Macroeconomic drivers of London house prices
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Abstract
Purpose – The purpose of this paper is to validate and quantify the effect of key macroeconomic drivers on London house prices using annual data over the period 1983–2016.
Design/methodology/approach – Within this context, the authors estimate alternative error-correction and partial-adjustment models (PAMs), which have been widely used in the empirical literature in modelling the slow adjustments of house prices to demand and supply shocks.
Findings – The results verify the existence of a strong long-term relationship between London house prices and key macroeconomic variables, such as UK GDP, London population and housing completions. A key finding of the study relevant to the debate on the causes of the housing affordability crisis is that the results provide little evidence in support of the argument that user demand, which is captured in the author’s model by Greater London population, may have had a diminished role in driving house price inflation in London.
Practical implications – The practical and policy implications of the results are that increased homebuilding activity in London will undoubtedly help limit house price increases. Also, any potential reduction of immigration and economic growth due to Brexit will also have a similar effect.
Originality/value – The originality of this research lies in the use of annual data that may better capture the long-term effect of macroeconomic drivers on house prices and the estimation of such effects through both error-correction and partial-adjustment models.
Keywords House prices, Housing market, London house prices, London residential market, House price determinants, House price drivers
Paper type Research paper

Introduction
The housing market is a very important segment of national economies in the developed world, as it is a large part, if not the largest, of their property markets. The London housing market is not only by far the largest and most active residential market in the UK, but also one of the largest and most active in Europe, attracting investors from all over the globe. In addition, a number of empirical studies have confirmed the “ripple effect” of London/Southeast house price movements on UK regions (MacDonald and Taylor, 1993; Meen, 1999; Wood, 2003) further highlighting the importance of this market in assessing house price movements across the major housing markets in the UK.

The importance of the London housing market and its ripple effect on regional markets becomes even more critical in light of the UK housing affordability crisis, which has been brought about by near-continuous price increases since the mid-1990s (Rossall, 2015). These price increases have led to decreasing homeownership rates, and an increasing number of individuals turning into long-term renters, or even becoming homeless. As noted by a number of analysts, this crisis is especially severe in the Southeast of England and the London urban area, which have registered the steepest house price increases (Hilber, 2015).

A number of analysts have highlighted the dichotomy of housing demand from users and investors and emphasised the role of investment demand, especially in London and the Southeast, in driving these steep house price increases (Gallent et al., 2018; Rossall, 2015).

According to Rossall (2015), the major source of investment demand for housing in UK has been primarily individuals of high net worth (both of domestic and foreign origin). Institutional investors (both domestic and foreign) have been heavily investing for long time in ground rents and student housing, but there has been an increasing interest for investments in the private-rented housing sector (Rossall, 2015). An IPF survey of...
Institutional investors in 2012 showed that over 40 per cent of the value of the respondents' investment in the residential sector at the time of the survey was focused on market-rented/assured short-hold tenancies, followed by student housing and development land. The long interest of foreign wealthy individuals and institutional investors in the London property market has been fuelled by London's rise to a global city and an international financial and business centre housing the regional headquarters of the world's top businesses and financial organisations. Furthermore, the long history of steep house price increases in the London housing market has cemented perceptions of the London property market as a safe haven.

Despite the above issues concerning the drivers of house price increases and the importance of the London housing market within the broader UK housing market and its international appeal, there have been only a few econometric studies trying to identify empirically the macroeconomic drivers of London house price movements. Most of the existing literature on UK house prices focuses on regional variations and the questions of the existence of ripple effects and price convergence across regions. White (2015) has estimated an error-correction model for the Greater London area using quarterly data spanning from 1983 to 2011. This study extends the period of analysis to 2016, thus providing a better insight to the long-run adjustment of London house prices to the significant exogenous shock of the global financial crisis that began in 2008. Furthermore, the study uses annual data, which may better reflect the slow long-term adjustments of real estate markets and the long-term cointegrating relationship assumed by the error-correction models. Adams and Fuss (2010) provide evidence of the slow pace by which residential markets adjust through a panel cointegration analysis of housing markets in 15 countries, which indicates that it may take up to 14 years to return to equilibrium in response to exogenous shocks that create supply-demand imbalances. Also estimates of the speed of adjustment of real house prices across the 51 states in the USA by Pan and Wang (2016) point to an average full adjustment time in excess of 22 quarters.

