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AN INVESTIGATION OF AFFORDABILITY IN THE UK REGIONS

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An Investigation of Housing Affordability in the UK Regions *

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Abstract

The housing market has been extensively investigated in the literature; however there is a lack of understanding of the fundamentals affecting housing affordability across UK regions as measured by the price to income ratio. The aim of this paper is twofold; firstly we calculate the affordability ratio based on individuals' incomes. Second we set off to ask which socio-economic factors could affect this ratio. The analysis finds a strong influence coming from the mortgage rate, the residents' age and academic qualifications. We also report a positive and significant effect from foreign capital coming to the UK. Finally, we record a non-negligible degree of heterogeneity across the twelve regions.

Keywords: House market, affordability index, heterogeneity, panel data.
JEL classification: E31, E52.

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1 Introduction

It is well known that the UK housing market is of primary importance for the UK-wide economy; an OECD study reporting data on the composition of household wealth shows that households hold a large share of their wealth in real estate properties (Catte et al., 2004). Furthermore, the literature has provided evidence that the property market may be region specific and can have a strong role to play in the transmission of monetary policy. In fact dwellings are typical examples of the collateral that households and firms provide in order to secure borrowing.[1] Against this background, numerous studies have investigated the dynamics of national and regional house prices, and we can identify two strands of this literature.

The first is concerned with house price valuation; here, the main objective is to understand the link between economic fundamentals and the property valuation, both at national and regional levels (see e.g. Cameron et al., 2006). The aim is to try to identify which macroeconomic factors can help policymakers detect possible deviation from fundamentals and the formation of bubbles. As Muellbauer and Murphy (2008, p.5) explain, "the deviation of prices from long-run fundamentals is then the 'bubble-burster'." More specifically, house prices may surge due to a series of positive shocks to fundamentals such as households' earnings. Thus, the expectation of further appreciation of houses leads to their overvaluation, but in due course the realisation that the improvement in fundamentals has been outpaced by house price increases, leads to a slowdown in the rate of appreciation.[2] McMillan and Speight (2010) analyse deviations of house prices from fundamental values in terms of the present value model for asset prices. Here the asset price is explained by the 'fundamental', which is the expected future payoffs of the asset itself; in the stock market literature these payoffs are dividends, while for bonds they are represented by interest and principal payments. The theoretical underpinning for the hypothesis is that the current price-earnings ratio predicts future movements in stock prices. In applying this methodology to the housing market the authors utilize the price-to-income ratio to investigate possible irrational deviations from fundamentals.

The second strand of the literature investigates the dynamics developing in regional property prices and the possibility of the existence of a 'ripple effect'. This refers to the fact that changes

[1] This is traditionally referred to as the balance sheet effect. See e.g. Bernanke and Gertler, 1989.

[2] There is a relatively vast literature examining the boom in house prices; mainly covering countries which experienced a major boom during the nineties. See e.g., Case and Shiller (2003) in the US, Cameron et al. (2006) and Black et al. (2006) in the UK, Abelson et al. (2005) in Australia; and Stevenson (2008) in Ireland. A cross-country comparison is provided by Girouard et al. (2006)

in the housing market are first observed in London, and then is propagated to other regions. As Cook (2005) explains, the diffusion of changes in house prices that the 'ripple effect' implies, is consistent with a constant expected value of the ratio of regional house prices to aggregate ones. He finds that the aforementioned ratio is stationary for a number of regions thereby supporting the notion of the 'ripple effect'. The majority of the empirical literature rests on empirical specifications which do not deal with asymmetric and non-linear behaviour, see e.g. Meen (1999) and Cook (2003). A notable exception is Cook (2006), who utilises a robust non-parametric test. More recently, Holmes and Grimes (2008) find that the first principal component of the differentials between regional and national houses prices is stationary, implying that UK regional house prices are driven by a single common stochastic trend.

The present paper extends the existing literature in various ways. Firstly, a characteristic of the studies mentioned above is the use of the price of dwellings as the main variable in order to capture markets' dynamics. We depart from the previous literature by utilizing data on the house price to earnings ratio (*HPER*) at a regional level. Although this is one of the oldest measures of housing affordability across regions (Andre, 2010), the UK literature has devoted little attention to its dynamics. Nevertheless, housing affordability has been the subject of a major policy debate particularly with regard to the impact of new home building in different regions.[3]

Second, we calculate the affordability ratio based both on male and female earners. The Halifax computes and disseminates an affordability ratio which is widely used by researchers. However, since this index utilizes only income data for men, the affordability ratio may not reflect a true value of housing affordability. For this reason, we calculate an affordability ratio using the house prices and individual income data collected directly from the Labour Force Survey; this allows us to include both male and female earners.

Finally, rather than focusing on the time-series properties and their ability to detect booms and busts in the housing market, we are interested in the determinants of the affordability ratio. To this end we estimate the relative importance of various socio-economic fundamentals collected from a survey data set, to each regional ratio.[4]

[3]The focus here is on *income affordability* as opposed to *purchase affordability* and *repayment affordability*. These measures include additional factors, which describe the downpayment ratio, the per period mortgage-payment-to-income ratio, the length of the mortgage and the actual mortgage interest rate (Gan and Hill (2009) and the next section).

[4]We should stress that this study is not meant to investigate this ratio as a measure to identify people who should be eligible for housing benefits or to verify the threshold level which can be used for that purpose.

Our analysis covers the twelve UK regions for the period 1995-2012; we find that there is a common trend in the housing market, but at the same time we show the presence of some heterogeneity in the *HPER* across regions. Furthermore, we report that the mortgage rate, the residents' age and academic qualifications have strong explanatory power over the *HPER*. Inward foreign investment also seems to have a statistically significant impact although their impact appears to be rather small.

The remainder of the paper proceeds as follows. In Section 2 we summarize the concept and brief history of housing affordability and its practical application in business and research. Section 3 describes the data and the methodology to construct the affordability ratio used in this paper. Section 4 summarizes the statistical method which enables us to obtain the sensitivity of the explanatory variables while making use of regional heterogeneity. Section 5 investigates the relationship between the *HPER* and fundamentals, followed by the conclusion in Section 6.

2 Housing affordability and the affordability ratio

While few economic studies have been carried out, the affordability ratio is well-known to consumers, businessmen and policymakers and has been analyzed by a number of statisticians and sociologists. According to Hulchanski (1995), the history of this ratio goes back to the work of Ernst Engel (1821-1896) who calculated the proportion of expenditure on economic goods to income, known as Engel's law or the Engle curve. This law has often been studied in the context of expenditure on food and other necessities and thus is closely related to a measurement of living standards. In this regard, this ratio has profound social implications especially for those who are on a low income.

