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The links between regional house prices and share prices in the UK.

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ABSTRACT

We investigate the interrelationships between house prices and share prices at the national and regional levels in the UK. We also investigate whether London house prices spill over to other regions of the UK. In the long-run share prices and house prices share a negative relationship but in the short-run they are positively related. We find that London prices are influencing prices in other regions, but we also find evidence of other UK regions influencing London house prices. In addition, we find regional differences in the response of house prices to movements in the stock market.

Key words: regions, housing market, stock market, spillovers, cointegration, Granger causality

JEL code: G10, C32, R10, R15, R30

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1.0 Introduction

House prices in the UK have recently surpassed their pre-2008 financial crisis level. Wages, however, have not been increasing at the same rate. Not surprisingly, housing affordability has become a major concern for many and is a frequent topic of political debate. While the lack of housing supply is often cited as a major reason for rising prices, this study will look into a factor that is often ignored in these debates but that may be having a significant impact on house prices. There are investors who have made gains in the stock market and subsequently invest in housing assets for private consumption or for diversifying their portfolio of assets. Such investments are likely to add to the inflationary pressure on house prices. In this study, we will be investigating whether or not the stock market and the housing market in the UK influence each other. There has not been a study of this kind in recent decades for the UK. One early UK study is by Sutton (2002) who finds that the stock and housing markets share a positive relationship. This study differentiates itself from Sutton (2002) in many ways. First, we also conduct analyses at regional levels for the UK. Second, we investigate house price spillovers between London and other parts of the UK. Third, we provide long-run estimations in addition to short-run ones. Fourth, in keeping with the recent literature, we provide Granger causality estimations.

Evidence for interlinkages between the stock and housing markets in other parts of the world are provided by, for example, Adcock *et al*. (2016) and Kapopoulos and Siokis (2005). The findings from these studies may not necessarily be relevant for investors and policymakers in the UK. Some studies have shown that attitudes towards taking the risks of investing are very heterogeneous across countries (see, for example, Campbell, 2006). Given that investing in the stock and housing markets carries the usual investment risks and that the preferences of UK investors towards risks may be very different to other investors, the interrelationships between the two markets may also be very different to other parts of the world and therefore need to be investigated. It is also quite timely to be looking at this topic for the UK due to impending Brexit. One of the consequences of Brexit will be less freedom of movement into the UK. This will potentially affect the demand for housing and therefore their prices. Furthermore, the Governor of the Bank of England recently warned ministers that in the worst-case Brexit scenario, house prices could drop by about 30%. If we establish strong links between the housing market and the stock market; particularly, if we find that house prices influence share prices, then Brexit, through a potential house price crash, could lead to unpleasant consequences in the financial sector – somewhat similar to what was experienced during the last global financial crisis. Moreover, in the aftermath of Brexit, if the economy is not performing well; for example, if sufficient trade deals cannot be established with the EU or other countries, then share prices of many firms will also be affected. If our analysis shows that the stock market has a strong influence on the housing sector, then any adverse effect of Brexit on the stock market could exacerbate the problems being encountered in the housing sector. Getting a better understanding of the interrelationships between house prices and the stock market, therefore, will not only help investors, whose investment portfolios encompass housing assets and equities, manage their risks better, but also help policymakers in devising policies to stabilise these markets when they are experiencing difficulties.