Within this context, this study focuses on providing further econometric evidence with respect to the major macroeconomic drivers of London's house prices taking into account the behaviour of the market during the period that followed the global financial crisis. The results of our analysis shed some further light on the dynamics shaping the affordability crisis in the London housing market and the role that user demand may have played in shaping house prices. Furthermore, the findings of the study provide insights that will help investors, major market players and financial institutions to better assess the nature of future movements in house prices, not only in the London/Southeast region but also in other regions within the UK, thereby enabling them to make more prudent residential development, management and investment decisions.

Given the widely accepted sluggishness by which real estate markets move to equilibrium, we use two relevant modelling frameworks – the error-correction model and the partial-adjustment model (PAM) – which have been used extensively in past studies of house price movements in many countries, including the UK. The time horizon of the study, which includes the global financial crisis that began in 2008, is well suited for testing empirically the existence of a long-term cointegrating relationship between London house prices and movements in macroeconomic fundamentals.

**Macroeconomic determinants of house prices**

In all studies of macroeconomic determinants of house prices, the focus is on the major drivers of the demand for, and the supply of, housing. The most relevant research with respect to the subject matter of this study is the White (2015) analysis of house price movements in the UK regions, including Greater London, using an error-correction framework. That study used quarterly data spanning from the first-quarter of 2008 until the
first-quarter of 2011. The results of the study confirm the cointegrating relationship between Greater London real house price movements and key macroeconomic variables, such as income measured by real gross value added, gross mortgage lending and interest rates. Net migration, although statistically significant, had the wrong sign while money supply and change in housing stock were statistically insignificant.

Taltavull de La Paz and White (2012) also studied the macroeconomic determinants of UK house prices at the national level using an error-correction model. The results of this study confirmed the existence of a cointegrating relationship between national UK house prices and macroeconomic variables such as income, mortgage lending, net migration and interest rates, with the first two having the strongest effect. They also confirmed the statistical significance of two structural breaks, in 2001 and 2008.

A number of other studies on UK house prices focus on regional variations and the questions of the existence of ripple effects and price convergence across regions. MacDonald and Taylor (1993), Meen (1999) and Wood (2003) confirmed the existence of a house price “ripple effect” initiating from the London/Southeast region and diffusing to the other UK regions. Muellbauer and Murphy (1997), as well as Munro and Tu (1996) confirmed the existence of statistically significant differences in house price levels and movements across regions, which are attributable to differences in housing market structures and regional economic structures.

Rossall (2015) in a study of the UK affordability crisis groups the demand-side drivers of UK house price inflation into three categories labelled as “population”, “incentivisation” and “financialisation”. The “population” factors include the drivers of population growth, that is, domestic population growth and immigration, while the “incentivisation” factors include interest rates, generous tax incentives to overseas buyers and government assistance to low-income buyers. Finally, the “financialisation” factors include the components of investment demand, that is demand from domestic and foreign wealthy individuals, buy-to-let demand fuelled by large scale availability of buy-to-let mortgages and demand from institutional investors. Some of these factors, such as population growth and interest rates, have been included in most econometric studies of house prices, but most of the rest are difficult to include directly in a long-term econometric study due to the lack of data. They do highlight though the dichotomy of housing demand to users and investors, a dichotomy that has been at the centre of the discussion of the drivers of house price inflation in the UK. Rossall (2015), although recognising the major role of population growth and user demand in driving UK house price inflation, argues that it is “investment demand […] that has corrupted the housing market in many areas and pushed average houses prices out of the reach of average citizens”.

Along the same lines, Gallent et al. (2017, 2018) emphasise the role of investment demand in driving house price inflation. In framing the problem of steep house price increases that caused the affordability crisis, Gallent et al. (2018) argue that in essence it is an “investment crisis” rather than a mere inadequacy of supply to meet demand. The authors argue that the dynamics of the affordability crisis in the UK housing market were shaped by two major shifts. The first shift was the transformation of housing from being a good serving, primarily the basic need of individuals and households for shelter, to an investment and savings vehicle. This shift was facilitated by low interest rates, and government policies such as limited regulation and tax incentives and was encouraged by strong long-term house price appreciation that cemented expectations of superior investment returns. The second shift, which affected the supply side, was the withdrawal of the state from the production and management of housing and the increasing reliance on market mechanisms.