The concept of housing affordability is essentially the same as that for commodities; it measures the proportion of the costs for accommodation out of income. A popular measure for the costs is the purchase (market) price or the rent of a house. Because a dwelling is a necessity in life and is normally the most expensive individual's purchase, this cost-income ratio is considered as important as that for food and also has a significant implication for the individual's well-being. Indeed, since the publication of Engel's work (1895), this ratio is used to this day by private banks and policy-makers to make lending decisions and/or to formulate housing policies. Banks are willing to lend money to those who would seem able to pay back the loan, and the government tries to identify residents who really need public support by means of

housing subsidies and benefit allowances, for example. Due to its simplicity as a concept, this ratio has been widely used across the world as a measure of housing affordability, and has been empirically analyzed in many countries: Australia (Bourassa, 1996, Gan and Hill, 2009), China (Lau and Li, 2006), Singapore (Ong, 2000), the UK (Hancock, 1993) and the US (Steinnes and Hogan, 1992, Bogdon and Can, 1997, Rappaport, 2008).[5]

Despite its popularity, in practice one needs to be very careful when interpreting this ratio. There are several sources of uncertainty around this ratio, which can give misleading signals. First, there is no clear and universally accepted definition of "affordability". This ratio means different things for different households; it gives a different picture of an individual's choice depending for example on the family composition. As an example, consider a *HPER* equal to 30% with two households earning the same income but with and without children. For a household with two children, 30% may be regarded as very high since they need to live on the rest of the income purchasing daily consumption for four people (17.5% for each). In contrast, each member of a household without children can spend 35% after deducting housing costs from income. In other words, a household with children needs to sacrifice more consumption after purchasing a house. Similarly, this ratio may mean very different things to people at different stages of their lives. For young people whose income would be expected to increase in future, 30% may be regarded as a modest proportion. But those people who are about to retire and would expect future income to fall, this ratio can be thought of as extremely high. Furthermore, consumers' preference for a house is likely to be different; for instance, some people may feel more emotionally secure by purchasing a house than others, and thus put a higher priority and value on their house compared to other economic goods and services.

Second, there is no clear definition of which data are to be used for research. Even among researchers, there is no consensus about what is to be included in the costs incurred in the purchase of a house. The house price is an obvious candidate, but there are many other definitions of housing costs. For example, Rappaport (2008) considers the required homeownership payments which consist of mortgage interest payments, mortgage principal payments, real estate taxes, fees, maintenance expenses, homeowner's insurance and tax savings. It follows that even with a similar purchase price for a house, actual costs may vary depending upon the size

[5]See Kearns (1992) and Stone (2006) regarding the debate about house affordability in the UK. Mayo and Gross (1987) discuss the controversy about using the simple affordability ratio to decide targets for housing subsidies in developing countries.

of the downpayment and the mortgage rate. Similarly, as for income, one could consider the present and future income when calculating the affordability ratio. But most previous research has used only the current income since there is always uncertainty involved about future income, arising for example from the possibility of divorce, illness and redundancy which would decrease income. Furthermore, not all people purchase a house with a fixed mortgage rate. It follows that costs are also dependent upon a variable mortgage rate. Finally, since micro data are often unavailable, many previous studies have used an aggregate affordability ratio. But there is a question about an aggregation bias for estimates obtained from macro data.

Third, there is no clear threshold based on which houses should be classified as unaffordable. Indeed, in the 19th century a house was believed to be appropriate in the US if one month's rent was equal to one week's wage. In more modern times, the appropriate level of this ratio has varied over time. Generally, the affordability ratio is expected to range from 20 to 30 percent (Hulchanski, 1995, Bourassa, 1996, Ziebarth et al., 1997), but there is a tendency for the appropriate level to increase over time. Obviously, in the world of a developed banking system, it is relatively easy for anyone to have a high ratio due to easier access to capital.

Against this background, Gan and Hill (2009) have argued that it is more appropriate to examine the distribution of household income and house prices which can be collected from a survey. Bourassa (1996) utilized household survey data for the period 1989-1990 in Australia and showed that a majority of house-owners are grouped in the unaffordable category if the standard threshold level were applied. Other researchers analyzed micro data for different research objectives. Bogdon and Can (1997) considered the importance of residential location on formation of public policy, and adopted a spatial approach in order to highlight the mismatch of the demand and supply of houses in the low-income group. Similarly, Ziebarth et al. (1997) examined housing affordability taking into consideration the location of houses and reported a higher ratio in rural areas.

There is an alternative approach for measuring affordability, the so-called residual income approach (see Stone, 2006). Unlike the house price-income ratio which measures the maximum level of expenditure on houses, this approach measures whether people can purchase the minimum level of necessities after deducting from their income the payment of tax and housing expenses. Therefore, the residual income approach is often regarded as more directly linked with welfare, and at times gives us different pictures about the level of housing affordability

compared with the cost-income ratio (Rappaport, 2008).

While there are some drawbacks in the cost-income ratio, the *HPER* still remains a very popular concept among practitioners and researchers. Furthermore, to our knowledge there are no micro socio-economic data whose classification method is consistent with UK housing prices. For this reason, in the next section, we shall analyze heterogeneity in the *HPER* by constructing regional level socio-economic data which are believed to affect income and house prices.

3 Data and preliminary analysis

The analysis of the UK housing market is based on several key economic and social indicators; the data set covers the period 1995Q1-2012Q3 for the twelve UK regions (North, Yorkshire & Humberside, East Midlands, East Anglia, London, South East, South West, West Midlands, North West, Wales, Scotland and Northern Ireland).[6] The house prices data correspond to the Halifax house prices.[7]

Tables 1 and 2 provide a snapshot of our data set. House prices are, on average, higher in London compared to anywhere else in the UK; for instance, in Scotland house prices are about half those of London. Furthermore, Figure 1 shows that house prices exhibit an increasing trend across the country over the years with a marginal decline in the last part of the sample, supporting the idea that the beginning of the housing market downturn coincided with the occurrence of the sub-prime loan problem and the Lehman Shock.

Data on the unemployment rate and population growth are collected from the Office of National Statistics (ONS); the former is high (more than 8%) in London and the North, and relatively low in the South East and South West (less than 5%). While not reported in the tables, the UK population has been generally increasing with the highest population growth (quarter to quarter) in the Yorkshire & Humberside (0.2%). On the other hand, the East Midlands has experienced the lowest population growth (0.01%) in the UK. In order to control for possible supply side effects in the housing market, we used the number of permanent dwellings completed, by region (Housing supply). Again, there is regional disparity; housing construction

[6]See Appendix for more detailed descriptions of the data. Our samples is limited by the availability of the socio-indicators. Population growth which is available only through 2010q1.

[7]Regional house prices are seasonally adjusted and standardized, rather than a simple average. The standardized prices are discussed as appropriate for panel data analysis since no two houses are exactly the same in terms of their characteristics. Thus this data transformation by the Lloyds Banking Group using 12 criteria to identify similar houses enables us to compare the values of houses in different locations and time periods.

is very active in the South East, while the North and Wales have experienced a relatively low level of construction.

In addition to these region-specific indicators, we use the mortgage rate as a variable influencing the affordability ratio, which is at a national level and is collected from the Bank of England. Another factor which could have an impact on the dynamics of the housing market, is the the influx of capital from Asia, other European countries and the USA, and a debate has recently emerged about the role of foreign capital in shaping the house price-to-income ratio. To test this hypothesis, we include in our data set the Foreign Direct Investment (FDI) in each economic region as a proxy of changes in foreign demand for UK dwellings. Unfortunately, region or house specific investment data are not available, and thus our data on capital inflows are rough estimates at a national level; nonetheless, the FDI data show the long-term commitment of foreign residents to invest in the UK.

