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ORIGINAL PAPER

Drivers of European housing prices in the new millennium: demand, financial, and supply determinants

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Abstract

Many countries in Europe have experienced a steady increase in housing prices over the past decade, which continued even during the recent crisis. We analyze a panel of 15 European countries over the period 2000–2020. We find that demand-side determinants, such as GDP, unemployment, wage and population, strongly influence housing prices. Nevertheless, we suggest that construction costs, access to finance (credit to GDP), and financing costs (long-term interest rate) should be included to avoid biased results. We find that financial development can significantly affect housing prices in the long run. We confirm the robustness of our results by conducting a lag sensitivity analysis of selected determinants. In addition, we find a negative effect of the GFC and a positive effect of the Covid crisis on housing prices. Furthermore, we find that countries with a mild reaction to or a quick recovery from the GFC experienced significantly higher housing price growth.

Keywords Housing price determinants · EU · Euro area · Housing prices · Panel data

JEL Classification C33 · E31 · R21 · R31

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1 Introduction

In recent years, many countries have experienced seemingly endless housing price growth. During the Covid crisis, housing prices did not fall as they did during the Global Financial Crisis (GFC); on the contrary, housing price growth actually accelerated in the Euro Area. Geng (2018) adds that housing prices have been rising faster than incomes in many economies. Many central banks have tightened monetary policy to combat rising inflation. The growth in housing prices, combined with rising financing costs, reduces the purchasing power of households, which have to allocate a larger share of their income to housing. In addition, rapid growth in housing prices can jeopardize financial stability and real economic activity (Vogiazas and Alexiou 2017).

We find a fairly significant gap in the literature in terms of underresearched supply-side effects, missing comparison of the effects of the GFC and Covid crises, and missing updates of older works that would reflect varying effects of housing price determinants during ZLB and zero to negative inflation periods. Moreover, we add a lag sensitivity analysis, which is also missing in the literature.

In our research, based on the literature review and identified gaps, we focus on three main questions connected to the two sides of the housing market and the means of financing:

1. Do demand-side determinants have statistically significant effects on housing prices?
2. Do supply-side determinants have statistically significant effects on housing prices?
3. Do financial determinants affect housing prices in any way?

We control for the effects of global crises, carefully specify the number of lags, and examine common characteristics across groups of countries. We analyze the factors influencing housing prices in European countries over the last two decades. We choose to examine housing price determinants using panel data regression. Our approach differs from the majority of the literature, which focuses on employing VAR models. These models are often limited to single-country studies and include only a limited number of determinants and lags to preserve degrees of freedom. We capture supply-side determinants by available proxies–construction costs, production in the construction sector, and construction permits. We aim to determine the impact of supply-side factors on housing prices. Can their effects compete with the effects of demand-side factors? Should we keep them in our models, or has their time passed and for now, their effects are negligible?

Our results suggest that demand-side and financial determinants have mostly significant effects on housing prices. Positive effects come from GDP growth, wage growth, population change, financial development, and availability of household credit. However, financial system development and availability of financing should go hand in hand with a well-designed macroprudential policy to overcome the possible negative effects of the formation of housing market bubbles and exclusion of

lower-income groups from the housing market. Conversely, rising unemployment, inflation, and higher long-term interest rates reduce housing price growth. We find that, except for the positive effect of construction costs, which partly motivated the recent housing price boom, supply-side proxies are mostly insignificant. Supply-side factors cannot compete with demand-side factors, which have been boosted by a period of low interest rates and QE, in terms of their impact on housing prices, but their exclusion from the model can lead to biased results. We find significant effects of crisis variables, with opposite effects of the GFC and the Covid crisis on housing prices. Subsequent lag sensitivity analysis of selected determinants confirms the validity of our initial model specification.

Our findings update and extend our knowledge of the effects of housing price determinants. Heterogeneity in housing price growth and the impact of its determinants have been documented in both the spatial and time dimensions. Some recent studies confirm our results, suggesting heterogeneity even across Euro Area countries, finding only smaller groups of countries with similar dynamics (see Maynou et al. 2021, and Miles 2020, among others). Regarding heterogeneity in effects over time, Dröes and van de Minne (2017) employ a large historical database and find changes in the significance and effect sizes of housing price drivers over the long run. They note that in Europe, housing accounts for 40–60% of total household wealth. Therefore, there is a need to revise our knowledge on the effects of housing price drivers.

The remainder of the paper is organized as follows: Sect. 2 presents a literature review focusing on the determinants of housing prices and the impact of crises. Section 3 describes the data and empirical methodology employed. Section 4 discusses the results of the panel data analysis, and Sect. 5 concludes.

2 Literature review

Over time, several topics have emerged in housing price research. One branch of the literature focuses on trends, correlations, co-movements, and gaps in housing prices (Knoll et al. 2017; Eichholtz et al. 2015; Abott and De Vita 2013, etc.). Knoll et al. (2017) conclude that housing prices in most developed countries were constant in real terms until the mid-twentieth century, but have risen sharply in recent decades. Eichholtz et al. (2015) uses a long time series of housing prices in Amsterdam to show that agent expectations are driven by fundamentals during economic downturns, and by momentum and recent trends during booms. Abott and De Vita (2013) find no long-run convergence among regional housing prices in the UK.

Several papers examine convergence in the EU (see, e.g., Tsai 2018; Miles 2020; Maynou et al. 2021; Álvarez et al. 2010). Miles (2020) states that the euro, as a common currency, was expected to trigger convergence of various financial and economic variables across the continent, but finds only marginal evidence of housing price convergence. Tsai (2018) finds that housing prices across EA countries are more correlated than across non-EA countries. Maynou et al. (2021) confirm convergence only within five smaller "clubs" of EU countries over the period 2004–2016. Álvarez et al. (2010) find significant co-movement of GDP cycles, but

rather weak co-movement of housing prices for four large EU economies. They state that country-specific variables largely determine housing prices. Our research contributes to this branch of the literature by investigating the effects of country groups in the panel data model using more recent data.