The macroeconomic determinants of house prices have been also examined by a number of studies in several countries other than the UK. Some of the most commonly examined demand drivers in studies of house price movements in countries other than the UK include
income per capita (Quigley, 1999) or GDP/capita (Sivitanides, 2015; Pashardes and Savva, 2009; Pose del and Vizek, 2009; Hossain and Latif, 2009; Egert and Mihaljek, 2007), the number of households or population size (Quigley, 1999; Pashardes and Savva, 2009; Arestis and Gonzalez, 2014; Sivitanides, 2015), interest rates (Arestis and Gonzalez, 2014; Pashardes and Savva, 2009; Egert and Mihaljek, 2007; Apergis and Rezitis, 2003), inflation (Kearl, 1979; Poterba, 1992) and credit availability or money supply (Egert and Mihaljek, 2007). The main factors that have been included in house price models from the supply side include construction permits (Quigley, 1999), residential investment (Arestis and Gonzalez, 2014), construction costs (Pashardes and Savva, 2009; Sivitanides, 2015) and interest rates (Sivitanides, 2015).

Egert and Mihaljek (2007) examined the determinants of house prices in Central and Eastern Europe (CEE) countries and OECD countries. Their results point to considerably higher income (GDP per capita) and interest rate elasticities in the CEE countries compared to the OECD countries, as well as higher sensitivity of house prices to credit availability in the OECD countries. Pose del and Vizek (2009) also estimated house price models for three CEE countries and three OECD countries. Their results confirm a statistically significant effect for GDP and interest rates in four countries, while a statistically significant effect for lagged house prices was confirmed for three of the six countries.

Sivitanides (2015) verified the effect of GDP per capita, as well as the effect of the number of households and construction costs on Cyprus house prices over the period 2006–2014. That study also verified a structural break in the effect of GDP over the period immediately following the beginning of the global financial crisis.

Hossain and Latif (2009), in a study of the intertemporal behaviour of house prices in Canada, also verified the effect of GDP on house prices, and particularly on house price volatility. Furthermore, their study revealed an asymmetric effect of GDP on house price volatility. More specifically, negative shocks were found to cause a longer destabilising effect on house prices compared to positive shocks. Finally, the study confirmed that past house price appreciation and inflation also had a statistically significant effect on house price volatility.

A study of fluctuations in Greek house prices by Apergis and Rezitis (2003) found that interest rates had a contemporaneous statistically significant and negative effect (demand-side effect). The study also confirmed the positive (demand-side) effect of CPI, employment and money supply on Greek house prices.

Quigley (1999) examined the macroeconomic determinants of house prices in the USA. The results of this study do not strongly support the effect of income per household on house prices, as this variable was only marginally statistically significant in one of the models estimated. Also the effect of construction permits was not verified since the coefficient of this variable had the wrong sign (positive).

Overall, previous research on the determinants of house price fluctuations has confirmed at large the effect of fundamental drivers of housing demand and supply. Within this context, the modelling approach of this research focuses on these drivers in trying to explain the intertemporal behaviour of London house prices over the period 1983–2016.

Modelling house prices
In modelling the intertemporal behaviour of London house prices, we adhere to the classical demand–supply framework according to which prices at each point in time are determined by the interaction of supply and demand. Following Quigley (1999), demand and supply functions are represented as follows:

\[ D_t = f(P_t, INC_t, X_t), \]

\[ S_t = f(P_t, Y_t), \]
where \( D_t \) is the demand for houses at time \( t \); \( S_t \) the supply of houses at time \( t \); \( P_t \) the house price at time \( t \); \( \text{INC}_t \) the household income, or per capita income or GDP at time \( t \); \( X_t \) the vector of other exogenous housing demand drivers at time \( t \); and \( Y_t \) the vector of other exogenous housing supply drivers at time \( t \).

In the demand equation, other exogenous demand variables that may be included in vector \( X_t \) include market size variables, such as population, as well as variables reflecting the availability and cost of capital, such as money supply and interest rates. Obviously, a larger population, greater availability of credit and lower interest rates should be associated with a larger demand for houses.

By equating demand with supply and solving for price we get the following general form equations where \( S_t \) represents the total housing stock at time \( t \):

\[
P_t = f(\text{INC}_t, X_t, Y_t) \quad \text{or} \quad P_t = f(\text{INC}_t, X_t, S_t).
\]  
(3)

On the basis of this equation, we estimated alternative error-correction model specifications (linear, log-linear, linear-log and log-log models) and PAMs including a specification in which we replaced the exogenous supply vector \( Y_t \) with the actual London housing stock \( S_t \) (represented by cumulative housing completions since a housing stock series for Greater London was not available).