In the UK, house prices show considerable regional variations. House prices in the South East and London commuter belt tend to be significantly higher than in other parts of the UK. Therefore, in addition to looking into the relationship between house prices and the stock market at the national level, this study will also investigate the links between UK regional house prices and share prices. To the best of our knowledge, no such study has been conducted for the UK before. Such an analysis can help us gain insights into whether the interrelationships between the two markets at a regional are different from the national level. If this is indeed the case, then following shocks in the stock market, policies devised at stabilising the housing market at the national level will not necessarily be effective in each of the regions of the UK. This line of investigation follows a growing literature on the regional analysis of the housing markets. It is becoming increasingly accepted that the individual regional characteristics may be very different to those of the national level. The work in the literature on the regional analysis of the housing market can be broadly categorised into two groups. One group is looking at the interrelationships between house prices and macroeconomic fundamentals such as interest rates and Gross domestic product (GDP). The motivation behind these studies is the important causal relationships that exist between these variables. The 2008 financial crisis, for example, has its origins in the housing market. Some studies in this category are seeking to gain a better understanding of the causal relationships between regional house prices and economic fundamentals (e.g., Chi-Wei (2018)). There are also studies seeking to identify bubbles by looking at the disconnect between house prices and economic fundamentals (e.g., Shi and Kabir (2018)). Studies such as Beraja et al. (2019) and Koblyakova et al. (2014) aim at providing insights into the differential impact of monetary policy on regional housing markets. The other group is looking at house price spillovers and price convergence between regions (e.g., Gray (2018), Kuethe and Pede (2011)). Our study is of both direct and indirect relevance to all the strands of research regarding the regional analysis of housing markets. In fact, our next contribution to the literature is to investigate whether there are any house price spillovers between London and other regions of the UK.

Studies such as Baltagi et *al*. (2014), Fingleton et *al*. (2018) and Meen (1999) provide evidence and discuss reasons for regional house price spillovers in the UK. One of the main explanations is that if differences exist in house prices between regions, then households may move to regions where housing is more affordable. Thus, increasing demand and, consequently, prices in the more affordable regions. We focus on spillovers from London as property prices there tend to be significantly higher than in other parts in the UK; Fingleton et *al*. (2018, pg 46, footnote 4) mention that, “In 2012, estate agents Savills estimated the total value of housing stock in the London Boroughs of Westminster and Kensington and Chelsea at £187bn, £11bn more than the value of the entire housing stock of Wales.”. Moreover, Holly et al. (2011) discuss that London is the largest city in Europe and a major world financial centre and therefore the London housing market can be affected by developments in world financial markets. Following the Brexit referendum, London house prices have been falling and may fall further after Brexit. If spillover effects exist, house prices in other parts of the UK are likely to experience a drop. While falling house prices will be very attractive to those who cannot get on the housing ladder, they can also have adverse effects on the macroeconomy and local economies. Edelstein and Lum (2004), for example, discuss the channels through which household consumption can be impacted if house prices fall. For example, they argue that a rise in prices increases the collateral value of houses and therefore households are able to borrow against their housing assets to finance consumption expenditures. Liu *et al*. (2016) show that when property prices fall, they affect the borrowing capacity for firms which leads to a fall in investment spending. This is then accompanied by a drop in the growth rate of capital stock; ultimately a rise in unemployment follows. Therefore, it is important to establish whether the current and any future London property price change will have any impact on house prices in other regions.

The remainder of the paper is organised as follows. Section 2 presents an overview of the relevant literature. Section 3 presents the models that will be used in our estimations. Section 4 presents the data and conducts some preliminary analysis. Section 5 presents and discusses the results. Section 6 provides some concluding remarks.

2.0 Literature review

2.1 Wealth, credit-price and substitution effects

The literature tends to focus on establishing whether or not a relationship between the housing and stock markets exists and the direction of causality between them. There are strong theoretical reasons as to why the two markets may have causal effects on each other. In this regard, the literature discusses the wealth effect, the credit-price effect and the substitution effect (see, for example, Adcock *et al*., 2016). Wealth effect refers to a positive relationship between the two markets, with share prices causing house prices to increase. The logic here is that investors that have made gains in the stock market increase demand in the housing market – for purposes of portfolio diversification and/or for private consumption. The credit-price effect is also a positive relationship between the two markets, but in this case the housing market leads share prices. The argument here is that rising property prices improve the collateral values of firms and therefore their balance sheet positions. Therefore, for firms that are especially credit-constrained, first, it becomes cheaper to borrow, which therefore reduces their costs and consequently increases their profits. Second, with more availability of finance, firms are likely to make more investments, and thus potentially leading to more revenue. Both situations are likely to increase the equity values of firms. The substitution effect refers to a negative relationship between the two markets. If returns in the property market are higher relative to the stock market, then there may be some net outflow of capital from the stock market towards the housing market; and vice-versa. In situations like these, a negative relationship will be observed. Evidence for these different types of effects are provided in the literature. Some examples are given here. Lizieri and Satchell (1997) and Adcock *et al*. (2016) provide evidence for the substitution effect for the UK and China respectively. Kapopoulos and Siokis (2005) provide evidence for the wealth effect in Athens, Greece. Lin and Lin (2011) find evidence for the credit-price effect in Taiwan and Singapore.