A branch of the literature that is closely related to our analysis focuses on housing price determinants. Regarding economic factors, various studies consider the output of the economy, as well as labor market conditions represented by the unemployment rate and average wages (see, e.g., Cunha and Lobão 2021; Maynou et al. 2021; Geng 2018; Vogiazas and Alexiou 2017; Égert and Mihaljek 2007; Abelson et al. 2005; Baffoe-Bonnie 1998). Housing prices are closely linked to monetary policy and financial stability. Therefore, some authors consider interest rates, credit conditions, and macroprudential policy as drivers of housing prices (Robstad 2018; Nocera and Roma 2018; Hanck and Prüser 2020; Iacoviello 2005). Moreover, systemic crises, such as the GFC, influence housing prices and should be included in the models (see, e.g., Maynou et al. 2021; Kang and Liu 2014; Agnello and Schuknecht 2011). These issues are discussed in more detail in the following sections.

2.1 Demand-side determinants

Various studies consider economic output, mostly represented by GDP growth, and labor market conditions, represented by the unemployment rate and average wage, to be the traditional demand-side determinants of housing prices (see, e.g., Maynou et al. 2021; Cunha and Lobão 2021; Geng 2018; Vogiazas and Alexiou 2017; Égert and Mihaljek 2007; Abelson et al. 2005; Baffoe-Bonnie 1998). In general, faster GDP growth, higher wages, and a lower unemployment rate support demand for housing, which increases housing prices. Most of these papers only use demand-side determinants, which are relatively easy to obtain data for, while only a few add supply-side determinants, as discussed below in Sect. 2.2. Demand-side models therefore dominate housing price research. Some authors add financial determinants to their models to capture how access to and cost of finance affect buyer demand (Maynou et al. 2021; Robstad 2018; Nocera and Roma 2018; Vogiazas and Alexiou 2017; Bouchouicha and Ftiti 2012; Beltratti and Morana 2010; Égert and Mihaljek 2007; Otrok and Terrones 2005; Baffoe-Bonnie 1998).

Maynou et al. (2021) find that housing prices are driven by fiscal factors and unemployment, specifically the consolidated private debt to GDP ratio, unemployment rate, and the crisis period (2008–2012). Furthermore, they identify the property tax to GDP ratio, the long-term government bond interest rate, and inflation as significant factors influencing housing prices. They confirm similar patterns across smaller groups of countries, but not within the overall EA or non-EA country groups. Several authors employed Bayesian structural VAR models. For Norway, Robstad (2018) finds significant reactions of housing prices, but no effect on household credit. Nocera and Roma (2018) find that the effects of housing demand and monetary policy shocks differ considerably across the seven analyzed European countries. On average, monetary policy shocks account for 25–30 percent of the

forecast error variance of housing price growth. However, the contribution of monetary policy shocks to housing price dynamics is historically highly heterogeneous.

Using a panel of advanced economies, Vogiazas and Alexiou (2017) find positive effects of GDP growth, the real effective exchange rate, and credit to the private non-financial sector on housing prices. Bouchouicha and Ftiti (2012) employ a dynamic coherence function and find a common trend driving the housing markets in the US and UK, which becomes stronger in the long run. During crises, housing expenditure and wealth channels are important in the real estate market in the US, whereas the wealth effect is significant in the UK. Beltratti and Morana (2010) find that the US is an important source of global economic fluctuations for real economic activity, as well as for nominal variables and stock prices in G7 countries. Furthermore, they identify global supply-side shocks as an important determinant of real housing prices. Using a VAR model, Otrok and Terrones (2005) confirms a strong but lagged impact of US monetary policy shocks on housing price growth both in the US and internationally.

Égert and Mihaljek (2007) find that increase in GDP per capita and housing or private sector credit significantly increase housing prices. Nevertheless, the size of the reaction varies across countries. Housing prices increase twice as much in response to an equivalent decline in the real interest rate in CEE compared with other OECD countries. Conversely, housing prices in other OECD countries react much stronger to credit growth compared to CEE economies. They also identify heterogeneous effects in housing price reactions to demographic and labor market factors. Housing prices respond more strongly to real wage increases in CEE countries due to initially lower average housing quality compared to non-CEE OECD countries. Development of housing markets and financial institutions, which is proxied by EBRD indicators, significantly affects housing prices in CEE. Using a VAR model, Baffoe-Bonnie (1998) finds that housing prices and number of homes sold respond significantly to regional economic conditions (i.e., national interest rate, money supply, employment growth, and inflation). Moreover, he notes that economic variables alone cannot explain the extreme fluctuations that occurred in some countries.

2.1.1 Macroprudential factors and credit conditions

Some authors consider macroprudential factors and credit conditions as determinants of housing prices (Kuttner and Shim 2016; Cerutti et al. 2017; Vandenbussche et al. 2015; Cronin and McQuinn 2016; Kelly et al. 2018; Shi et al. 2014). According to Cerutti et al. (2017), use of macroprudential policies is more commonly associated with lower credit growth, most notably in household credit, and these policies are less effective during busts than during booms. Shi et al. (2014) examine the impact of real fixed interest rates on housing prices in New Zealand. They find that higher interest rates do not have the expected negative effect on real housing prices, once household mortgage choice and other economic conditions are controlled for.