The error-correction model is estimated in a two-step procedure as suggested by Engle and Granger (1987). In the first step we estimate (3) to obtain the long-run effects of the independent variables and in the second step we estimate the short-term relationship with all variables in first differences and the inclusion of the lagged error term, \( e_{t-1} \), from the estimation of (3):

\[
\Delta P_t = f(\Delta \text{INC}_{t-1}, \Delta X_{t-1}, \Delta Y_{t-1}, e_{t-1}).
\]  
(4)

The basic partial-adjustment specification is derived from the following equation, which is quite suitable in describing price movements in slowly adjusting markets, such as the housing market:

\[
P_t = P_{t-1} + a \left( P_t^* - P_{t-1} \right).
\]  
(5)

In the above equation, \( a \) captures the per-period rate of partial adjustment, while \( P_t^* \) represents the long-run equilibrium house price as described by the following equation:

\[
P_t^* = b_0 + b_1 \text{INC}_t + b_2 X_t + b_3 Y_t.
\]  
(6)

Substituting (6) into (5) produces:

\[
P_t = ab_0 + ab_1 \text{INC}_t + ab_2 X_t + ab_3 Y_t + (1-a)P_{t-1}.
\]  
(7)

Estimation of (7) allows quantification of the short-term effects of the independent variables, which are represented by their estimated coefficients, and the long-run effects, which are derived by dividing their estimated coefficients by \( a \) (Zheng et al., 2010). As it can be derived from (7), \( a \) can be estimated as \( a = 1 - c \), where \( c \) is the OLS estimate of the coefficient of \( P_{t-1} \).

The data

In order to empirically analyse the determinants of London house prices, we use the Halifax and Nationwide House Price Indices (referred to as HHPI and NHPI, respectively, thereafter). These are constant-quality transaction-based indices, as opposed to appraisal-based, and as such they do not suffer from the widely discussed smoothing bias in appraised values (Geltner, 1991). Although ONS also publishes a constant-quality house price index produced with the same methodology used for the estimation of the NHPI and the HHPI, it was not
included in this analysis as the data starts in 1995, while the two latter indices start from 1983. Given the use of annual data for this analysis, the inclusion of the ONS house price index would considerably reduce the number of the observations of the dependent variable and the number of independent variables that could be potentially included in the estimated models. It should be noted that the annual levels of the two indices that were used in the analysis were determined by averaging the four quarterly levels for each year. The data spans from 1983 through 2016 and captures the effect of the global financial crisis that started in 2008.

Demand-side data used in our analysis include UK GDP (as a proxy for income), the Greater London population as a proxy for the size of demand, mortgage rates representing the cost of financing house purchases and money supply as proxy for the availability of financing for housing purchases. We are using M4 as proxy for money supply instead of M3, which has been used by other studies such as White (2015), due to the lack of a time series starting from 1983 for the latter. In any case, we believe that M4 is still a good proxy of intertemporal fluctuations in availability of financing and given the availability of data from 1983 it was used in our analysis. Data on Greater London population and UK GDP were obtained from the Office of National Statistics, while the mortgage rate series was obtained from the Halifax Building Society.

Supply-side data, and particularly the Greater London housing completions series, were obtained from the Department of Communities and Local Government, while the construction cost series (average construction output prices for both private and public housing) was obtained from the Department of Business, Innovation and Skills and the ONS (from 2014 until 2016).

Figures 1 and 2 depict the movements in the two London house price indices in terms of levels and percentage changes, respectively. As it can be seen from Figure 1, which shows both indices adjusted so that the base year (100) is 1983, the two house price series recorded very similar movements. There is a visible divergence occurring after 2007 as the HHPI recorded noticeably more severe drops over the period 2008–2009. However, after that the two indices have moved in a parallel way and registered approximately similar percentage changes until 2014, after which they registered again visibly different changes as shown in Figure 2.