2.2 Regional evidence

Some studies have looked into the stock market and housing market relationship at a regional level. Whilst looking at different regions of California, USA, Green (2002) does not find any evidence of Granger causality from house prices to share prices, but finds causal links from share prices to house prices. This effect, however, is not found in all the regions. Green finds that causality can only be established in regions consisting of high-income households; which, he argues, are more likely to hold stocks as compared to less affluent households. Similarly, Kapopoulos and Siokis (2005) only find evidence for Granger causality running from share prices to house prices, and again this effect was not observed in all parts of Greece but in Athens. On the other hand, Sim and Chang (2006) do not find any evidence of Granger causality running from share prices to house prices, but find support for causality running from house prices to share prices. They also find regional differences in their results. In particular, the causal effect is more pronounced in affluent regions. Adcock *et al*. (2016) find evidence of Granger causal effects in both directions between house prices and share prices for different regions in China. However, not all regional house prices affect share prices and vice versa. As mentioned earlier, no such analysis has been conducted for the different regions of the UK.

2.3 Spillover effects

The often-cited study of Meen (1999) discusses four possible reasons for house price spillovers: (i) migration, (ii) equity transfer, (iii) spatial arbitrage and (iv) spatial patterns in the determinants of house prices. The literature presents evidence on spillovers for the UK and some other countries. For example, Miao *et al*. (2011) provide evidence of spillover effects for regions in the US, Zhang *et al*. (2019) for Canadian regions, Lee and Chien (2011) for regions in Taiwan and *Liu et al*. (2008) for regions in Australia. For the UK, Baltagi et *al*. (2014) using a novel approach based on hierarchical panel modelling show that house prices in a region are positively associated with prices in neighbouring regions. Meen (1996) presents evidence of convergence between house prices in different regions of the UK and the South East. However, he also notes that the rate of convergence decreases as one moves northwards. MacDonald and Taylor (1993) find evidence of long-run relationships between house prices from different regions in the UK. Moreover, they find that London house prices tend to have an impact on the house prices of different regions in the UK. Drake (1995), on the other hand, finds very little evidence of convergence between house prices in different parts of the UK and those in the South East. In fact, in many cases, he finds house prices diverge from those in the South East. This study will focus on the house price linkages between London and other parts of the UK within the novel framework that allows for the interrelationships between house prices and share prices in the UK. As discussed in the Introduction, the focus on London is due to the value of its housing stock and the fact that it is a major financial centre. This line of research is also linked to a specific branch of the spillover literature which looks at the effects of large urban centres on other regions. Ali *et al*. (2011), for example, show that people commute longer distances for employment in larger urban areas as compared to smaller urban areas in Canada. Holly et al. (2011) show that London plays a dominant role in terms of house prices influencing other regions in the UK. Moreover, they discuss that proximity to a region should be measured not just in terms of distance but also in terms of ease of commuting to a region based on the transport infrastructure. Therefore, the willingness of people to commute from faraway places to big employment centres, in all likelihood, will also have an impact on the house prices and economies of the regions they travel from.

3. 0 Econometric Model

Following studies such as Sutton (2002), the key variables we include in our models to explain house prices are total income, interest rates and stock prices. Interest rates represent the availability and affordability of credit, whereas total income has a substantial influence on the purchase of houses. As discussed earlier, investors making gains in the stock market could be investing in the housing market or vice versa. We will conduct both short-run and long-run analyses. For the long-run analysis we will use cointegration analysis, whereas for the short-run analysis we will use Granger causality tests and impulse response functions.

