clubs. This might be particularly due to serious differences in ownership based on GDP per capita as discussed in the Introduction.

5. Conclusion

In this paper, we analysed housing price development across selected European countries. We performed a pairwise correlation analysis of housing prices, followed by a GARCH model of conditional correlations, an analysis of trends and gaps, and a cointegration analysis. The correlation analysis shed some light on the basic co-movement of housing prices, whereas the trend and gap analysis provided a deeper understanding of their development.

4 The full results are extensive and are therefore available upon request.

The correlations indicate that housing price development among European countries is not synchronized (correlated), and that housing prices correlate only within certain groups of countries. We may call one of them the "northern group", where countries situated in the north of Europe (the Scandinavian countries, Belgium, and the United Kingdom) show stronger correlations with highly developed Central European countries (Switzerland, Austria and Germany). On the other hand, South European countries heavily affected by the GFC deviate from the rest of Europe and produce relatively smaller within-group correlations. Extraordinary results appeared in the case of Greece, for which 60% of the correlations with other countries in the sample are negative. The most prominent ones are with the "northern group".

The GARCH model estimation for our four groups yielded somewhat mixed results. The most significant relationships are proven in Group D, where the United Kingdom is the major country. In Group A, significance was proved only in the case of Austria and Germany, which is not surprising due to their economic similarities as well as geographical proximity. The majority of significant correlations also occur in Groups B and C. For Group B, it might be somewhat surprising that no statistical significance was proved in the case of Greece, given the composition of the remainder of Group B. In Group C, the Southern European countries report significant coefficients, only Denmark's coefficient is not significant.

However, the GARCH approach might not be the best to describe long-term co-movement and magnitude of the responses. Therefore, after this initial correlation analysis, we further analysed trends and gaps. This allowed us to segment countries into four subgroups with different housing price dynamics. Firstly, some countries experienced only a slowdown or a minor and rather short housing price drop in reaction to the GFC, followed by a long period of fast growth (Austria, Germany, Norway, Switzerland). Secondly, other countries experienced a long and painful correction started by the GFC (Greece, Ireland, the Netherlands, and Spain). Thirdly, some countries affected by the GFC experienced a short recovery and growth, followed by a second wave of price decreases in reaction to the second recession in 2012 and the subsequent debt crises that emerged in some of these countries (Belgium, Denmark, Finland, France, Italy, Portugal, Sweden, and the United Kingdom). Fourthly, the remaining countries (Serbia and North Macedonia) showed an unstable housing price development after the GFC. These subgroups showing similar development are in line with the findings of some previous studies (Ciarlone, 2015; Miles, 2020; Maynou et al., 2021). We confirmed most of the findings based on the trend and gap approach with a subsequent cointegration analysis.

In general, our results are robust to different specifications of housing prices, including real housing prices, price to rent ratio and price to income ratio, with just small deviations in specific cases. Our categorization created subgroups with high similarities in housing price development and its reaction to crises. Furthermore, our results show that housing prices in old EU member states and among EA countries are far from being synchronized, and their reaction to crises may differ significantly. Our results suggest that some countries may experience long-term growth and overvaluation of housing prices (market price vs. fundamental price). Furthermore, only large gaps between one-year and three-year moving averages of housing prices lead to significant corrections and decline. In this sense, one can consider them early warning signals. Our results may be of interest to several user groups, including international investors lacking own analytical capacity to identify national housing markets to invest in, households considering buying or selling real estate, and policy makers. Nevertheless, different development of housing prices and their reaction to crises poses problems when it comes to common monetary policy reactions to booming housing prices in the eurozone. The different needs could make it difficult for the ECB to find one reaction that fits all. This may intensify the role of prudential policies of central banks in individual countries. Independence of central banks in non-EA countries may therefore pose a significant advantage since we see that our identified groups reflect the heterogenous structure of European countries.

Research including all EU countries should follow, but data limitation is a possible concern since time series for most new EU member states begin around the GFC. Future research could focus on examining the effect of the ECB's response on house prices using, for example, the quantitative easing measure of Altavilla et al. (2019).