The explanation for the more severe drops registered by the HHPI over the period 2008–2009 is not a change in the methodology of any of the two indices as no changes are reported in the description of the methodologies used by the two indices. The most likely explanation for the divergence of the two indices during those two extreme years in terms

![Figure 1. London house price indices](image-url)
of market conditions and transaction activity is that the HHPI might have registered more accurately the true changes in market prices as their hedonic price model via which transactions are analysed includes more property characteristics (age of property, number of garages, number of garage spaces, number of separate toilets, presence of a garden, etc.) compared to the model used for the construction of the NHPI. The explanation for the relatively larger differences in percentage changes registered in 2015 and 2016 by the two indices is more likely a change in methodology in the NHPI starting from 2015. This change involved the discontinuation of the use of floor area, type of garage and number of bathrooms in the calculation of the index due to changes in the bank’s mortgage application process.

Overall, the NHPI registered a higher average annual increase (8.4 per cent) over the 33-year period compared to the HHPI (8.0 per cent). These levels of annual price increases over such a long period are definitely high. On a cumulative basis, the HHPI registered an increase of 1,013 per cent over the 33-year period while the NHPI registered an increase of 1,169 per cent.

Looking at Figure 2 we can see that according to both indices, London house prices registered capital losses only during six years, specifically during the periods 1990–1993 and 2008–2009. During the period 1990–1993, the HHPI recorded a 24 per cent drop while the NHPI recorded a 29 per cent drop. However, during the period 2008–2009, the HHPI fell by 20 per cent while the NHPI fell by only 11 per cent. Both indices registered their largest annual increase in 1987 (HHPI increased by 24.3 per cent and NHPI by 26.8 per cent) but the largest decreases were recorded in different years. In particular, the HHPI recorded its largest fall (11.8 per cent) in 2009 while the NHPI fell the most (11.6 per cent) in 1990.

In the analysis that follows, we will try to identify the key macroeconomic factors that have driven these extraordinary capital gains in the London housing market over the 33-year period covered by the data.

**Econometric analysis**

Before proceeding with the estimation of the aforementioned time-series models for identifying and quantifying the effect of major macroeconomic variables on London house prices, we carried out stationarity tests for all variables that were used in our analysis. Such tests are necessary in order to avoid the spurious regression problem, which results in misleading OLS estimates and *t*-statistics that may indicate that an independent variable has a statistically significant effect on the dependent variable while in reality it does not.
In order to test the variables that were used in the alternative model specifications, we carried out Phillips–Perron (PP) tests, which correct for any serial correlation and heteroskedasticity in the errors of the test regression. The results of these tests are presented in Table I. As indicated in this table, all variables tested are non-stationary in terms of their levels and their logarithms. In terms of first differences, all variables except money supply (DMFOUR) can be considered stationary at an 85 per cent confidence level or higher.

In Table II, we present the best-fitting estimates of the cointegrating regression for HHPI and NHPI. It should be noted that the coefficients of this regression represent the long-term effects of the independent variables on London house prices. Due to the limited number of observations, we restricted the number of independent variables to three and experimented with alternative combinations of the available variables. For example, on the demand side,

<table>
<thead>
<tr>
<th>Series</th>
<th>PP statistic</th>
<th>PP statistic levels in logarithms</th>
<th>Optimal lag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Halifax house price index (HHPI)</td>
<td>−1.16</td>
<td>−2.35</td>
<td>4</td>
</tr>
<tr>
<td>Nationwide house price index (NHPI)</td>
<td>−0.45</td>
<td>−2.28</td>
<td>4</td>
</tr>
<tr>
<td>Real UK GDP (GDP)</td>
<td>−2.07</td>
<td>−1.71</td>
<td>3</td>
</tr>
<tr>
<td>London population (POP)</td>
<td>−0.18</td>
<td>−1.07</td>
<td>2</td>
</tr>
<tr>
<td>London housing completions (COMPL)</td>
<td>−3.31</td>
<td>−3.23</td>
<td>3</td>
</tr>
<tr>
<td>Cumulative London housing completions (CCOMPL)</td>
<td>−0.79</td>
<td>−13.49**</td>
<td>4</td>
</tr>
<tr>
<td>Construction Costs (COST)</td>
<td>−1.85</td>
<td>−1.46</td>
<td>4</td>
</tr>
<tr>
<td>Money supply – M4 (MFOUR)</td>
<td>−1.89</td>
<td>−1.56</td>
<td>4</td>
</tr>
<tr>
<td>Mortgage rate (RATE)</td>
<td>−2.95</td>
<td>−3.06</td>
<td>2</td>
</tr>
<tr>
<td>First differences</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DHHPI</td>
<td>−3.06</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>DNHPI</td>
<td>−3.89*</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>DGDP</td>
<td>−3.37*</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>DPOP</td>
<td>−3.77*</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>DCOMPL</td>
<td>−7.07**</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>DCCOMPL</td>
<td>−3.25</td>
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<td>4</td>
</tr>
<tr>
<td>DCCOST</td>
<td>−3.04</td>
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<tr>
<td>DMFOUR</td>
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<td></td>
<td>4</td>
</tr>
<tr>
<td>DRATE</td>
<td>−4.71**</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