For the UK and London, we will seek to establish long-run relationships of the following form:

$$hp_t = \alpha_{0+} \alpha_1 \ sp_t + \alpha_2 \, y_t + \alpha_3 \, I_t + \varepsilon_{1t} \qquad (1)$$

where hp represents the logarithm of real house prices, sp represents the logarithm of real share prices, y represents the logarithm of real total income, I represents an interest rate and ε_{1t} represents the residual term. For other parts of the UK, we will seek long-run relationships of the following form:

$$hp_t = \alpha_{0+}\, \alpha_1\ sp_t + \alpha_2\, y_t + \alpha_3\, I_t + L_t + \varepsilon_{2t}. \tag{2}$$

The additional variable in Equation 2 is the logarithm of real London house prices (L_t). We will use Equation 2 to establish whether or not there are spillover effects between London prices and other parts of the UK. To search for the long-run relationships represented in Equations 1 and 2, we will employ a cointegrated vector autoregressive (VAR) model framework based on Johansen's (1988) maximum likelihood method. The trace test and the maximum eigenvalue tests are used to establish the number of cointegration relationships. The cointegrated VAR model will also be employed for the short-run analysis; in other words for conducting Granger causality tests and for producing impulse response functions. More details about the cointegrated VAR and Granger causality test are provided in Appendix A.

4.0 Data and preliminary analysis

Quarterly data from 1975Q1 to 2018Q1 are used. The start of the data sample is determined by the availability of house price data, which is from Nationwide's website[1]. The other variables - share prices, total income, interest rates and overall price deflator - are from Datastream. The variable representing share prices is the FTSE all share price index, total income is measured by GDP and the three months rate is used the representative interest rate. The consumer price index is used as a measure of overall prices and is used to convert nominal variables into real variables.

[INSERT FIGURE 1 here]

Figure 1 presents the variables employed in the analysis. These are GDP, interest rates, share prices, house prices for the UK and its regions – North, Yorkshire and Humberside, North West, East Midlands, West Midlands, East Anglia, Outer South East, Outer Metropolitan, London, South West, Wales, Scotland and Northern Ireland. Apart from the interest rate, all variables are seasonally adjusted and are in real and logarithm form. Although house prices show some regional variations, they display a similar increasing trend over time. In Figure C1 of Appendix C, we plot the average house

[1] http://www.nationwide.co.uk/about/house-price-index/download-data#xtab:regional-quarterly-series-all-properties-data-available-from-1973-onwards

price for the entire sample from left to right in ascending order. London and its neighbouring regions (Outer South East, Outer Metropolitan, South West and East Anglia) have the highest house prices. Average house prices in Northern Ireland also are close to London prices.

In Figure 1, similar to house prices, GDP displays an increasing long term trend and thus might be expected to have a positive influence on house prices. Although share prices largely display an increasing long term trend, they appear to fluctuate more as compared to GDP. As discussed earlier, investors making gains in the stock market could be investing in the housing market or vice versa. Our empirical analysis in the next sections will be shedding more light into this matter. Interest rates have displayed a decreasing trend over time; given they represent the cost of borrowing, their low values are expected to have fuelled house price growth.

All variables were subjected to the augmented Dickey-Fuller (ADF) unit root test (Dickey and Fuller, 1979). The results, reported in Table B1 of Appendix B, suggest that all variables are at most I(1) variables, and hence are valid candidates for cointegration analysis.

5.0 Results

5. 1 Long-run analysis

5.1.1 Cointegration tests

Cointegration test results and the corresponding lag length used in the tests are given in Table B2 of Appendix B. Different lag length selection criteria often suggest different values; therefore we experiment over a number of lag lengths and choose the lag length based on the following criteria: (i) at least one of the two cointegration tests suggests the existence of a long-run relationship, (ii) the long-run cointegration relationship is fairly stable over a number of lag lengths, and (iii) the long-run relationship is consistent with economic theory. Our results suggest that a long-run relationship can be established for each of the regions as well as at the national level. The specific cointegration relationships are presented in Table 1.