Banti and Phylaktis (2019) investigate the impact of global liquidity on the world's housing prices proxied by the availability of funding to global banks located in global financial centers. They find a significant impact of liquidity shocks on housing prices in advanced and emerging economies. Nevertheless, developed

countries can use their macroprudential policy and other policy tools to shield their economies more effectively than developing countries. Using loan-level data on Irish mortgages in a property-level housing price model, Kelly et al. (2018) show that a 10% increase in available credit leads to a 1.5% increase in the value of purchased property. However, the decline in housing prices is sensitive to the choice of LTV and LTI. Kuttner and Shim (2016) examine the impact of nine non-interest rate policies on housing credit and housing prices in 57 countries over 30 years. Introducing or increasing a maximum DSTI ratio and increasing housing-related taxes have significant negative effects on housing credit.

Overall, the literature emphasizes the importance of demand-side factors in determining housing prices and suggests that the effects may be similar for certain smaller groups of countries. However, evidence on the latter remains very limited. We fill this gap in the literature by providing evidence on recent developments in a panel model framework.

2.2 Supply-side determinants

Use of supply-side factors is rather scarce in the literature compared with demand-side factors, and is often limited to single-country models and regional analyses due to data availability–see Cunha and Lobão (2021), Geng (2018), Sivitanides (2018), Belke and Keil (2018), Dröes and van de Minne (2017), Hanck and Prüser (2020), Hlaváček et al. (2016), Adams and Füss (2010), Duca et al. (2011), Borowiecki (2009), and Janet Ge (2009).

Cunha and Lobão (2021) use a four-level analysis of housing prices—the EU as a whole, the 28 EU countries, Portugal, and the 25 administrative regions of Portugal—considering construction costs and construction permits as supply-side determinants. They find that GDP, interest rates, tourism, and the number of residential properties under construction are significant drivers of real estate prices; however, their significance varies across the geographic levels. Geng (2018) uses cross-country analysis and finds a significantly negative effect of housing stock per capita on housing prices. He concludes that tax relief on housing finance and the strictness of rent controls also drive housing prices and may cause different dynamics across countries. Sivitanides (2018) uses supply-side determinants as control variables only, and finds a long-term relationship of housing prices in London with UK GDP, London population, and housing completions. Belke and Keil (2018) employ a panel data model for German regions covering nearly a hundred German cities. They find that construction activity and housing stocks are significant supply-side determinants of housing prices. Dröes and van de Minne (2017) examine housing prices over a 200-year period. They find that the relative importance of determinants changes over time and reflects the current economic environment. Supply-side determinants were dominant before 1900 and again after WW2, especially construction costs and new housing supply. In the post-WW2 period, reconstruction and a baby boom greatly contributed to housing price growth.

Hanck and Prüser (2020) examine housing prices in Germany using Bayesian VAR models and find that interest rates significantly influence housing prices.

Nevertheless, a permanent increase of interest rates to 4% may stop housing price growth. Borowiecki (2009) analyzes the situation in Switzerland using a VAR model and a self-constructed housing quality index. He finds that construction prices have a significantly positive effect on housing prices, whereas housing construction has a significantly negative effect. Hlaváček et al. (2016) analyze commercial property prices in Central Europe. Apart from the significantly positive effect of traditional demand-side determinants (GDP, credit to GDP ratio, and inflation), they find a significantly negative effect of available office space. Adams and Füss (2010) examine the impact of macroeconomic variables on housing prices in 15 countries using panel cointegration analysis. They find that in the long run, a 1% increase in both economic activity and construction costs leads to a similar increase in housing prices (0.6%). Conversely, a 1% increase of interest rates decreases housing prices by 0.3% in the long run.

Duca et al. (2011) emphasize that housing supply and user costs help explain housing prices only if credit conditions remain stable. However, changes in the degree of financial liberalization, credit standards, and the responsiveness of housing supply may cause fluctuations in construction and housing prices across economies and over time. Substantial swings in housing construction led to macroeconomic effects in the US, Ireland and Spain. Janet Ge (2009) analyzes housing prices in New Zealand using quarterly real housing prices while experimenting with different lags of explanatory variables. She finds that the different variables show their effects with different lags, and therefore that appropriate lag setting is important in housing price modeling. We reflect this finding in our analysis by empirically testing the optimal number of lags in our model and by conducting a lag sensitivity test.

In general, the literature suggests that supply-side factors may be important for housing price developments. However, the results vary across studies and evidence from international samples remains scarce. We fill this gap in the literature by analyzing the effects of three supply-side factors (construction costs, construction output, and building permits) on housing prices in a panel of 15 European countries. Moreover, the supply-side factors may partly reflect different institutional conditions, a domain for which data are limited. We provide more details on institutional conditions in terms of key business indicators related to the processing of construction permits and the registration of properties in Table 6 in the Appendix.[1]

2.3 Effects of crises on housing prices

Since the beginning of the millennium, two global crises have hit European economies. The first was the Global Financial Crisis (GFC), with its roots in the US housing market, and the second was the Covid crisis, which quickly transformed from a public health to an economic crisis as a result of the restrictions imposed, the extraordinary spending, the increase in debt, and the disruption of supply chains, among other things. Surprisingly, even recent studies tend to neglect the effects

[1] We cannot include these indicators in the model because they are only available with short time series and low frequency.

of the GFC in their models. The effects of the GFC on housing are documented in several studies (see, e.g. Maynou et al. 2021; Kang and Liu 2014; Agnello and Schuknecht 2011). In addition, Dröes and van de Minne (2017) demonstrate on their large dataset that global crises in the past had significant effects on local housing prices in the Netherlands. Furthermore, the Covid crisis and its impacts differ significantly from the GFC. Therefore, it is necessary to update our knowledge on the effects of global crises on housing prices.