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Appendix

Table A1: Correlation matrix of housing prices

	AUT	*BEL*	*DNK*	*FIN*	*FRA*	*DEU*	*GRC*	*IRL*	*ITA*	*NLD*	*PRT*	*ESP*	*SWE*	*NOR*	*GBR*	*SERBIA*	*MKD*	*CHE*	*EA17*	*OECD*
AUT	1																			
BEL	0.8888	1																		
DNK	0.8021	0.9186	1																	
FIN	0.8421	0.9863	0.8758	1																
FRA	0.7177	0.9508	0.9143	0.9531	1															
DEU	0.9505	0.7442	0.7223	0.6600	0.5478	1														
GRC	–0.4631	–0.0648	0.0682	–0.0536	0.2141	–0.5263	1													
IRL	0.0953	0.2240	0.5507	0.1344	0.3426	0.1918	0.4806	1												
ITA	0.0452	0.4873	0.5023	0.5305	0.7201	–0.1464	0.7848	0.3954	1											
NLD	0.6592	0.7270	0.8392	0.6263	0.7320	0.6977	0.2232	0.6827	0.4305	1										
PRT	0.6372	0.4727	0.6235	0.3395	0.3754	0.8026	–0.1368	0.5844	-0.0684	0.8548	1									
ESP	0.2321	0.5751	0.7153	0.5512	0.7559	0.1453	0.7154	0.7397	0.8701	0.7474	0.3650	1								
SWE	0.9641	0.9600	0.9043	0.9230	0.8442	0.8769	–0.2615	0.2374	0.2646	0.7384	0.6038	0.4458	1							
NOR	0.9666	0.9656	0.8751	0.9445	0.8473	0.8547	–0.3061	0.1347	0.2584	0.6615	0.5182	0.3830	0.9885	1						
GBR	0.8797	0.9479	0.9618	0.9132	0.8988	0.7928	–0.0863	0.4385	0.4212	0.8007	0.6093	0.6123	0.9592	0.9381	1					
SERBIA	0.8760	0.9700	0.8489	0.9639	0.8944	0.7250	–0.1141	0.1269	0.4457	0.6652	0.4056	0.5141	0.9506	0.9501	0.9101	1				
MKD	0.6831	0.8787	0.6998	0.8805	0.8609	0.4956	0.1383	0.0603	0.6111	0.6202	0.2400	0.5751	0.7864	0.7860	0.7570	0.9004	1			
CHE	0.9712	0.9612	0.8542	0.9379	0.8359	0.8604	–0.3260	0.0948	0.2356	0.6490	0.5129	0.3512	0.9793	0.9942	0.9161	0.9407	0.7925	1		
EA17	0.8018	0.9498	0.9648	0.9092	0.9562	0.7087	0.1391	0.4863	0.5884	0.8842	0.6194	0.7594	0.9061	0.8779	0.9557	0.8988	0.8243	0.8639	1	
OECD	0.9285	0.9312	0.9485	0.8723	0.8483	0.8863	–0.1648	0.4246	0.3026	0.8482	0.7284	0.5437	0.9691	0.9420	0.9781	0.8911	0.7225	0.9308	0.9443	1

Source: authors' calculations

Table A2: Group Johansen cointegration tests of housing prices

Group	**A**	**B**	**C**	**D**
Cointegration	Yes	Yes	Yes	No

Notes: results of Johansen cointegration tests. Significant at 5% level = Yes / No
Source: authors' calculations

Table A3: Pairwise Johansen cointegration tests of housing prices

Group A	AUT	DEU	NOR	CHE	BEL
AUT	-	Yes	No	No	No
DEU		-	No	Yes	Yes
NOR			-	No	No
CHE				-	No
BEL					-

Group B	GRC	IRL	NLD	ESP
GRC	-	Yes	Yes	Yes
IRL		-	Yes	Yes
NLD			-	Yes
ESP				-

Group C	DNK	ITA	FRA	PRT
DNK	-	Yes	Yes	No
ITA		-	Yes	No
FRA			-	No
PRT				-

Group D	SWE	FIN	GBR	SERBIA	NMAC
SWE	-	No	No	No	No
FIN		-	No	No	No
GBR			-	No	No
SERBIA				-	No
NMAC					-