While the above economic data have already been aggregated, many social indicators need to be compiled from survey data in order for them to be consistent with the definition and classification method for the Halifax house prices. Hence, we utilize information published in the Quarterly Labor Force Survey (LFS), which contains a variety of questions related to the characteristics of households residing in the UK.[8] We aggregate information from the LFS to obtain regional observations. More specifically, data on the age, income, academic achievements and job type are averaged for each region and quarter; a proportion of married respondents is calculated in order to create a quarterly regional variable related to marital status. A low value in academic achievements from our data suggests more education obtained by the respondents, and a high value in our marital status variable implies a high proportion of married people in the region.

As a snapshot, our final data set comprises of quarterly data based on responses from 512,442 individuals. Information is based on answers from respondents aged between 16 and 92. Their average age is around 40, and about 50% of the respondents are male, this can be seen in the density presented in Figure 2. Furthermore, around 60% of respondents are married. With respect to academic achievements, more than 30% of respondents possessed O levels, and about 30% have a higher degree (Degree or Teaching and Nursing). In terms of job type, about 70% are employed in the private sector.

[8]More information on the LFS is provided in the Appendix.

Like house prices, income is substantially different among regions. Residents in London on average report earning about 1.5 times higher than those in the North, Northern Ireland and Wales. While there are respondents reporting their income as zero in all regions, the maximum income varies substantially among regions (Table 2).[9] Our further analysis suggests that there is a clear difference in income between male and female. The average income for men is higher than that for women, and this trend is persistent during the whole sample period (see Figure 3). The data suggest that this discrepancy in income is attributable to the fact that most men (about 90%) have a full-time job while a less proportion of women (about 55%) tends to work full-time.

Finally we calculate an affordability ratio by dividing the house prices by our annual income data.[10] Table 3 summarizes the basic statistics and gives a first insight about the *HPER*; in most regions this ratio exceeds the value of 5. This ratio is relatively high in London, the South East and South West; residents in these regions tend to purchase a house whose value is nearly 8 times higher than their annual income. In contrast, this ratio is relatively low in Scotland where the purchased house value is less than 5 times higher than the annual income.

Before proceeding to our econometric framework we carry out some preliminary analyses of the *HPER*. Firstly, in order to understand commonality in regional *HPERs*, their cross sectional independence is tested using statistical tests (Pesaran, 2004, Frees, 1995 and Friedman, 1937). All tests examine the null hypothesis of cross sectional independence; $\rho_{it} = \rho_{jt} = 0$ for region $i \neq j$ where ρ is a correlation coefficient. This null can be tested by analyzing the independence of the residual (u) in the standard panel data estimation method, i.e., $cor(u_{it}, u_{jt}) = 0$. Since high dependence implies a high degree of economic integration in the UK, we expect that this null will be rejected by the data. Table 4 summarizes the results from these tests and indeed suggests that there is strong evidence of dependence among regional *HPERs*. This is consistent with previous studies (e.g., Cook, 2005, Holmes and Grimes, 2008) who report that there is a common trend in UK housing market, especially the ripple effect from London to other regions.

Second, we run stationarity tests for the *HPER* using three panel unit root tests (the Levin-Lin-Chu, Im-Pesaran-Shin (IPS), and Hadri LM tests). The first two tests examine the null hypothesis of the unit root against the stationary alternative, while the third test evaluates the

[9] In particular, there is a respondent in London who reported a weekly income equivalent to GBP44,000. However, this is an exception, and the majority of respondents earned less than 500 pounds a week (Figure 2).

[10] Annual income is obtained by multiplying the weakly gross earnings by 52. Here, our income is based on earnings of both men and women.

null of the stationarity against the alternative of the nonstationarity. From the results presented in Table 5 we cannot draw a clear conclusion. The Levin-Lin-Chu test cannot reject the null of stationarity at the 5% confidence level, while the Im-Pesaran-Shin test accept the alternative hypothesis. The Hadri Lagrange Multiplier test cannot accept the null hypothesis that all the panels are stationary. Given the above mixed results, in the subsequent analysis, we shall consider the possibility of nonstationary data when analyzing the evolution of the affordability ratio.

4 Econometric framework

The central feature of the econometric analysis is to test whether various socio-economic indicators have a direct link with the house affordability ratio and to investigate the degree of homogeneity across regions. To this end our approach is based on Augmented Mean Group (AMG) estimator (Eberhardt and Bond, 2009 and Eberhardt and Teal, 2010). This statistical method has some clear advantages over the alternatives proposed by the literature. Unlike other competing approaches, this method considers both heterogeneity among panels and cross-sectional dependence by inclusion of a common factor in potentially nonstationary environments.

Over the last decade, there has been a rapid development in panel data estimation methods.[11] As a result, today there are several options of panel data estimation methods. For example, in order to take account of heterogeneous parameters within a stationary panel data framework, Pesaran and Smith (1995) proposed a Mean Group (MG) estimator which is in its simplest form equivalent to the average of parameters from each panel. Furthermore, they have considered several estimation methods for dynamic models of heterogeneous panels allowing for cross-section dependence without imposing a priori homogeneity restrictions. In addition, Pesaran (2006) proposed the Common Correlated Effect estimator (CCE) which treats a common factor as the cross-section average of dependent and independent variables, and then developed an MG estimator for the CCE (the so-called CCEMG) in order to allow for heterogenous slops. This is similar to the Common Correlated Effects Pooled (CCEP) estimator, which can be derived under a priori assumption about parameter homogeneity. However, the abovementioned methods are

[11] In particular, researchers have focused the attention on how to obtain common factors while dealing with nonstationary data. Obviously these issues are improvements over classic approaches such as the fixed effects model which assumes cross-sectional independence, the stationarity of data and homogeneous parameters across panels.

applicable to stationary data, and thus may be of limited use for most economic and financial indicators which are reported to be nonstationary.

In contrast, there are few approaches put forward to estimate potentially nonstationary data. Among them, early studies in this field are Pesaran et al. (1999) and Pedroni (2000). The former considers a common factor in a cointegration framework, and heterogeneity is allowed only for the intercept and short-run adjustment parameters. The long-run (or cointegrating) parameters are assumed to be identical, and are argued as a reasonable compromise on the grounds of economic theories. On the other hand, while taking into account heterogeneity across panels, Pedroni extended the Fully Modified OLS for nonstationary data, but did not consider possible cross-section dependence. More recently, Kapetanios et al. (2011) have proposed a method to extract the common factor based on a principle components approach for nonstationary data.

Staring from this background, the AMG appears to be the most flexible panel data estimation approach and is thus applied to our analysis on the affordability ratio. The general concept of the AMG with one common factor can be summarized as follows.

$$HPER_{it} = \beta_i x_{it} + u_{it} \tag{1}$$

$$\text{where} \quad u_{it} = \alpha_{1i} + \lambda_i f_t + \epsilon_{it} \tag{2}$$

$$x_{it} = \alpha_{2i} + \rho_i f_t + \xi_{it} \tag{3}$$

where $HPER_{it}$ is the house affordability ratio calculated in the previous section for region i at time t. The x_{it} is a set of observable region specific socio-economic indicators as well as national level explanatory variables, and β_i is their region-specific slope. The residual u_{it} contains any other information which could not be explained by x_{it} and consists of the fixed effects α_{1i}, the unobservable common factor f_t and the error terms ϵ_{it}. Furthermore, conceptually, x_{it} could be decomposed into the fixed effects α_{2i}, the unobservable common factor f_t and the time-varying regional specific component ξ_{it}. Thus f_t is the driving force of all factors affecting the $HEPR$, and λ_i and ρ_i are the factor loadings for region i, which should capture the heterogeneous impacts of this common factor on the $HEPR$. Eberhardt et al. (2013) show that ignorance of the common factor in Eqs. 1-3 will result in biased estimators.