Maynou et al. (2021) explicitly capture the effects of the GFC and its aftermath with a crisis dummy covering the period 2008–2012. They find a significant negative effect of the crisis on housing prices due to the bursting of a housing price bubble and strong adjustment of housing prices. Kang and Liu (2014) employ quantile regression to analyze the impact of the GFC on housing prices in China and Taiwan. In Taiwan, the impact of the GFC on housing prices appears to be higher where real estate prices were already high. Conversely, a lesser impact of the GFC on housing prices was found where property prices had been high in China. Using a multinominal probit model, Agnello and Schuknecht (2011) find significant influence of domestic credit and interest rates on the probability that booms and busts in housing markets will occur. In conjunction with banking crises, international liquidity plays a significant role in the occurrence of housing booms and busts. Zhao (2020) employs a structural break model and zip code level data to analyze the impact of Covid on the US housing market. Monetary easing and consequent lower mortgage rates increased housing demand and created a structural break in that demand, which led to a sharp increase in housing prices. He concludes that for the period April–August 2020, median housing prices rose faster than in any four-month period before the GFC.

Inspired by the literature, we incorporate the effects of global crises in our model and provide new evidence on the effects of the GFC and the Covid crisis on European housing prices.

3 Data and methodology

3.1 Data

The available data are limited either in terms of series length or cross-sectional coverage. The longer series are available only for approximately half of all European countries, while the time series of the other half only start around the GFC. In this paper, we prefer longer time series to cover more than one business cycle and to capture the impact of the two global crises (GFC and Covid crisis). The GFC had severe impacts on the economy and housing market. Geng (2018) notes that housing prices remained below their pre-crisis level for a long time in some countries, for instance, Denmark, Ireland, and Spain. Our dataset covers the period 2000–2020 and includes quarterly data for 15 European countries from Eurostat, the BIS, and the IMF. This leaves us with more than 1100 observations even after we transform the data and consider the lags in the model. We analyze mostly old EU member states and only

a few non-EU countries (Great Britain and Norway).[2] The housing price index data limits our ability to construct a broader panel, as it is only available for new EU member states from 2008 onwards (Table 1).

3.2 Methodology

In line with our research questions, we formulate several assumptions regarding the effects of the explanatory variables that are reflected in the regression model (1). To test these assumptions, we employ panel data models that account for both individual-specific and time-specific effects and are able to capture the interdependence between observations within the same individual unit. Overall, panel data regression offers several advantages over cross-sectional or time series analysis alone, including increased efficiency, controlling for unobserved heterogeneity, and the ability to analyze both individual-level and aggregate-level effects simultaneously. We use two types of panel data models, which we briefly describe. The fixed effects model accounts for individual-specific effects by including dummy variables for each individual unit in the regression equation, which capture the unobserved heterogeneity across individual units that remains constant over time. This type of model is useful when there are time-invariant characteristics that vary across individual identities. In contrast, the random effects model assumes that the individual-specific effects are random and uncorrelated with the independent variables. In the random effects model, individual-specific effects are treated as random variables with a specific distribution. Random effects models are more efficient than fixed effects models when the individual-specific effects are uncorrelated with the independent variables.

In our analysis, we use a panel data regression with fixed effects. The FE model is estimated as follows:

$$\begin{aligned} d\_HPI_{i,t} =& \beta_0 + \beta_1 GDP\_gr_{i,t-1} + \beta_2 d\_U_{i,t-6} + \beta_3 gr\_W_{i,t-6} + \beta_4 Pop\_gr_{i,t-1} \\ &+ \beta_5 \_Inf_{i,t-1} + \beta_6 d\_LTIR_{i,t-6} + \beta_7 d\_FD_{i,t-8} + \beta_8 d\_CH\_GDP_{i,t-6} \\ &+ \beta_9 d\_CC_{i,t-6} + \beta_{10} d\_PC_{i,t-6} + \beta_{11} d\_CP_{i,t-6} + \beta_{12} GFC_{i,t} \\ &+ \beta_{13} COVID_{i,t} + \mu_i + \tau_t + \varepsilon_{i,t} \end{aligned} \quad (1)$$

where d denotes differences and gr is growth, μ_i represents unobserved country fixed effects, τ_t denotes an unobserved common time effect across countries, and ε_{it} is the idiosyncratic disturbance term (residual). For interpretation purposes, we standardize all variables and present them in separate tables. We calculate z-scores using Stata data options. That is, for each observed value of the variable we subtract the mean and divide by the standard deviation. This standardization enables us to compare effect sizes across variables.

We make several assumptions derived from economic theory that motivate the inclusion of variables in the model and inform sign expectations for their effects on housing prices. The GDP growth variable serves as a proxy for the business cycle

[2] Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden, Norway, Great Britain.

Table 1 Data and sources

Variable	Index	Description and source
Housing price index	HPI	Index of transaction prices of residential properties, both newly built and existing, purchased by households; Eurostat
Gross domestic product growth	GDP_gr	Annual growth of real gross domestic product (yoy); Eurostat
Unemployment rate	U	Rate of unemployment as percentage of the population in the labor force aged 15–74; Eurostat
Average wages	W	Average wages; Eurostat
Population change	Pop_gr	Growth of population; Eurostat
Inflation	Inf	Inflation based on harmonized customer price index; Eurostat
Long-term interest rate	LTIR	Yield on government bonds with a maturity of 10 years; Eurostat
Financial development index	FD	Relative ranking of countries on depth, access, and efficiency of their financial institutions and financial markets. An aggregate of Financial Institutions and Financial Markets indices; IMF
Credit to households	CH_GDP	Credit to households provided by financial institutions and banks as share of GDP; BIS
Construction costs index	CC	Measures costs of the building for contractors. It reflects the prices that they have to pay for the input factors in the construction process; Eurostat
Production in construction index	PC	Business-cycle indicator, which measures the monthly changes in production of buildings (residential and non-residential) and of civil engineering (roads, railways, bridges, tunnels, utility projects); Eurostat
Construction permits index	CP	Business cycle indicator providing information on the development of granted building permits; Eurostat
Global financial crisis	GFC	Global Financial Crisis; dummy for the period 2008–2009
Euro area member	EA	Member state of the Euro Area; dummy
Covid crisis	COVID	Covid-19 crisis; dummy for year 2020