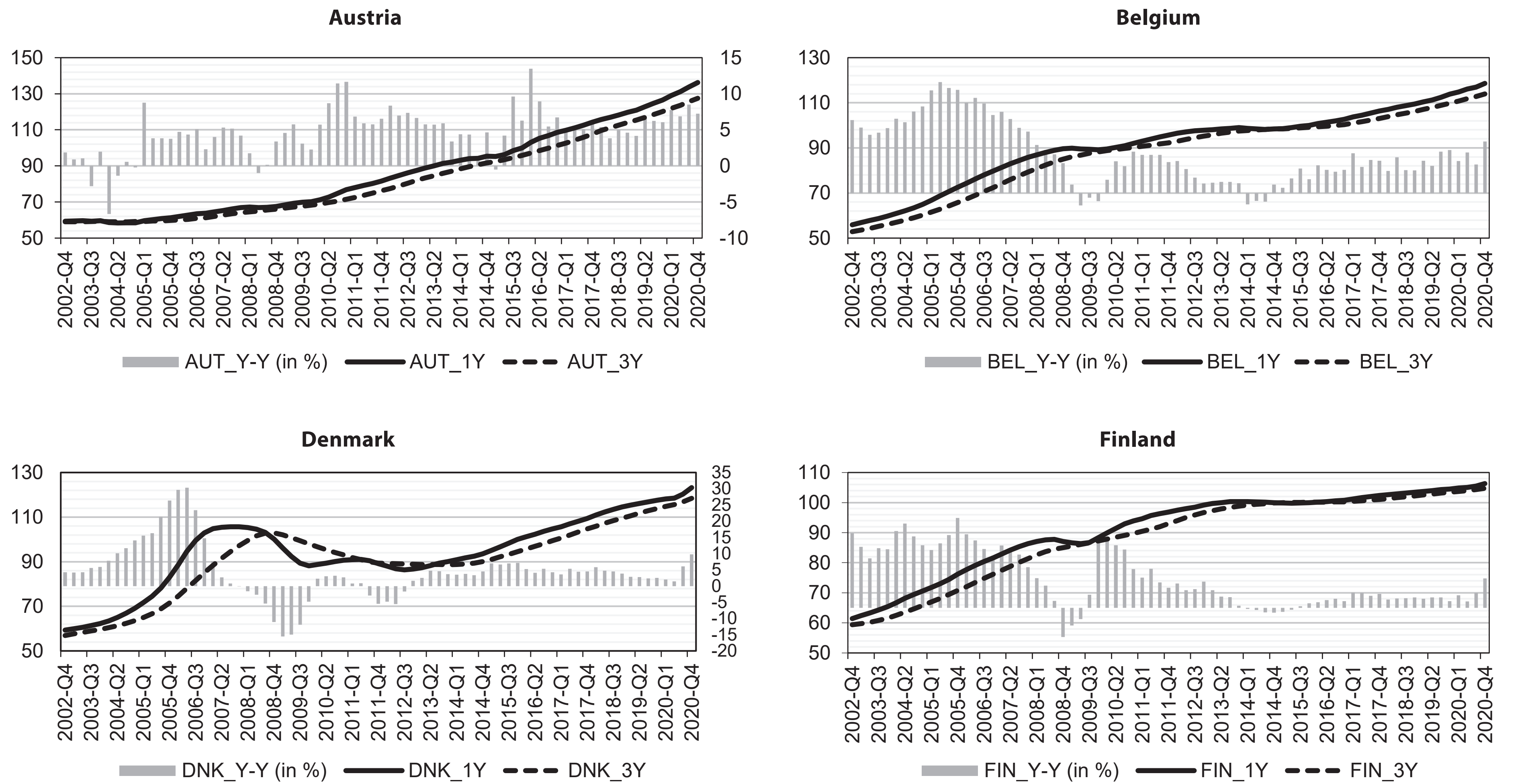
Notes: results of Johansen cointegration tests. Significant at 5% level = Yes / No
Source: authors' calculations

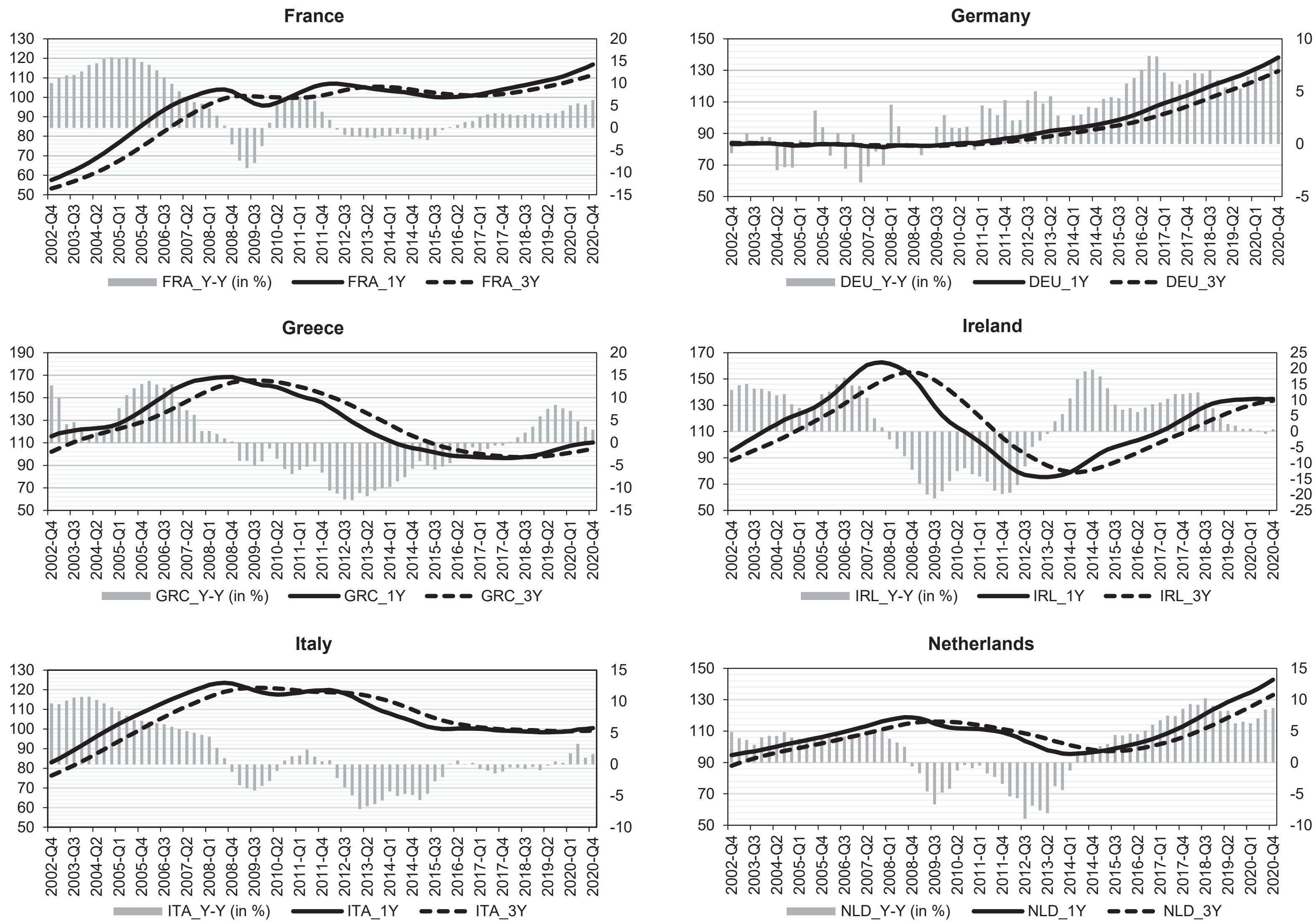
Table A4: Statistics on group Johansen cointegration tests of housing prices