For operational purposes, the AMG has two stages of estimation. The first step is to estimate

the common factor while considering potentially nonstationary characteristics of the data. This can be achieved by estimating the first difference of the data by the OLS with a time dummy D_t.

$$\Delta HPER_{it} = b\Delta x_{it} + \sum_{t=2}^{T} c_t \Delta D_t + e_{it} \quad (4)$$

In this pooled regression model, $\sum_{t=2}^{T} c_t = \Theta_t$ can be regarded as a common dynamic process of the $HPER$. In the second stage, the heterogeneous impacts of all explanatory variables, including the common factor, will be estimated using the following $HEPR$ specification:

$$HPER_{it} = a_i + b_i x_{it} + d_i \Theta_t + u_{it} \quad (5)$$

The AMG estimator is obtained as the average of region specific parameters: $a_{AMG} = N^{-1}\Sigma a_i$, $b_{AMG} = N^{-1}\Sigma b_i$ and $d_{AMG} = N^{-1}\Sigma d_i$. The model can be expanded to include multiple common factors, but here we assume the presence of one common factor which helps us interpret the empirical results.[12]

5 Empirical results

Mean Group estimations for six different specifications are presented in Table 6. The first specification (Column 1) includes the average age of individuals living in the regions, the proportion of the married couples, the public sector indicator, the regional unemployment rate and the national mortgage rate.[13] It shows the tendency among younger people to purchase a more expensive house relative to their income, i.e., a high affordability ratio, which is consistent with the view that purchasing a house requires a long-term financial commitment and has a high priority even among younger generations whose income may not be very high now but is expected to increase in the future. Therefore, the results confirm that individuals expecting higher remuneration in the future are willing to take on board a higher level of mortgage debt; this is in line with economic theory given that this is a debt with an average maturity of 25 years. Furthermore, as expected the sign on the cost of finance is negative and significant, although it

[12]The panel Tobin analysis suggests that there is no censored observation in our data.

[13]We also consider family composition but this variable is found to be statistically insignificant and thus is not reported here.

appears to have a smaller impact on the $HPER$ than age and the public sector variable.

This table also shows that regions with a higher proportion of public sector employees tend to have a low affordability ratio; however, when the academic qualification variable is added to the specification, in Columns 3, 5 and 6, the public sector variable becomes insignificant suggesting that these two variables could be correlated. As regards academic qualifications, the positive relationship with the $HPER$ implies that people with low qualifications tend to purchase a relatively more expensive house measured by income than those with higher qualifications. This relationship can be explained by the fact that income is generally low for people with a low standard of education, and thus given a house price, the low income group has to make a further financial commitment to purchasing a house, i.e., rasing the level of their affordability ratio. Furthermore, we control for supply side effects by accounting for the number of dwellings built in each region (Table 6, Column 2). Although the coefficient is of the correct sign and of a magnitude similar to the mortgage rate, we cannot reject the null hypothesis of the coefficient being equal to zero.

Finally, as highlighted in the previous section, we consider foreign determinants (captured by capital inflow to the UK) as one of the possible factors affecting house prices and thus the affordability ratio. The results are reported in Column 6 in this table. The variable of interest is statistically significant and positive, thereby confirming that capital inflows are a driving force behind the increase in the affordability ratio in the UK. The coefficient is however extremely small, suggesting that one billion of FDI changes the *HPER* by only 0.008. Perhaps surprisingly, the unemployment rate and population growth are not significant in any of the first five specifications.[14]

All these results are obtained from models which impose a unitary restriction on the AMG estimate for the common factor (i.e., $d_{AMG} = 1$). This parameter restriction is cannot be rejected for each AMG equation (t-values range between 0.416 and 1.033), and thus d_i is not reported in the table. The acceptance of this parameter restriction is consistent with our cross sectional dependence tests. Furthermore, we perform the Im-Pesaran-Shin (IPS) unit root test on the residuals from Eq. 5; for all cases we cannot accept the null hypothesis that panels contain a unit root. The implication is that our results are statistically reliable since potential nonstationary elements in the affordability ratio (if any) are cointegrated with those of explanatory variables.

[14]This may be due to the definition of the our regions which are quite large compared with the sizes of cities and villages and to potential measurement errors which may arise from data aggregation.

The results in Table 6 help us to understand the general trend in the housing market; however, these are UK averages and give us little insight into the contribution of each socio-economic variable to the regional affordability ratio although our AMG estimates are based on region specific parameters and thus take regional heterogeneity into account. In fact, regional disparity in housing prices is frequently cited in the popular press as one important economic and social issue in the UK,[15] and indeed previous academic literature (see e.g. Cook, 2006) has confirmed such heterogeneity in the UK housing market. This is a rather unique feature of the housing market compared with UK general commodity prices measured by the Consumer Price Index (CPI) which are homogeneous among regions.[16]

For this reason, Table 7 presents the regional estimates obtained from Eq. 5; Panels A and B in this table correspond to our basic specification used in Columns 1 and 2 in Table 6 respectively. Some interesting and important results emerge; firstly, the mortgage rate is negatively affecting the $HPER$ across all regions. However, there is a pronounced difference across various parts of the UK; for instance a 1% change in the mortgage rate decreases the affordability ratio by about 0.13 in London and the South regions, but its impact on the Northern region is about halved. The impact is even smaller for the peripheral areas of Scotland and Northern Ireland. This is in line with the idea proposed by Dow and Montagnoli (2007) that UK monetary policy has been designed partly to choke off the South East housing boom.

The academic qualification variable is strongly significant across all regions, reinforcing the idea that qualifications can be a good proxy for expected income; here there is a small degree of heterogeneity, for instance in London the impact is about 0.180 while the coefficient records a value of 0.130 and 0.117 in Wales and Scotland respectively.

Conflicting signs come from the unemployment rate in Panel A. While only in the West Midlands and the North we cannot reject the null-hypothesis, it is positive and significant in four regions (Yorkshire Humberside, North West, Wales and Scotland), and is negative in the remaining regions. If high unemployment results in lower average income, the affordability measure should increase (e.g. dwellings become less affordable since the $HPER$ would increase); a negative coefficient, however, suggests that house prices fall faster than income. Overall the

[15] See for example the Financial Times (FT) Weekend (February 2 and 3, 2013) which documents the widening disparity especially between London and the rest of the UK.

[16] Due to the absence of a regional CPI in the UK, Hayes (2005) constructed a regional price index for 1974-1996. Based on his estimates, we can conclude that the price level of general commodities is homogenous among UK regions.

results are difficult to interpret, since there is no prior economic theory that we can rely on. It is likely that these results hide region specific supply and demand factors that determine the value of properties in a market.