and the state of the economy, indicating possible changes in housing demand. The same applies to the change in unemployment and wage growth variables, which represent households' economic prospects and ability to purchase a property. Population growth affects the number of economic agents that might be willing to enter the housing market, as well as the need to renovate and increase the number of available housing units as the population continues to grow. We include inflation to control for changes in household purchasing power. Long-term interest rates are a proxy for mortgage costs, which are essential in the decision to purchase a new home, and the financial development index is also closely related to financing opportunities. Credit to households, measured as a share of GDP, represents the size of credit financing opportunities for households in a given economy. Construction permits issued and production in the construction industry approximate expected and current increases in the supply of housing, and construction costs reflect changes in the prices of inputs that will be reflected in housing prices.

The lags are empirically motivated with respect to the significance of the variables and the explanatory power of the model. Furthermore, our idea for the number of lags is based on the premise of a monetary policy horizon; we distinguish two sets of lags for our variables. Variables with a fast effect on housing prices represent the business cycle, with GDP growth and inflation being lagged by one quarter. Other variables have a rather slow effect over the monetary policy horizon (six quarters) and sluggish reaction of prices to financial development. We have tested other lag settings, using the explanatory power of the model and the significance of the parameters as criteria for final selection. Finally, the financial development index is lagged by 8 quarters, as it is an annual index incorporated into quarterly data. In addition, our empirical results suggest that in this case it takes longer for positive institutional changes in the financial sector to affect the real economy and thus housing prices.

Next, we use a random effects model to examine the impact of country dummies, which would otherwise be correlated with the fixed effects. The country groups are based on a comprehensive analysis that includes the trend and gap approach, GARCH models, and cointegration analysis conducted in our previous work (see Melecky and Paksi 2023). Dummy variables are used to express whether a country belongs to a particular group.

4 Results

Table 2 shows the results of the fixed effect models for our set of European countries. The first model considers only demand-side variables, the second model adds financial variables that influence demand for housing (cost and availability of financing), and the third model considers a complete set of variables, including supply-side factors. We employ lagged variables for two main reasons–to capture possible transmission mechanisms, and to mitigate endogeneity concerns. We follow two rules when employing lags. First, we take into account central bank policy horizons regarding most of the financial indicators, such as interest rates and credit to households. Second, since we use quarterly data, we lag the variables with "short-term

Table 2 Housing price drivers in European countries (FE model, standardized variables, demand, financial and supply-side factors)

Variables	(1) M_FE_D	(2) M_FE_D + FIN	(3) M_FE_FULL
GDP growth t-1	0.262***	0.248***	0.219***
	(0.062)	(0.062)	(0.045)
Unemployment t-6	−0.202***	−0.197***	−0.181***
	(0.039)	(0.039)	(0.036)
Wage growth t-6	0.100	0.103	0.134*
	(0.063)	(0.062)	(0.063)
Population change t-1	0.266***	0.263***	0.246***
	(0.060)	(0.059)	(0.062)
Inflation t-1	−0.185**	−0.169**	−0.122**
	(0.069)	(0.068)	(0.056)
Long-term interest rate t-6		−0.100**	−0.095**
		(0.045)	(0.034)
Financial development index t-8		0.003	0.062***
		(0.024)	(0.018)
Credit to household GDP t-6		0.008	0.026*
		(0.012)	(0.014)
Construction costs t-6			0.109*
			(0.054)
Production in construction t-6			0.019
			(0.067)
Housing permits index t-6			0.009
			(0.009)
GFC			−0.997***
			(0.244)
COVID			0.758***
			(0.164)
Constant	0.011	0.011	0.075**
	(0.007)	(0.007)	(0.034)
Observations	1110	1110	1110
Overall R-squared	0.209	0.218	0.336
Number of ID	15	15	15

Note: Robust standard errors in parentheses, ***$p<0.01$, **$p<0.05$, *$p<0.1$

effect" by only a single period. We document the explanatory power of each model by presenting the coefficient of determination in terms of the overall R-squared.

Our results confirm that traditional demand-side determinants explain housing price development in European countries to a significant extent. With the exception of the impact of wages, the effects are large and robust across the three specifications of the model. Below we focus on discussion of the full model. We find strong positive effects of population growth (0.246) and GDP growth (0.219) on housing price

growth in the European countries examined. Population growth in these countries primarily reflects immigration, as birth rates remain low. Therefore, with the recent upsurge in immigration due to the Russia-Ukraine war and ongoing immigration from other countries, one may expect rising pressure on property prices, especially in countries that receive large numbers of migrants relative to their population, such as Germany, Switzerland, and most recently Poland. As expected, the strong impact of GDP growth on housing prices reflects the fact that household expectations regarding the output of the economy significantly influence demand for housing. The positive impact of wage growth is slightly weaker and significant only at the 10% level. We identify a consistent negative effect of changes in unemployment and inflation on housing prices, which is in line with the idea that unemployment may significantly limit households' willingness to buy and purchasing power, and vice versa. Furthermore, higher unemployment may affect households' job security expectations, leading to conservative behavior, which creates downward pressure on housing prices.

The negative impact of inflation is not surprising given our sample period and countries, as the sample includes a long period of very low inflation (even deflation in some countries), during which housing prices increased in many countries. Another theoretical prediction suggests that as the value of money erodes during periods of relatively high inflation, people search for assets that will safeguard their purchasing power. Investment in housing generally falls into that category. This channel may have become even more significant during the Covid crisis, when some households significantly increased their savings, while the subsequent Ukraine crisis resulted in relatively high inflation rates in Europe. Furthermore, the negative effect of inflation may reflect uncertainty in decision making. During periods of relatively high inflation, many economic agents abandon investment plans, which may contribute to a decrease of demand for housing.