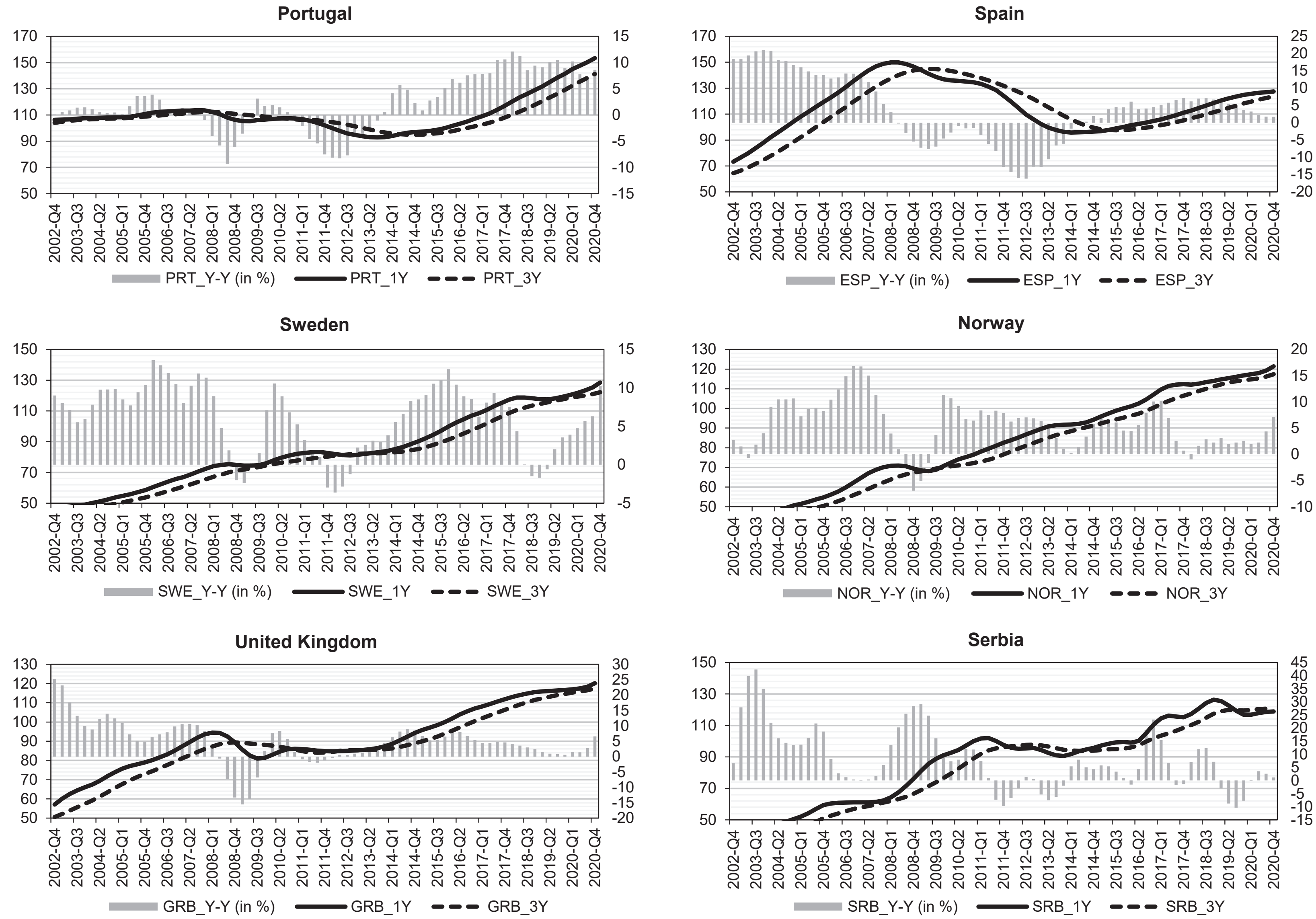
Johansen tests for cointegration **Group A**					
Trend: constant	Sample: 2000q4 - 2021q1		Number of obs = 82	Lags = 2	
maximum rank	**parms**	**LL**	**eigenvalue**	**trace statistic**	**5% critical value**
0	30	-574.31418	.	132.7318	68.52
1	39	-545.59538	0.50364	75.2942	47.21
2	46	-523.76471	0.41284	31.6329	29.68
3	51	-514.49485	0.20236	13.0931*	15.41
4	54	-508.17234	0.14291	0.4481	3.76
5	55	-507.94827	0.00545		
Johansen tests for cointegration **Group B**					
Trend: constant	Sample: 2000q4 - 2021q1		Number of obs = 82	Lags = 2	
maximum rank	**parms**	**LL**	**eigenvalue**	**trace statistic**	**5% critical value**
0	20	-517.47227	.	39.3081*	47.21
1	27	-506.81188	0.22896	17.9873	29.68
2	32	-500.74459	0.13755	5.8527	15.41
3	35	-498.48275	0.05367	1.3290	3.76
4	36	-497.81824	0.01608		
Johansen tests for cointegration **Group C**					
Trend: constant	Sample: 2000q4 - 2021q1		Number of obs = 82	Lags = 2	
maximum rank	**parms**	**LL**	**eigenvalue**	**trace statistic**	**5% critical value**
0	20	-406.84866	.	48.6502	47.21
1	27	-395.48816	0.24201	25.9292*	29.68
2	32	-389.12891	0.14367	13.2107	15.41
3	35	-385.46749	0.08543	5.8879	3.76
4	36	-382.52356	0.06929		
Johansen tests for cointegration **Group D**					
Trend: constant	Sample: 2000q4 - 2020q4		Number of obs = 81	Lags = 2	
maximum rank	**parms**	**LL**	**eigenvalue**	**trace statistic**	**5% critical value**
0	30	-658.30052	.	138.4210	68.52
1	39	-621.74693	0.59447	65.3138	47.21
2	46	-605.07989	0.33737	31.9798	29.68
3	51	-597.35805	0.17359	16.5361	15.41
4	54	-591.24045	0.14020	4.3009	3.76
5	55	-589.09	0.05171		