The public sector indicator is negative and strongly significant for Southern regions; however when the academic qualification variable is added in Panel B the significance drops in London and the South East. This, again suggests that people working in the private sector and with higher qualifications expect increasing future income.

Finally, capital inflows are found to be stimulating the UK regional housing market; however we also notice that there is no discernable variability across regions, casting some doubts on our proxy of foreign capital being able to explain the *HPER* in some regions but not in others.[17]

6 Conclusion

There is an extensive literature investigating both the dynamics and determinants of the UK housing market; however, the literature has little to say about housing affordability across regions. Starting from these premises, this paper has sought to fill in a gap in the literature by investigating the determinants of the house price-to-income ratio using micro data for the twelve UK regions. Differently from the conventional *HPER* used in the popular press, we use the both the male and female income as reported in the Labour Force Survey. The empirical analysis is carried out by using an Augmented Mean Group estimation method, which has the advantage to account for both heterogeneity among panels and cross-sectional dependence.

Overall, we find that the key variables driving the affordability ratio are often related to the demand side in the housing market, and socio-economic indicators play significant roles in explaining the *HPER*. In particular, we note that the average age of individuals living in the region, academic qualifications, the mortgage rate and capital inflows are important explanatory variables. At the same time, while recognizing that all regions are confronted significantly with common shocks implying a high level of housing market integration, as some explanatory variables have suggested, there is a non-negligible degree of heterogeneity across regions. This suggests that regional *HPERs* contain both common and region specific elements and underlines the importance of the regional level investigation along with the national level research which

[17] For instance London shows a coefficient equal to 7.80E-06, which is very similar to Scotland (7.56E-06) and Yorkshire (7.90E-06). A full set of results are available upon request.

seems to dominate the academic literature.

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DATA

We have gathered data from several data sources which cover 12 regions over the sample period from 1995q1 to 2012q3. The standardized house prices are obtained for each region from the Halifax.[18] Unemployment rates are from the Labour Market Statistics published by the Office of National Statistics (ONS), UK. Regional population is from the ONS and it is available through 2010q1. The supply side effect in the housing market is captured by the number of dwellings completed, which is compiled by the Department for Communities and Local Government (Table 232). The original annual data are converted to a quarterly frequency.

Interest rates are UK monetary financial institutions (excluding the central bank) standard variable mortgage rates to households (Bank of England), and they are nation-level (as opposed to region-specific) data. Foreign direct investment data are downloaded from the OECD Main Economic Indicators. The rest of the variables used in this paper include income data which are obtained from the Quarterly Labor Force Survey (LFS). This is a survey of households living at private addresses in Great Britain, and is carried out by the ONS in Great Britain and by the Central Survey Unit of the Department of Finance and Personnel in Northern Ireland. The data cover households who remain part of the survey for five periods, but it is only in the last wave that individuals have been asked questions about their earnings. Our quarterly data are based on a group of respondents called Wave-5 in order to avoid a double-counting problem.

Since the original data were compiled on the basis of responses from individuals, we have averaged these data in order to create quarterly data for each region. Below provides further data description with the LFS code in parentheses.

- Regional classification (uresmc). North, Yorkshire & Humberside, East Midlands, East Anglia, London, South East, South West, West Midlands, North West, Wales, Scotland and Northern Ireland

- Age (age). The average of respondents for each region and quarter.

- Income (grsswk). Weekly gross income is multiplied by 52 to create a proxy for annual income. The data for 2001q1 are missing from the LFS and are created as a mid-point average of our quarterly income data for 2000q4 and 2001q2. Units are UK pounds.

- Marital status (marsta, marstt). A proportion of the married people using the information

[18] `http://www.lloydsbankinggroup.com/media1/economic_insight/halifax_house_price_index_page.asp`.

in the LFS, which classifies a marital status as Single (1), Married (2), Widowed (3), Divorced (4) and Separated (5).

- Type of work (publicr). The public sector variable is the average of raw data: Private (1) and Public (2).

- Academic qualifications (hiquap, hiqual4, hiqual5, hiqual8, hiqual11, levqual). The academic achievement is the average of raw data: Degree (1), Teaching, nursing (2), Apprentices (3), A level (4), O level (5) and None (6).

- Population growth. Quarterly changes in population (%)

- Affordability ratio. It is calculated as regional average house prices divided by regional average income, where income is our estimate as discussed above.

Table 1: Descriptive statistics

Region	Mean	SE	Min	Max	Mean	SE	Min	Max
	House prices				Unemployment rate			
North	95666	38705	48750	156202	8.377	1.810	5.400	11.700
Yorkshire & H	93212	36073	50249	149716	6.810	1.657	4.400	10.200
E. Midlands	108683	40984	52618	169528	5.814	1.293	4.000	8.300
E. Anglia	125434	47076	57724	195604	5.110	1.278	3.400	7.800
London	200370	74883	76946	322769	8.217	1.593	6.100	12.100
South East	174247	61388	76607	265318	4.718	1.103	3.100	6.900
South West	140527	52976	60996	212995	4.820	1.315	3.000	7.800
West Midlands	119889	43070	60441	184958	6.958	1.550	4.600	10.600
North West	97687	36742	52158	154492	6.604	1.538	4.400	9.600
Wales	103190	41389	49674	167810	6.713	1.575	4.200	9.400
Scotland	91238	30521	57349	145242	6.818	1.344	4.200	9.100
N. Ireland	104500	49319	43232	229590	6.534	1.839	3.600	11.200
	Gender				Marital status			
North	0.482	0.022	0.431	0.533	0.572	0.037	0.462	0.653
Yorkshire & H	0.484	0.015	0.435	0.526	0.575	0.033	0.492	0.663
E. Midlands	0.492	0.016	0.461	0.539	0.595	0.029	0.533	0.667
E. Anglia	0.497	0.024	0.430	0.563	0.598	0.042	0.494	0.673
London	0.480	0.016	0.444	0.524	0.488	0.025	0.433	0.564
South East	0.490	0.014	0.462	0.533	0.591	0.021	0.546	0.640
South West	0.483	0.017	0.433	0.520	0.588	0.025	0.542	0.664
West Midlands	0.494	0.019	0.445	0.548	0.591	0.031	0.511	0.658
North West	0.476	0.018	0.420	0.508	0.566	0.035	0.500	0.635
Wales	0.470	0.022	0.426	0.527	0.576	0.043	0.470	0.685
Scotland	0.477	0.015	0.444	0.519	0.581	0.035	0.500	0.669
N. Ireland	0.466	0.041	0.328	0.578	0.595	0.073	0.222	0.734
	Type of work				Housing supply			
North	0.676	0.030	0.561	0.746	6474.706	1160.284	4550	8150
Yorkshire & H	0.698	0.027	0.617	0.748	13420.590	2246.344	8710	16250
E. Midlands	0.726	0.028	0.653	0.794	14404.710	2325.437	9930	17990
E. Anglia	0.713	0.035	0.619	0.789	18831.180	2456.132	15220	22570
London	0.699	0.026	0.651	0.767	17567.650	3611.968	12650	24060
South East	0.735	0.021	0.687	0.785	24754.120	2733.273	20000	30230
South West	0.706	0.025	0.640	0.765	16685.290	1599.683	13680	19430
W. Midlands	0.717	0.032	0.648	0.795	13178.820	2297.069	8460	16190
North West	0.689	0.028	0.618	0.747	16948.820	3575.111	9580	20620
Wales	0.638	0.033	0.518	0.715	8027.059	1234.720	5510	10090
Scotland	0.658	0.022	0.600	0.722	22050.590	3069.837	15940	26470
N. Ireland	0.625	0.044	0.511	0.778	11814.120	3260.552	6800	17800

Notes: Statistics are based on our quarterly data. Full sample. See Appendix about the definition of data.