**Notes:** *Due to small number of observations all tests are performed with maximum lag of four years. The optimal lag is the lag for which we obtained the lowest PP statistic. *Significant at the 5 and 1 per cent level, respectively

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Dependent variable log (HHPI) coefficient</th>
<th>Dependent variable log (NHPI) coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>−0.90 (−0.82)</td>
<td>−2.77 (−2.46)**</td>
</tr>
<tr>
<td>UK real GDP</td>
<td>3.05E−06 (9.47)**</td>
<td>3.35E−06 (8.88)**</td>
</tr>
<tr>
<td>London population</td>
<td>3.95E−07 (2.88)**</td>
<td>6.06E−07 (4.27)**</td>
</tr>
<tr>
<td>Cumulative completions</td>
<td>−4.01E−06 (−3.85)**</td>
<td>−4.24E−06 (−3.78)**</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.976</td>
<td>0.978</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.973</td>
<td>0.976</td>
</tr>
<tr>
<td>PP statistic of error term (fourth lag)</td>
<td>−3.06</td>
<td>−3.36</td>
</tr>
</tbody>
</table>

**Note:** *Significant at the 5 per cent level
we used alternatively the combination of money supply and London population, instead of the combination of GDP and London population, which are included in the best fitting model in Table II. Also, on the supply side, we used construction costs, mortgage rates and money supply as drivers of London completions (which represent the change in the existing housing stock not the total housing stock in the market) as alternatives to including the actual housing stock, which in our analysis is represented by cumulative London completions since a housing stock series was not available. We also tested alternative functional forms, that is, linear, log-log, linear-log and log-linear. Given that all analysed variables are non-stationary, we tested the residual of all these alternative specifications for unit root using the PP test. Only in the case of the log-linear model, the PP statistic was low enough to allow the rejection of the unit root hypothesis at a significance level below 10 per cent. Furthermore, in some model specifications, such as the log-log model, we obtained wrong signs for some variables.

Within this context, we present in Table II the results of the log-linear cointegrating regression of the error-correction model for the HHPI and the NHPI. The demand-side variables include UK GDP and London population while the supply side is directly represented by the London housing stock calculated, as the cumulative completions of new houses since 1983. All variables are statistically significant at high levels of confidence and have the expected signs. It should be noted that the results of the NHPI are considered more reliable since the PP test of the error term of the regression suggests that we can reject the unit root hypothesis at a level of confidence that is greater than 90 per cent. This is not true for the error term of the HHPI regression results.

As indicated earlier, the coefficients of the estimates of the cointegrating equation, presented in Table II, represent the long-term effects of the independent variables on London house prices[1]. The NHPI results point to a slightly stronger effect on London house prices from GDP growth as opposed to London population growth. In particular, the estimated coefficients for that model suggest that 1 per cent growth in the former from its 2016 level would cause a 5.9 per cent rise in house prices, while 1 per cent increase in London’s population from its 2016 level would cause a 5.3 per cent rise, assuming zero completions of new housing units. On the supply side, according again to the NHPI results, an addition of 20,000 new units (which represents the rounded annual average of the period 2006–2016) in the market would cause an 8.5 per cent drop in house prices, assuming a stagnant UK economy and no growth in London’s population.

The HHPI results point to a considerably stronger effect on London house prices from GDP growth as opposed to London population growth. In particular, the estimated coefficients for these two variables indicate that 1 per cent growth in UK GDP from its 2016 level would push London house prices up by 6.2 per cent, while 1 per cent growth in London’s population from its 2016 level would push house prices up by 3.5 per cent, assuming again zero completions of new housing units. The results for the effect of supply are similar as the estimated coefficient implies that the completion of 20,000 new housing units in Greater London would cause an 8 per cent drop in house prices in the face of a stagnant UK economy and zero London population growth.