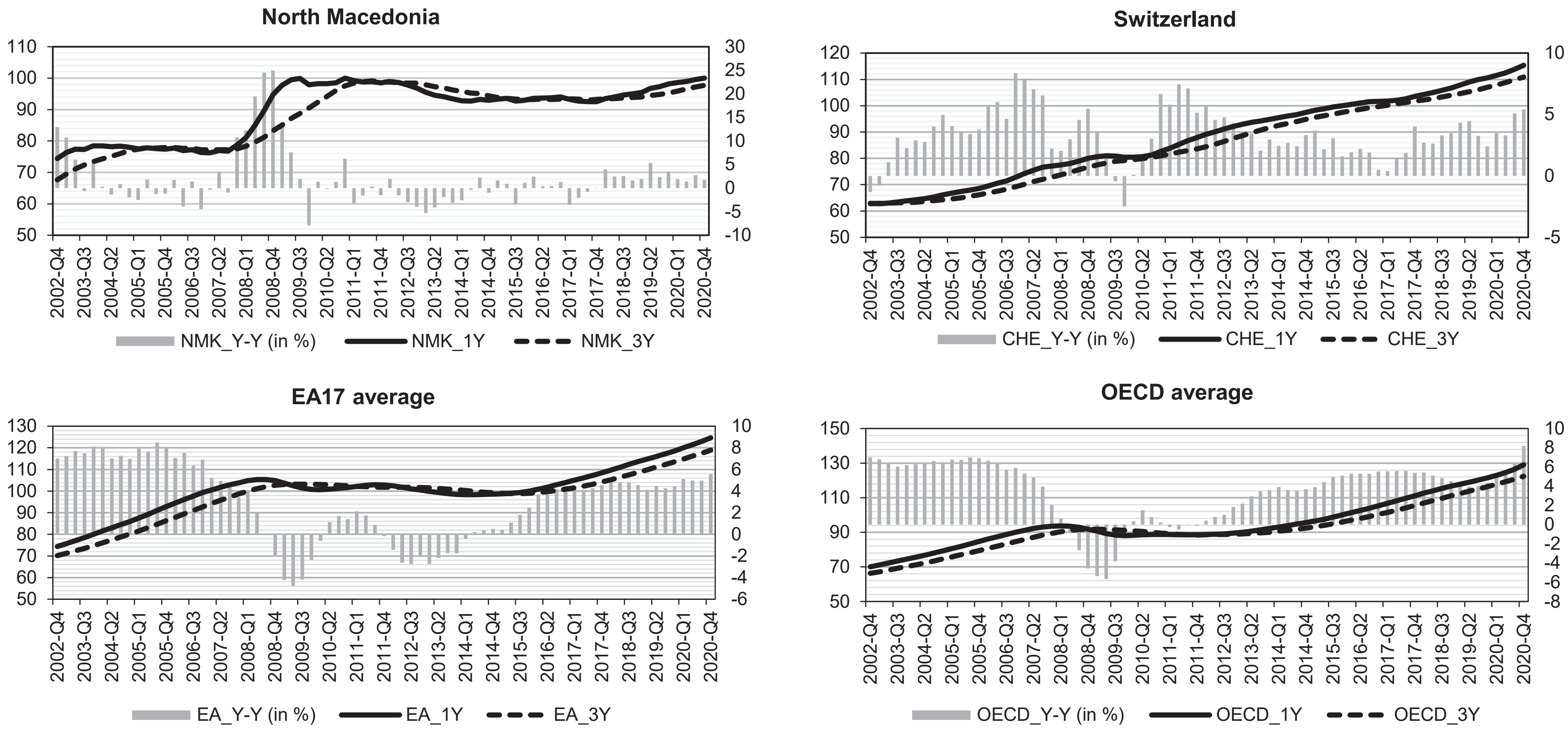
Source: authors‘ calculations

Figure A1: Groups of countries by gap in housing prices



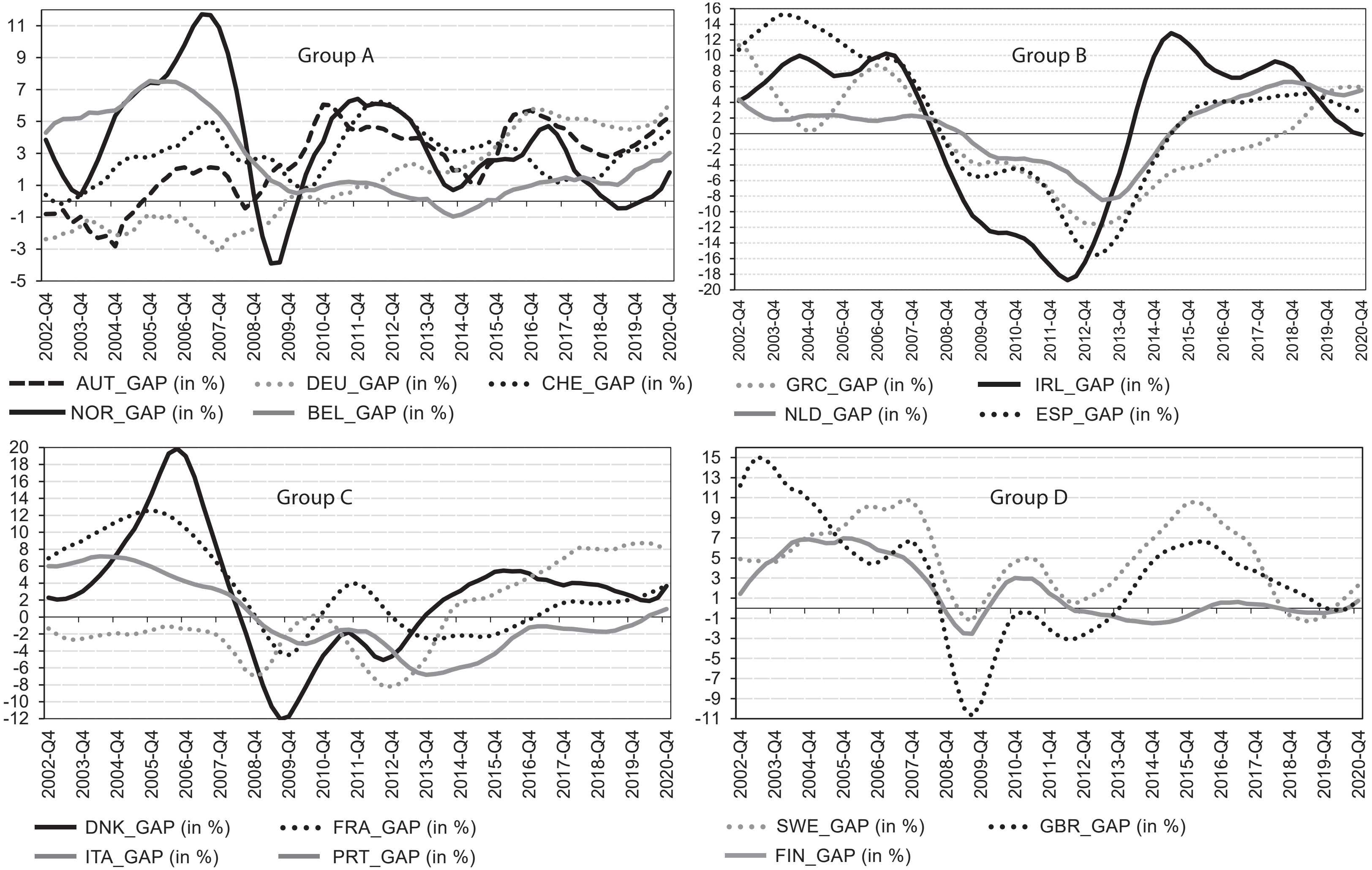

France
FRA_Y-Y (in %)
FRA_1Y
FRA_3Y
Germany
DEU_Y-Y (in %)
DEU_1Y
DEU_3Y
Greece
GRC_Y-Y (in %)
GRC_1Y
GRC_3Y
Ireland
IRL_Y-Y (in %)
IRL_1Y
IRL_3Y
Italy
ITA_Y-Y (in %)
ITA_1Y
ITA_3Y
Netherlands
NLD_Y-Y (in %)
NLD_1Y
NLD_3Y


Portugal
PRT_Y-Y (in %)
PRT_1Y
PRT_3Y
Spain
ESP_Y-Y (in %)
ESP_1Y
ESP_3Y
Sweden
SWE_Y-Y (in %)
SWE_1Y
SWE_3Y
Norway
NOR_Y-Y (in %)
NOR_1Y
NOR_3Y
United Kingdom
GRB_Y-Y (in %)
GRB_1Y
GRB_3Y
Serbia
SRB_Y-Y (in %)
SRB_1Y
SRB_3Y