Table 2: Descriptive statistics

Region	Mean	SE	Min	Max	Obs.
	Income				
North	317.470	64.257	0	10615	27838
Yorkshire & H	322.027	62.236	0	15692	46420
E. Midlands	332.695	65.704	0	10000	38654
E. Anglia	340.930	66.162	0	15000	20888
London	475.868	94.510	0	44000	47418
South East	404.688	74.106	0	23076	106040
South West	332.895	66.653	0	31000	45664
West Midlands	330.329	61.573	0	8750	45795
North West	334.140	61.546	0	22226	50488
Wales	314.149	59.482	0	6154	23412
Scotland	344.725	68.122	0	10038	47966
N. Ireland	294.192	60.930	0	3462	11859
	Age				
North	40.014	1.919	16	83	27838
Yorkshire & H	39.965	1.574	16	87	46420
E. Midlands	40.376	1.695	16	87	38654
E. Anglia	40.782	1.704	16	92	20888
London	39.177	1.517	16	92	47418
South East	40.726	1.513	16	89	106040
South West	40.814	1.621	16	91	45664
West Midlands	40.575	1.692	16	84	45795
North West	40.091	1.539	16	84	50488
Wales	40.018	1.794	16	81	23412
Scotland	40.190	1.860	16	86	47966
N. Ireland	38.742	1.774	16	84	11859
	Academic qualifications				
North	3.822	0.544	1	7	27838
Yorkshire & H	3.839	0.534	1	7	46420
E. Midlands	3.863	0.520	1	7	38654
E. Anglia	3.898	0.545	1	7	20888
London	3.407	0.537	1	7	47418
South East	3.721	0.532	1	7	106040
South West	3.762	0.545	1	7	45664
West Midlands	3.875	0.541	1	7	45795
North West	3.760	0.539	1	7	50488
Wales	3.773	0.554	1	7	23412
Scotland	3.572	0.552	1	7	47966
N. Ireland	3.860	0.587	1	7	11859

Notes: Statistics are based on our quarterly data, but the values for max and min are directly obtained from the LFS raw data. Full sample.

Table 3: Descriptive statistics: Regional price-to-income ratio

	Mean	S.D.	Quantiles				
			Min	0.25	Mdn	0.75	Max
North	5.60	1.50	3.79	3.97	5.51	7.02	8.03
Yorkshire & H.	5.39	1.33	3.71	4.07	5.40	6.51	8.02
E. Midlands	6.09	1.50	4.08	4.51	6.21	7.67	8.66
E. Anglia	6.86	1.71	4.38	5.00	7.07	8.27	9.94
London	7.82	1.89	4.34	6.16	8.19	9.23	11.67
South East	8.03	1.81	5.05	6.12	8.43	9.56	10.9
South West	7.85	1.94	4.99	5.74	8.20	9.62	10.94
West Midlands	6.78	1.55	4.66	5.22	6.85	8.22	9.5
North West	5.46	1.35	3.85	4.20	5.47	6.32	7.96
Wales	6.10	1.64	4.20	4.47	6.04	7.56	9.24
Scotland	4.98	0.87	3.85	4.28	4.72	5.62	7.04
N. Ireland	6.59	2.21	3.81	5.05	5.69	7.72	13.52

Table 4: Cross sectional independence tests for the affordability ratio

Tests	Stat	p-value
Pesaran test	60.703	0.000
Free test	8.983	0.000
Friedman test	740.606	0.000

Notes : The null hypothesis is cross sectional independence.

Table 5: Panel unit root tests for the affordability ratio

Tests	Stat	p-value
Levin-Lin-Chu test	-1.340	0.090
Im-Pesaran-Shin test	-2.870	0.002
Hadri LM test	32.346	0.000

Notes : The tests are based on 4 lags and the cross-section average is removed. The null hypothesis of the first two tests is the nonstationarity of data, and that of the third test is the stationarity.

Table 6: House price/income fundamentals

	(1)	(2)	(3)	(4)	(5)	(6)
Age	-0.292*	-0.243 *	-0.335**	-0.252	-0.325*	-0.315**
	(0.165)	(0.128)	(0.164)	(0.177)	(0.175)	(0.147)
Proportion married	0.083	-0.010	0.065	0.092	0.086	0.029
	(0.076)	(0.076)	(0.085)	(0.107)	(0.119)	(0.080)
Public sector	-0.291*	-0.242*	-0.059	-0.319**	-0.121	-0.044
	(0.157)	(0.138)	(0.142)	(0.159)	(0.162)	(0.156)
Unemployment rate	0.000	0.0008	-0.002	0.002	-0.001	-0.003
	(0.010)	(0.010)	(0.010)	(0.011)	(0.011)	(0.010)
Mortgage rate	-0.089***	-0.087***	-0.124***	-0.101***	-0.072***	-0.058***
	(0.010)	(0.009)	(0.010)	(0.011)	(0.011)	(0.010)
Academic qualifications			0.143***		0.172***	0.158***
			(0.009)		(0.013)	(0.017)
Population growth				0.090	0.093	
				(0.117)	(0.109)	
FDI						7.92e-06 ***
						(0.000)
Housing supply		-0.096				
		(0.063)				
Constant	3.646***	4.397***	3.252***	3.569***	2.689***	2.561***
	(0.842)	(1.050)	(0.791)	(0.818)	(0.779)	(0.727)
Unit root test	-4.595***	-4.989***	-4.616***	-4.286***	-4.153***	-4.880***
Observations	852	816	852	756	756	840
N. of id	12	12	12	12	12	12

Notes: Standard errors in parentheses. $***p < 0.01$, $**p < 0.05$, $*p < 0.1$. The unit root test is based on the Im-Pesaran-Shin unit-root test on the residuals; the null-hypothesis is that all panels contain unit roots. The four lags are included in the test.