Regarding the duration of transmission, the effects of GDP growth and inflation are quickly transmitted to housing prices, which may suggest that central bank communications influence households' expectations regarding their future prospects and inform their decisions in the housing market. Except for some short periods of immigration spikes, population growth changes rather smoothly and the trends are highly predictable, which enables rather quick transmission of population changes to housing prices. By contrast, the effect of labor market variables materializes with some lag. This may be influenced by the fact that short-term unemployment or wage changes have only limited impact on what is for most people a very long-term investment decision.

To further investigate the impact of demand-side variables with shorter lags, we conduct a sensitivity analysis for three variables (GDP growth, inflation, and population growth) by lagging these variables by up to 8 periods. The results are summarized in Fig. 1. The impact of GDP growth is fairly stable and robust, with estimated coefficients ranging from 0.13 to 0.27 across the lags. Inflation, on the other hand, proves to be more volatile, with the coefficient even changing sign over the lag period. Initially, the impact of inflation on housing prices is negative, which may be due to the initial shock to consumers, who shift their spending from housing to more essential goods and services (lowering housing prices mainly through reduced demand for housing as an investment). With longer lags, higher inflation leads to increases in housing prices. Perhaps, experiencing inflation can, in the long run, shift consumer

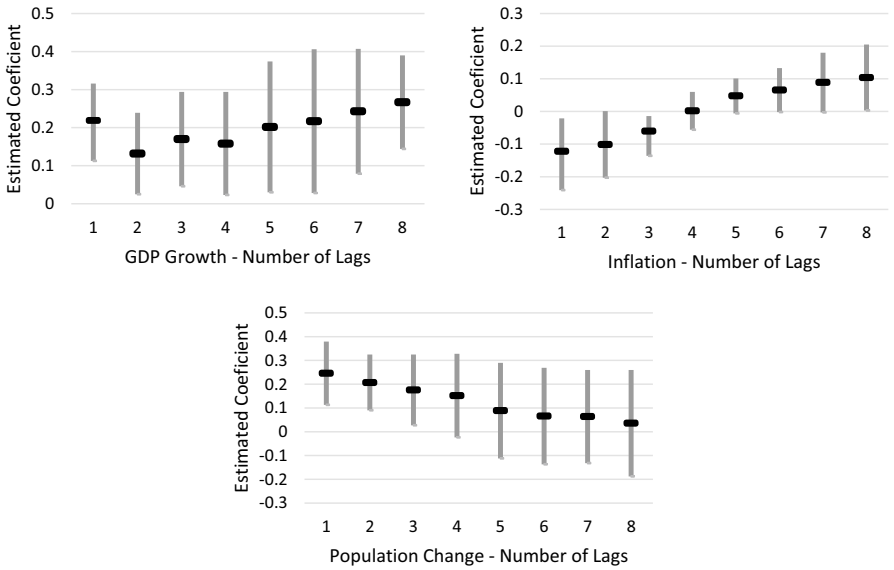

Fig. 1 Lag sensitivity tests. Note: Estimated coefficients with 95% confidence intervals

attention back to housing assets as insurance against further price increases. Moreover, the impact of population change appears to be significant only in the short run, probably reflecting waves of immigration rather than natural population growth.

The role of financing seems to be of great importance, as all variables capturing access to and cost of financing, as well as financial development, are significant. Increasing long-term interest rates have a negative impact, probably through two main channels: First, higher interest rates reduce the affordability of mortgages due to higher repayments, which hinders housing demand. Second, higher interest rates may cause a reallocation of investment from housing to other types of assets, leading to a decline in housing demand and prices. We confirm the finding of Adams and Füss (2010) that the positive impact of economic activity on housing prices is much stronger than the negative impact of interest rates. Credit to households positively impacts housing prices, since it provides additional funds most buyers find necessary to acquire housing. The financial market development index positively impacts housing prices, suggesting that financial market soundness and availability of funds increase demand for housing and contribute to housing price growth. Nevertheless, the impact of financial development only materializes with relatively longer lag compared to other variables.

We find only a limited effect of supply-side determinants on housing prices. However, a significant effect of construction costs (at the 10% level) indicates that the recent steep growth of construction costs, precipitated by disruption of supply chains, may contribute to current housing price increases. A positive effect of construction costs on housing prices is in line with Borowiecki (2009), but we do not confirm a negative effect of housing construction on housing prices. Moreover, we find that supply-side factors contribute to more precise estimation of the effects of other model determinants. A closer look at the data on production in construction

and construction permits reveals that short-term growth in the production of new properties was largely compensated by a decrease in the following periods. Except for some spikes in countries such as Greece and Finland, only a few countries were able to boost housing supply over longer periods, such as Ireland (2014–2019), Portugal (2016–2018), and the Netherlands (2014–2015). Therefore, the effects of production in construction and construction permits remain statistically insignificant.

We identify the effects of the two global crises that hit Europe in recent decades using dummy variables. The GFC stemmed from problems in the housing (mortgage) markets and financial system, while the Covid economic crisis was triggered by the coronavirus pandemic (a public health crisis). Our results show that these crises vary substantially in their effects on housing prices. In fact, their effects are completely opposite, and significant at the 1% level. The sharp decrease of housing prices during the GFC is not surprising, as it was a housing market crisis by nature—the availability of credit decreased significantly, and the crisis triggered, among other things, fire sales of real estate. This result is in line with the findings of Maynou et al. (2021). Conversely, we find a positive effect of the Covid crisis on housing prices. This effect could be a result of the various restrictions and limitations that affected the economy during the crisis. Limited and postponed consumption, stimulus programs that injected money into the economy, and consequent higher savings may be the most significant drivers of the positive effect of the Covid crisis. This is in accordance with the finding of Zhao (2020) for the US market that monetary easing and lower mortgage rates increased housing demand and caused a boom in housing prices. Disruptions in supply chains, which limited the availability of certain goods and increased their prices, may be another significant aspect of the Covid crisis that contributed to the increase in housing prices. In particular, highly open economies faced declining imports and exports because of the interruption of supply chains and insufficient transportation capacities. The combination of these factors may explain the differences in the effects of the GFC and the Covid crisis on housing prices.