The relative effect of GDP growth vs population growth is relevant to the debate regarding the dichotomy of demand and the effect of each component on house prices. As discussed earlier, the prevalent view is that population growth may have played a secondary role in pushing house prices up, with investment demand being the primary driver of house price inflation. Although GDP does not necessarily reflect only investment demand, as GDP growth affects both investor and user demand through expectations and income growth, it seems that its aggregate effect, as evidenced by the more robust results of the NHPI estimates, is only slightly stronger than the effect of population growth. This provides little support to the argument that the role of population growth was secondary in inducing the steep house price increases registered in the London market.
Table III presents the estimates of the short-term error-correction model. The results do not provide very strong evidence of the error-correction mechanism. Although the error-correction term, which is the lagged residual of the cointegrating regression, is statistically significant at the 5 per cent level in both the HHPI and NHPI short-run regressions the first differences of UK GDP and London population are not statistically significant. The only variable that is statistically significant is the supply variable. Given the poor results of the short-term model, the estimated short-term effects of each variable are not discussed.

The estimates of the PAM using the two indices provide alternative estimates of the long-term and short-term effects of the key macroeconomic drivers of London house prices. Actually, these results are more robust than the results of the error-correction models, as the PP test of the error term of the regressions for both indices indicate that the unit root hypothesis can be rejected at very high levels of confidence. Furthermore, the Breusch–Godfrey serial correlation tests confirm the lack of serial correlation in the residuals of both regressions at a 94 per cent or higher confidence level.

Table IV presents the estimates of the PAMs, which have the same functional form (log-linear specification) and include the same independent variables (with the exception of the lagged dependent variable) as the cointegrating equation. These estimates provide further and more robust evidence against the argument that population growth may have played a secondary role in inducing house price increases in the London housing market. In particular, the estimated coefficients in both the NHPI and the HHPI regressions suggest a stronger long-term effect from population growth rather than GDP growth.

### Table III.

<table>
<thead>
<tr>
<th>Independent variables in first differences (Lagged by one period)</th>
<th>Dependent variable D (LogHHPI) coefficient</th>
<th>Dependent variable D (LogNHPI) coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.313 (3.99)**</td>
<td>0.304 (3.81)**</td>
</tr>
<tr>
<td>UK real GDP</td>
<td>6.66E–07 (1.19)</td>
<td>4.03E–07 (0.71)</td>
</tr>
<tr>
<td>London population</td>
<td>5.84E–07 (1.62)</td>
<td>5.91E–07 (1.67)</td>
</tr>
<tr>
<td>Cumulative completions</td>
<td>−1.78E–05 (−3.57)**</td>
<td>−1.66E–05 (−3.33)**</td>
</tr>
<tr>
<td>Error term of cointegrating regression</td>
<td>−0.304 (−2.31)**</td>
<td>−0.316 (−2.17)**</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.54</td>
<td>0.46</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.46</td>
<td>0.38</td>
</tr>
<tr>
<td>PP statistic of error term (first lag)</td>
<td>−4.54**</td>
<td>−4.46**</td>
</tr>
</tbody>
</table>

**Note:** **Significant at the 5 per cent level

### Table IV.

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Dependent variable log (HHPI) coefficient</th>
<th>Dependent variable log (NHPI) coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>−2.37 (−4.39)**</td>
<td>−2.98 (−5.27)**</td>
</tr>
<tr>
<td>UK real GDP</td>
<td>1.99E–06 (8.18)**</td>
<td>1.89E–06 (7.33)**</td>
</tr>
<tr>
<td>London population</td>
<td>4.29E–07 (6.19)**</td>
<td>5.00E–07 (6.42)**</td>
</tr>
<tr>
<td>Cumulative completions</td>
<td>−3.65E–06 (−6.38)**</td>
<td>−3.54E–06 (−6.38)**</td>
</tr>
<tr>
<td>Lagged dependent variable</td>
<td>0.556 (8.75)**</td>
<td>0.549 (8.14)**</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.994</td>
<td>0.994</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.994</td>
<td>0.994</td>
</tr>
<tr>
<td>$p$-value Breusch–Godfrey SC test</td>
<td>0.06</td>
<td>0.00</td>
</tr>
<tr>
<td>$p$-value for Durbin $h$</td>
<td>0.07</td>
<td>0.04</td>
</tr>
<tr>
<td>PP statistic of error term</td>
<td>−4.84**</td>
<td>−4.08**</td>
</tr>
</tbody>
</table>

**Note:** **Significant at the 5 per cent level
(assuming equal overall growth in both factors). In particular, based on the HHPI results, a 1 per cent increase in London’s population from its 2016 level would cause an 8.5 per cent increase in house prices in the long term while a similar increase in the UK GDP would cause an 8 per cent increase. In the case of the NHPI results, the effect of population growth compared to GDP growth is even stronger (9.7 vs 7.5 per cent).