Table 7: Regional HPERs fundamentals

	North	Yorkshire & H.	E. Mids	E. Anglia	London	S.E.	S.W.	W. Mids	N.W.	Wales	Scot	N. Ireland
Panel A												
Age	0.232	-0.341	-0.672***	-0.259	-1.389***	-0.807**	-0.641***	-0.667***	-0.001	0.557**	0.401	0.086
	(0.321)	(0.262)	(0.254)	(0.297)	(0.347)	(0.351)	(0.217)	(0.230)	(0.297)	(0.247)	(0.328)	(0.487)
Proportion married	-0.126	0.286	0.208	-0.143	0.144	0.452	0.550**	0.150	-0.156	-0.294*	0.048	-0.118
	(0.279)	(0.251)	(0.271)	(0.198)	(0.379)	(0.402)	(0.267)	(0.188)	(0.247)	(0.177)	(0.317)	(0.252)
Public sector	0.074	0.840***	0.020	-0.531*	-0.789***	-1.048**	-0.940***	-0.259	-0.105	-0.144	0.138	-0.751
	(0.356)	(0.285)	(0.320)	(0.280)	(0.368)	(0.462)	(0.262)	(0.246)	(0.308)	(0.241)	(0.441)	(0.380)
Unemployment rate	0.010	0.027***	-0.010*	-0.017***	-0.041***	-0.036***	-0.027***	0.003	0.020***	0.013***	0.077***	-0.018*
	(0.005)	(0.004)	(0.006)	(0.007)	(0.006)	(0.007)	(0.004)	(0.004)	(0.004)	(0.004)	(0.008)	(0.010)
Mortgage rate	-0.074***	-0.070***	-0.105***	-0.112***	-0.134***	-0.133***	-0.132***	-0.099***	-0.065***	-0.073***	-0.026***	-0.045**
	(0.010)	(0.007)	(0.007)	(0.008)	(0.009)	(0.007)	(0.006)	(0.005)	(0.006)	(0.007)	(0.010)	(0.015)
Constant	1.050	1.773*	4.701***	4.282***	9.134***	6.981***	6.130***	5.066***	2.030*	0.314	-0.608	2.897
	(1.124)	(0.968)	(0.952)	(1.072)	(1.209)	(1.261)	(0.779)	(0.748)	(1.066)	(0.944)	(1.215)	(1.860)
Panel B												
	North	Yorkshire & H.	E. Mids	E. Anglia	London	S.E.	S.W.	W. Mids	N.W.	Wales	Scot	N. Ireland
Age	0.218	-0.407	-0.699***	-0.483*	-1.274***	-0.859**	-0.707***	-0.787***	-0.038	0.638**	0.285	0.089
	(0.314)	(0.265)	(0.248)	(0.266)	(0.356)	(0.331)	(0.214)	(0.207)	(0.299)	(0.255)	(0.319)	(0.481)
Proportion married	-0.263	0.312	0.246	-0.144	-0.178	0.603	0.523**	0.068	-0.108	-0.258	-0.016	-0.007
	(0.278)	(0.260)	(0.266)	(0.177)	(0.410)	(0.380)	(0.263)	(0.170)	(0.252)	(0.178)	(0.316)	(0.244)
Public sector	0.302	0.990***	0.133***	-0.126	-0.448	-0.476	-0.769***	0.064	0.014	0.055	0.260	-0.713*
	(0.351)	(0.289)	(0.330)	(0.256)	(0.393)	(0.457)	(0.267)	(0.228)	(0.314)	(0.254)	(0.426)	(0.388)
Unemployment rate	0.013**	0.026***	-0.011**	-0.025***	-0.042***	-0.047***	-0.030***	-0.001	0.02***	0.013***	0.079***	-0.014
	(0.005)	(0.004)	(0.006)	(0.006)	(0.006)	(0.007)	(0.004)	(0.003)	(0.004)	(0.004)	(0.008)	(0.010)
Mortgage rate	-0.106***	-0.105***	-0.139***	-0.145***	-0.170***	-0.166***	-0.166***	-0.133***	-0.099***	-0.107***	-0.061***	-0.083***
	(0.009)	(0.007)	(0.006)	(0.007)	(0.008)	(0.007)	(0.005)	(0.004)	(0.006)	(0.007)	(0.009)	(0.014)
Average qualifications	0.111***	0.137***	0.146***	0.190***	0.179***	0.180***	0.144***	0.155***	0.144***	0.129***	0.117***	0.077**
	(0.016)	(0.013)	(0.013)	(0.013)	(0.018)	(0.013)	(0.010)	(0.008)	(0.011)	(0.013)	(0.016)	(0.031)
Constant	0.671	1.556	4.333***	4.145***	8.090***	6.001***	5.907***	4.834***	1.715***	-0.492	-0.472	2.726
	(1.104)	(1.006)	(0.948)	(0.956)	(1.254)	(1.225)	(0.771)	(0.674)	(1.092)	(0.953)	(1.174)	(1.812)

Notes: Standard errors in parentheses. $***p < 0.01$, $**p < 0.05$, $*p < 0.1$.