4.1 The role of country groups in a random effect model

To reveal the effect of country groups on housing prices, we run a battery of random effects models. Our approach is motivated by some recent studies that find heterogeneity in housing price development across Euro Area countries, with co-movement only observed within smaller groups of countries (see e.g. Maynou et al. 2021, and Miles 2020). We form four country groups (A, B, C, D) based on our previous findings on the development of housing prices over time and their reaction to the crises—see Table 7 in the Appendix. Moreover, we test the effect of the Euro Area group (EA). We find that countries with long-term housing price growth that experienced the GFC with only a slowdown in growth rather than a significant decrease of housing prices (group A) show higher housing price growth over the whole period compared to other countries. Conversely, countries in group B that experienced a long and painful decline of housing prices during the GFC show substantially lower housing price growth, significant at the 5% level. The effects in the other two groups (C and D) are not statistically significant. Furthermore, we form larger groups by creating dummies that include each combination of

the two groups. This requires three dummies; the results are provided in Table 3 (models 5–7). The only relevant result which is significant at the 1% level is that group A+C, i.e., countries with minor GFC impact or rather quick recovery, experienced significantly larger housing price growth.

Finally, we evaluate whether the expected effects formulated in the theoretical model are consistent with our empirical results. The results summarized in Table 4 show that the effects of the demand-side variables are in line with theoretical expectations. The results for the supply-side variables are mixed. The effect of construction costs is consistent with our expectations, but the other two supply-side factors are insignificant. The GFC reduced housing prices as predicted by the theory, but the specificity of the Covid crisis caused its positive effect on housing prices.

5 Conclusion

This paper analyzes housing price drivers using a sample of 15 European countries over the period 2000–2020. Compared to existing studies, we employ a longer data series with a larger set of determinants, including traditional demand-side variables, determinants capturing cost and availability of financing, supply-side variables, and crisis dummies. This enables us to study the impact of two global crises (the GFC and Covid crisis) in addition to the effects of the determinants. Furthermore, we analyze the effects of sorting countries into smaller groups.

Our results suggest that income stability and economic prospects, including population changes, drive housing prices more than the macroeconomic aggregate of wages. We confirm a significant role of financial factors. Higher interest rates have a negative impact on housing prices, whereas financial sector development and the ratio of household credit to GDP have a positive effect on housing prices. The effects of supply-side factors remain inconsistent, with the exception of the positive impact of construction costs on housing prices. However, supply-side determinants help properly identify the effects of other variables and should be considered when modelling housing prices. We find different impacts of the two global crises on housing prices—negative for the GFC and positive for the Covid crisis—that stem from their different nature, adopted measures, and effects on the economy. Supply chain problems, rising costs of construction, and immigration in some countries, in combination with higher cost of capital due to growing policy rates and risks, create pressure on housing price growth. On the other hand, higher cost of loanable funds and economic slowdown work in the opposite direction, slowing down housing price growth. Moreover, we confirm that the Euro Area group is heterogeneous. Instead, smaller groups of countries with similar development paths should be considered when analyzing housing prices. Subsequent lag sensitivity tests show a stable effect of GDP growth, a diminishing effect of population growth after three lags and two opposite effects of inflation—negative in the short run and positive in the long run.

This paper contributes to our understanding of housing price development in European countries and provides a comparison of the relative effects of demand, financing, and supply-side conditions on the housing market. It should be noted

Table 3 Country groups as explanatory variables (RE model, standardized variables)

Variables	(1) M_RE_A	(2) M_RE_B	(3) M_RE_C	(4) M_RE_D	(5) M_RE_AB	(6) M_RE_AC	(7) M_RE_AD
GDP growth t-1	0.178***	0.184***	0.180***	0.178***	0.179***	0.184***	0.177***
	(0.049)	(0.046)	(0.051)	(0.051)	(0.051)	(0.048)	(0.049)
Unemployment t-6	−0.200***	–0.194***	–0.199***	–0.200***	−0.198***	−0.198***	−0.199***
	(0.041)	(0.039)	(0.041)	(0.041)	(0.041)	(0.040)	(0.040)
Wage growth t-6	0.139**	0.140**	0.140**	0.141**	0.142**	0.137**	0.142**
	(0.065)	(0.065)	(0.065)	(0.065)	(0.064)	(0.066)	(0.065)
Population change t-1	0.118	0.142**	0.130	0.120	0.127	0.136*	0.118
	(0.080)	(0.070)	(0.080)	(0.082)	(0.079)	(0.074)	(0.081)
Inflation t-1	−0.083	−0.081	−0.079	−0.079	−0.077	−0.085	−0.079
	(0.057)	(0.057)	(0.059)	(0.059)	(0.058)	(0.058)	(0.056)
Long-term interest rate t-6	−0.103***	–0.103***	–0.103***	–0.104***	−0.104***	−0.102***	−0.103***
	(0.037)	(0.036)	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)
Financial development index t-8	0.067***	0.064***	0.067***	0.067***	0.066***	0.066***	0.066***
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.017)	(0.018)
Credit to household GDP t-6	0.026*	0.023*	0.022	0.023	0.021	0.025*	0.024*
	(0.014)	(0.014)	(0.015)	(0.015)	(0.015)	(0.014)	(0.014)
Construction costs t-6	0.126**	0.120**	0.124**	0.126**	0.123**	0.124**	0.124**
	(0.062)	(0.059)	(0.061)	(0.061)	(0.060)	(0.061)	(0.061)
Production in construction t-6	0.026	0.022	0.027	0.027	0.026	0.025	0.025
	(0.073)	(0.071)	(0.074)	(0.074)	(0.074)	(0.073)	(0.072)
Housing permits index t-6	0.010	0.010	0.011	0.011	0.011	0.010	0.010
	(0.010)	(0.009)	(0.010)	(0.010)	(0.010)	(0.009)	(0.010)
GFC	−1.047***	–1.040***	–1.047***	–1.050***	−1.049***	−1.040***	−1.049***
	(0.269)	(0.263)	(0.270)	(0.271)	(0.269)	(0.267)	(0.268)