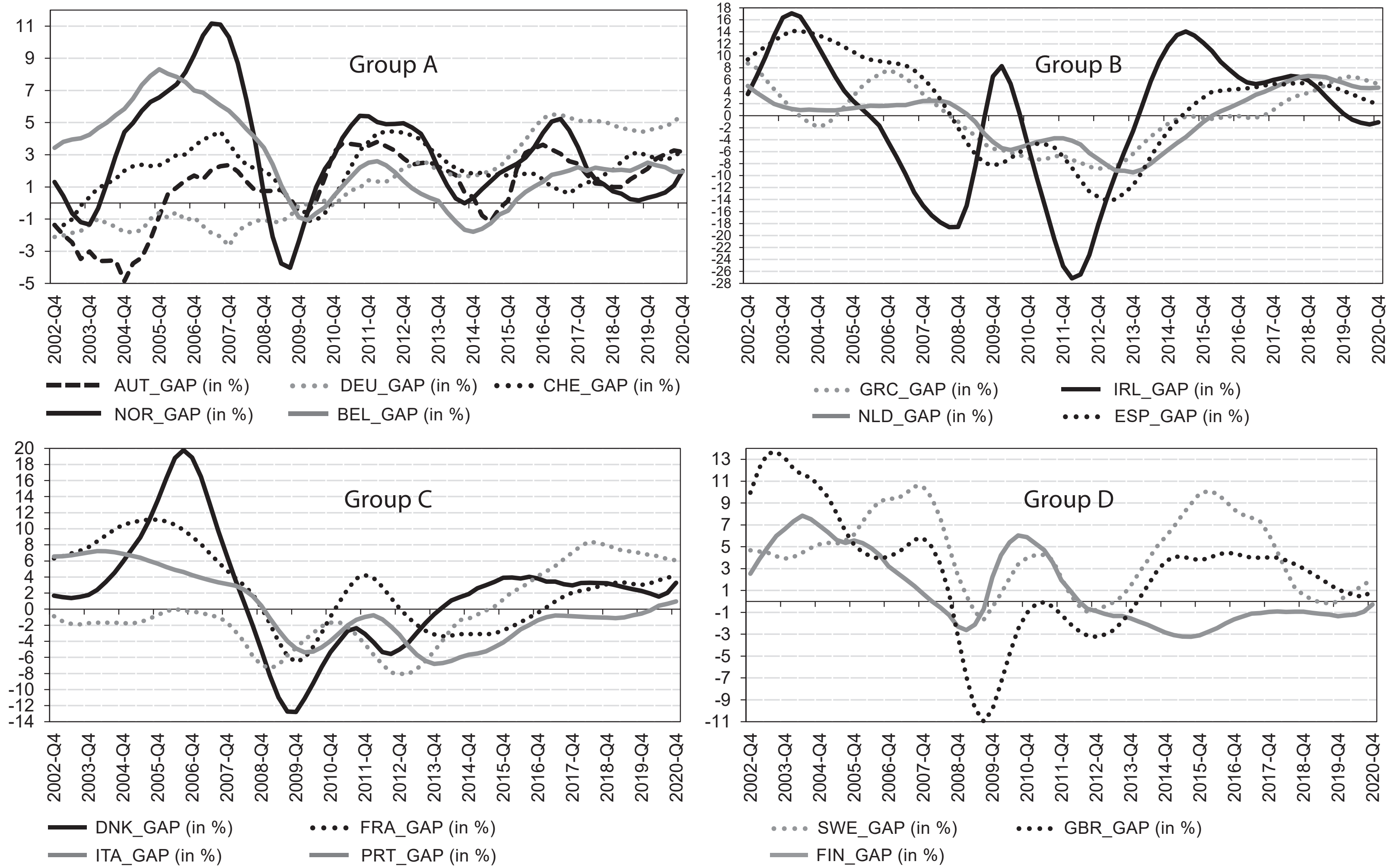
Source: authors' calculations

Figure A2: Groups of countries by real housing price dynamics



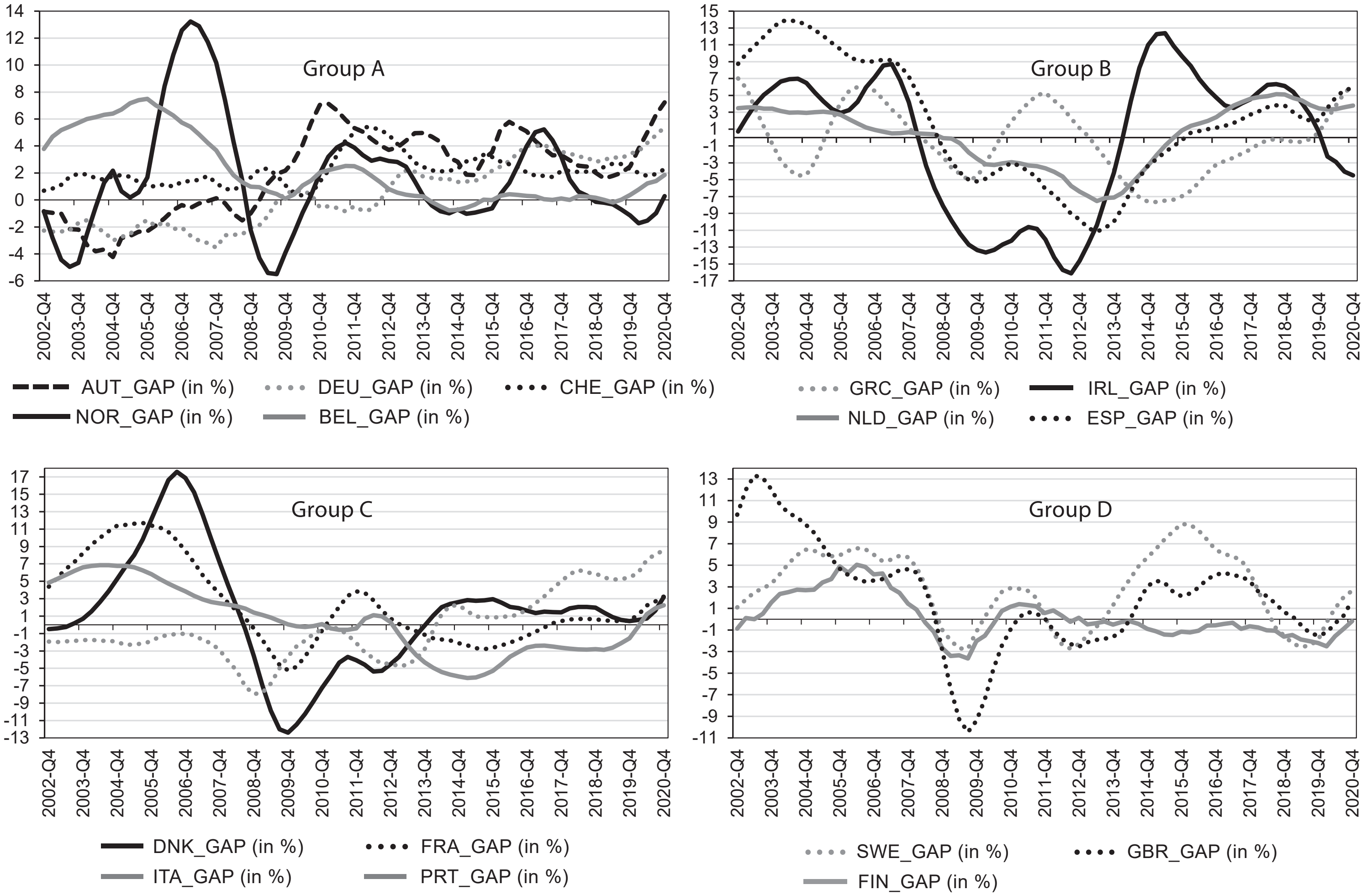
Source: authors' calculations

Figure A3: Groups of countries by price to rent ratio dynamics



Source: authors' calculations

Figure A4: Groups of countries by price to income ratio dynamics



Source: authors' calculations