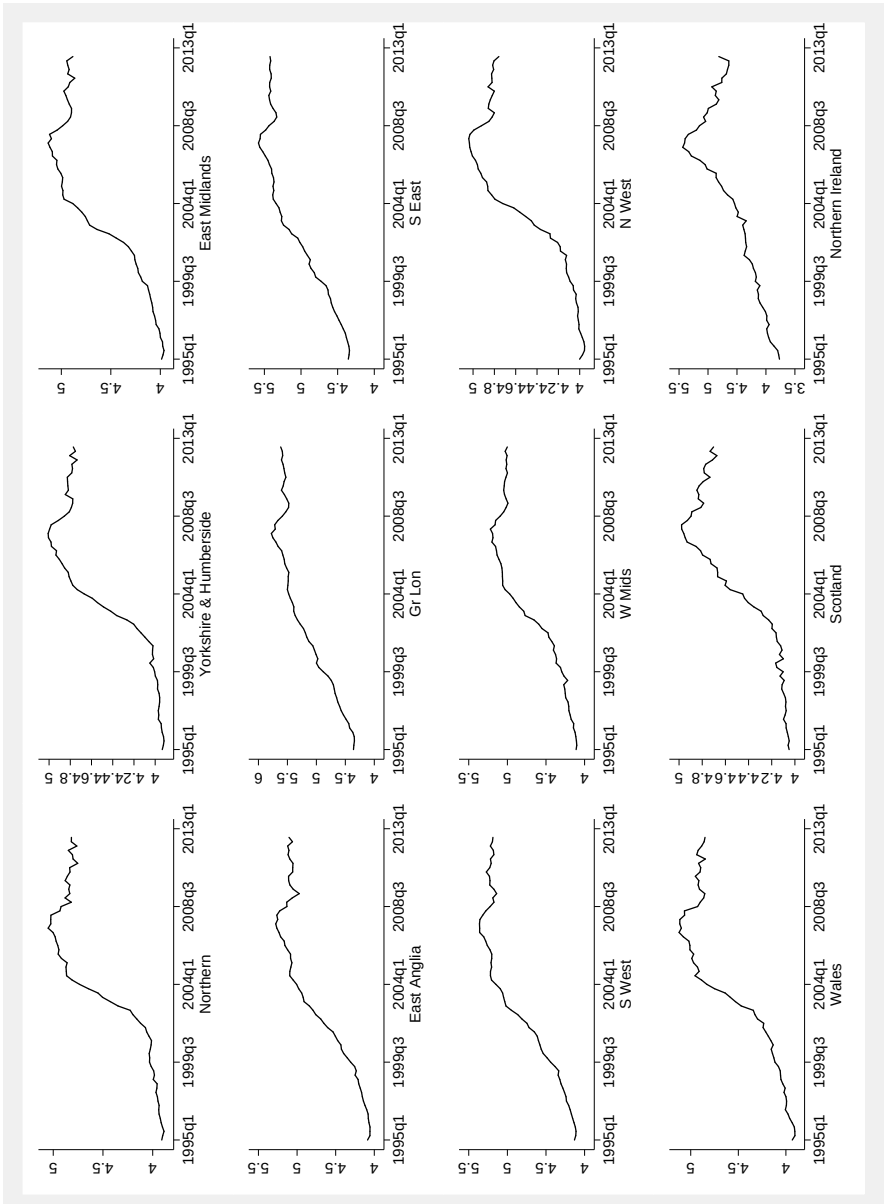

Figure 1: House prices

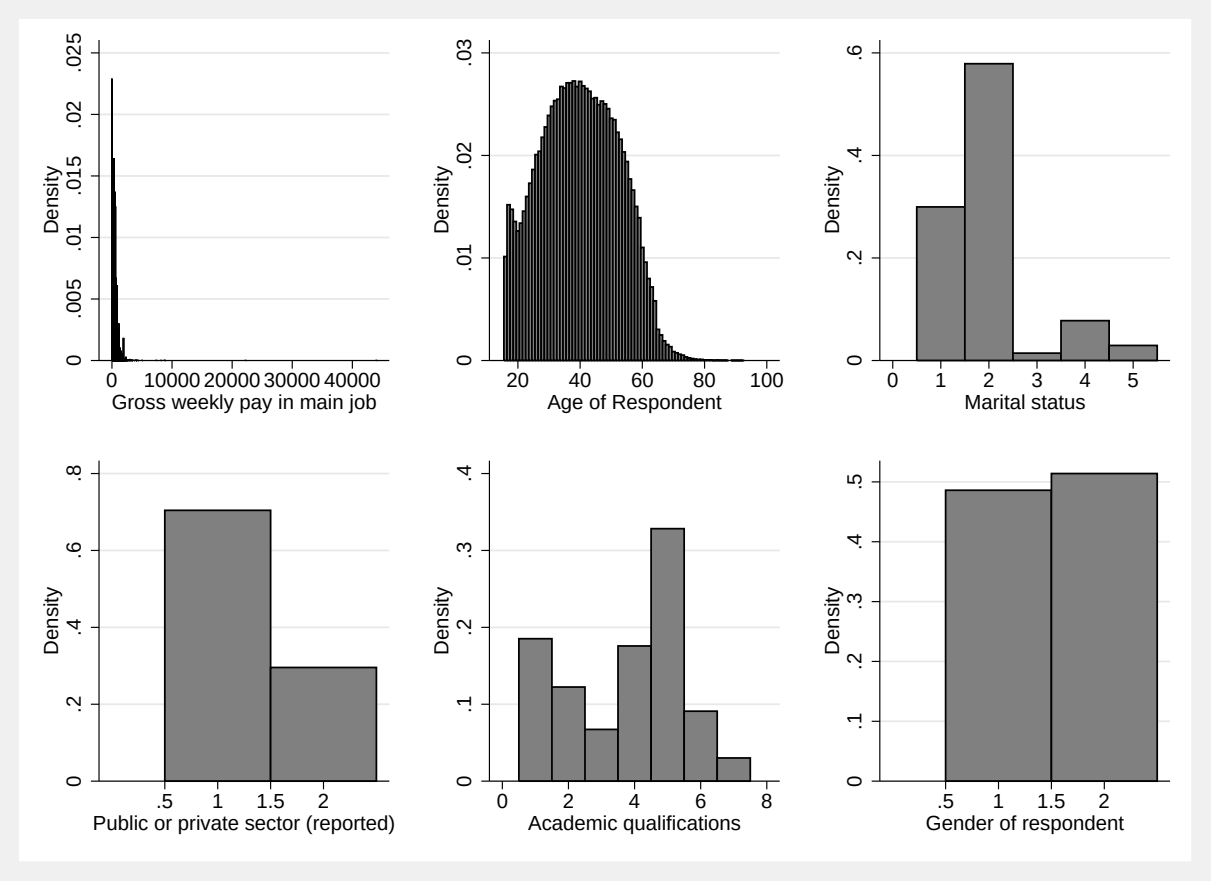

Figure 2: Density of social indicators

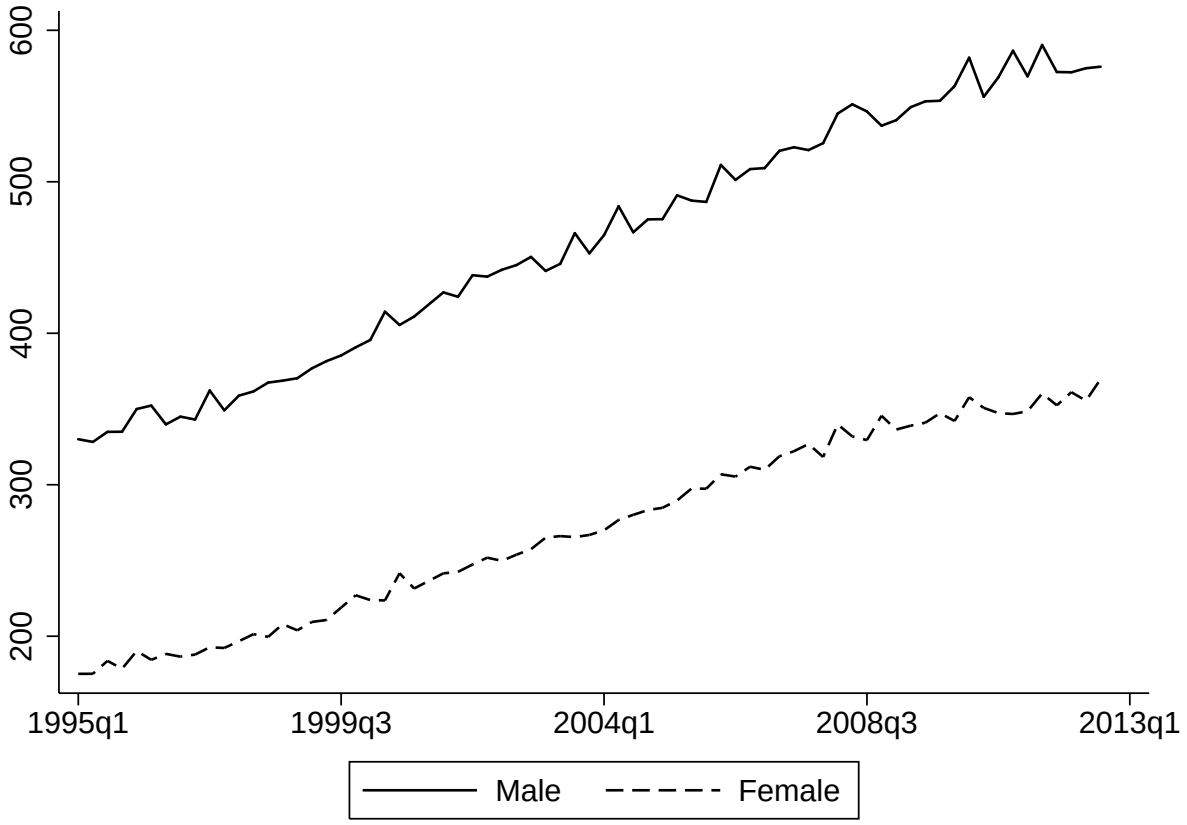

Figure 3: Average weekly gross income for male and female (UK pounds)