Table 3 (continued)

Variables	(1) M_RE_A	(2) M_RE_B	(3) M_RE_C	(4) M_RE_D	(5) M_RE_AB	(6) M_RE_AC	(7) M_RE_AD
COVID	0.661***	0.684***	0.671***	0.662***	0.669***	0.677***	0.662***
	(0.195)	(0.184)	(0.198)	(0.199)	(0.196)	(0.192)	(0.194)
EA	−0.107	−0.007	−0.100	−0.112	−0.074	−0.102	−0.067
	(0.084)	(0.057)	(0.075)	(0.072)	(0.072)	(0.080)	(0.078)
Country group dummy	0.123*	−0.236**	0.090	−0.022	−0.067	0.169***	0.097
	(0.070)	(0.097)	(0.072)	(0.043)	(0.073)	(0.063)	(0.076)
Constant	0.049	0.075*	0.055*	0.091*	0.096*	−0.010	0.009
	(0.053)	(0.045)	(0.033)	(0.048)	(0.054)	(0.041)	(0.088)
Observations overall	1110	1110	1110	1110	1110	1110	1110
R-squared	0.3248	0.3301	0.3235	0.3222	0.323	0.3283	0.324
Number of ID	15	15	15	15	15	15	15

Note: Robust standard errors in parentheses, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Table 4 Coefficients Hypotheses and their evaluation

Variable	Expected impact	Empirical result	Compliance with expectations
GDP	+	+	Yes
Unemployment	−	−	Yes
Average wages	+	+	Yes
Population	+	+	Yes
Inflation	−	−	Yes
Long-term interest rates	−	−	Yes
Financial development	+	+	Yes
Credit to households	+	+	Yes
Construction costs index	+	+	Yes
Production in construction index	−	0	No
Construction permits index	−	0	No
Global financial crisis	−	−	Yes
Covid crisis	−	+	No

that the effect of crises on housing prices varies depending on the nature of the crisis and the measures adopted.

Appendix

See Tables 5, 6 and 7.

Table 5 Descriptive statistic

Variable	N	Mean	Std. Dev	Min	Max
Housing price index	1344	96.09	24.64	38.36	169.16
GDP growth	1344	1.37	3.48	−21.60	29.08
Unemployment	1303	7.97	4.46	2.20	27.60
Wage growth	1279	1.03	0.05	0.79	1.20
gr_pop	1330	0.13	0.14	−0.92	1.04
Inflation	1344	1.63	1.35	−6.13	6.57
Long-term interest rate	1344	3.25	2.42	−0.78	26.40
Financial development index	1280	0.73	0.10	0.44	1.00
Credit to household GDP	1344	70.87	26.95	1.00	137.90
Construction costs	1343	91.75	12.74	55.90	121.10
Production in construction	1343	123.30	75.69	56.60	679.80
Housing permits index	1259	258.77	423.46	26.90	6217.30

Note: Indices tend to vary due to the baseline year (2010 or 2015). Therefore, outliers occur in states severely hit by the GFC and subsequent debt crises

Table 6 Indicators Related to the Processing of Building Permits and the Registration of Properties. *Source*: Self processing based on Doing Business 2021 dataset (data for 2020)

Economy	Dealing with construction permits					Registering property				
	Score-dealing with construction permits	Procedures (number)	Time (days)	Cost (% of warehouse value)	Building quality control index (0–15)	Score-registering property	Procedures (number)	Time (days)	Cost (% of property value)	Quality of land administration index (0–30)
Austria	75.3	11	220.5	1.1	13	80.3	3	17.5	4.6	23
Belgium	76.5	9	211	0.9	12	51.0	8	56	12.7	22
Denmark	87.9	7	64	0.6	11	89.9	3	4	0.6	24.5
Finland	73.6	17	98	0.7	10	79.0	3	61.5	4.0	26.5
France	73.3	10	213	3.9	13	63.3	8	42	7.3	24
Germany	78.2	9	126	1.1	9.5	66.5	6	52	6.7	23
Greece	69.5	17	180	1.9	12	47.7	11	26	4.8	5.5
Ireland	76.3	10	164	4.3	13	71.7	5	31.5	6.5	23.5
Italy	68.3	14	189.5	3.4	11	81.7	4	16	4.4	26.5
Netherlands	66.9	13	189	4.0	10	80.0	5	3	6.1	28.5
Norway	80.6	11	109.5	0.6	11	87.3	1	3	2.5	20
Portugal	73.2	14	160	1.2	11	78.4	1	10	7.3	20
Spain	70.8	13	147	4.7	11	71.7	6	13	6.1	22.5
Sweden	78.0	8	117	1.9	9	90.5	1	7	4.3	28
United Kingdom	80.3	9	86	1.1	9	75.7	6	21.5	4.8	26

Table 7 Country groups in random effect models

Group A	Group B	Group C	Group D
Austria	Greece	Denmark	Finland
Belgium	Ireland	France	Great Britain
Germany	Netherlands	Italy	Sweden
Norway	Spain	Portugal	

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Declarations

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