On the supply side, the partial-adjustment results suggest a considerably stronger role in limiting house price inflation compared to the results of the error-correction models. In particular, the estimated coefficients indicate that an addition of 20,000 new units in the market would help bring down price levels by 15–16 per cent in the long term, assuming a stagnant UK economy and no growth in London’s population.

The short-term effects of the macroeconomic factors on the HHPI and NHPI, as derived from the PAM estimates, indicate that with no supply growth a 1 per cent increase in UK GDP and London population from their 2016 levels would cause a 3.4–3.5 per cent and a 3.8–4.4 per cent increase in house prices, respectively. On the contrary, with no population and GDP growth, the entrance in the market of an additional 20,000 units would cause a 7.1–7.3 per cent drop in house prices in the short term.

Overall, the results of the estimated models verify at high levels of confidence the long-term impact of both GDP growth and population growth (capturing user demand) with the latter appearing to have a stronger effect (per percentage unit increase) than the former, based on the more robust results of the PAM specifications. Furthermore, our results confirm clearly the role that increased homebuilding activity can play in limiting house price inflation.

**Conclusion**

Our results are consistent with the results of the previous study by White (2015), as they confirm the existence of a long-term cointegrating relationship between London house prices and key macroeconomic drivers. In particular, our analysis has verified and quantified at high levels of confidence the long-term effects of UK GDP, London population and cumulative housing completions on London house prices. The results are consistent with our expectations of the effect of these three key variables on the London housing market. Estimates of alternative functional forms indicate that the long-term relationship between these key drivers and London house prices is best represented by the log-linear model specification. Furthermore, the PAMs have provided clearly more robust estimates compared to the error-correction models.

An important finding of our analysis that relates to the debate on the causes of the London housing affordability crisis is the stronger effect of population growth and, thereby user demand, than GDP (on an equal growth assumption), in driving house price inflation. The estimated effect of GDP must include the effect from investor demand through its effect on investor expectations and income. However, the GDP effect should also include additional user demand effects (beyond the effect of population size) through the same channels. In particular, increasing household income and positive expectations can cause increases in demand for housing from users, even if population remains constant. Therefore, the aggregate user demand effect on London house prices should be even greater than the effect implied by the estimated coefficients for population.

If we take into account the average annual growth rates of GDP and London population after 2009, our estimates provide little support to the argument of a lesser role of user demand and an excessive role of investor demand in driving house price inflation in Greater London. In particular, the average GDP growth rate over the period 2010–2016 was 2 per cent while the average London population growth rate was 1.5 per cent. Based on the more robust results of the PAM for NHPI, these growth rates would translate to a GDP-driven long-term house price increase of 15 per cent and a population-driven price
increase of 14 per cent, ignoring any growth in the London housing stock. Similarly, based on the partial-adjustment HPI results, the average annual growth rates for GDP and London population over the period 2010–2016 would translate to long-term house price increases of 16 and 12 per cent, respectively. Taking into account that some of these GDP effects should incorporate and some effect from user demand, beyond the effect of population size, then the argument of a diminished role on the part of user demand compared to the effect of investor demand does not seem to be supported by our estimates.

Other important implication of our findings in relation to the UK affordability crisis is that any potential reduction of immigration and/or GDP growth as a result of Brexit will have a limiting effect on London house price inflation. Furthermore, our results indicate clearly that increased homebuilding activity can have a considerable limiting effect on house price inflation in the Greater London area.

The main limitation of our study is the relatively small number of observations because it uses annual data, which were considered more appropriate in capturing the long-term effects of key macroeconomic variables on the slowly adjusting housing market. The annual frequency of the data used may be the reason for the poor results of the short-term error-correction model. Further research could test the effect of additional independent variables with the use of quarterly data that would include more observations.

Note
1. Given the log-linear specification of the model, the interpretation of the estimated coefficients is that for a one unit increase in one of the independent variables in the model (while all other variables in the model are held constant) the dependent variable (London house price index) changes by a per cent equal to 100 times the coefficient of that independent variable.

References


Rossall, V.D. (2015), Solving the UK Housing Crisis, The Bow Group, London.


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