[INSERT TABLE 1 here]

Share prices, GDP and interest rates are all statistically significant in the long-run relationships. As expected, we find a positive relationship between house prices and GDP. This implies that as GDP rises the demand for real estate increases, leading to an increase in house prices. Share prices exhibit a negative relationship with house prices in the long-run. The negative relationship implies that periods when the two markets diverge dominate periods when they are moving in the same direction. In other words, the magnitude of divergence is stronger than the magnitude of parallel movement. Therefore, for the UK, over the long-run, a negative relationship exists which is suggestive of a substitution effect between the two markets. This implies that, if, for example, the returns in the stock market are relatively low, investors switch their investments into the housing market where the returns on investments may be relatively higher. Interest rates surprisingly share a positive relationship with house prices. Given that interest rates represent the cost of borrowing, one would expect to find a negative relationship between house prices and interest rates. Our results suggest the contrary. However, there is a plausible explanation for this long-run behaviour. An increase in interest rates may lead to a fear of further increases in the future, which may push the investors to make contemporaneous investments in the housing market through a fixed mortgage rate scheme to protect themselves against future interest rate increases. London house prices is the only variable which is not always statistically significant and does not always carry the same sign. It would seem, however, regions where house prices are higher than the national average (Figure C1) tend to have a positive relationship with London prices. These regions are also mostly in the vicinity of London. Regions further away from London, where prices are also below the national average, predominantly share a negative relationship with London prices.

5.2 Short-run analysis

5.2.1 Granger Causality tests

Granger causality test results are presented in Table 2. The short-run Granger causality tests reveal some interesting insights into the interaction between different variables in the system. At the national level, we find that there is bidirectional Granger causality between house prices and share prices. This implies that activities in the stock market have an impact on the housing market in the UK and vice versa. However, there are some differences in the causal impact between the two markets at a regional level. We find that share prices Granger cause house prices in a number of regions, but house prices in only a small number of regions affect share prices. Share prices Granger cause house prices in North, Yorkshire and Humberside, North West, East Midlands, West Midlands, East Anglia, South West, Wales and Northern Ireland. There are only four regions, in the short-run, where share prices do not Granger cause house prices in a statistically significant manner. These regions are Scotland, London, the Outer Metropolitan and the South East. However, in the long-run share prices do have a causal impact on London, Outer South East and Scotland and there are some indirect causal links from share prices to the Outer Metropolitan through London prices. In sum, share prices have an impact on house prices in all regions in the short-run and/or the long-run. In terms of long-run Granger causality, we generally find that the variables in the models have a significant causal impact on each other. It is interesting to note that share prices do not have a direct causal impact on London prices in the short-run, especially when considered in the light of previous findings in the literature which show short-run Granger causality running from share prices to house prices in affluent regions. However, it is not just share prices that do not have a direct causal impact on London prices; except for house prices in other regions, none of the macroeconomic fundamentals has a significant direct causal impact on London house prices. Such a finding suggests that in the short-run, London prices, to a large extent, may be following a different pattern to what macroeconomic fundamentals are suggesting. Factors such as wealthy individuals from around the world buying properties in London may explain the evolution of house prices in London.

[INSERT TABLE 2 here]

London, West Midlands and Northern Ireland are the only three regions where house prices Granger cause share prices in the short-run. It appears that there is a link between the amount of financial activity in regions and the causal impact of house prices on share prices. London and the West Midlands are the largest financial providers in the UK. Northern Ireland has established itself as one of the world's top locations for financial services technology investment. However, house prices in the majority of cases Granger cause share prices in the long-run. The only region where long-run and/or short-run causal relationships from house prices to share prices are absent is the Outer Metropolitan; however, indirect causal links can be established via Outer Metropolitan causing London prices in the short-run and subsequently London prices causing share prices both in the short-run and long-run.

In line with the majority of the literature, we find that in the short-run London prices Granger cause prices in a number of UK regions; in particular, North, East Midlands, West Midlands, East Anglia, Outer Metropolitan, South West and Scotland. Interestingly, our analysis also suggests that house prices in some regions of the UK are Granger causing London prices. These regions are Yorkshire and Humberside, West Midlands, Outer South East, Outer Metropolitan and South West. While the arguments are clear as to why London house prices spill over to other parts of the UK, there is little or no discussion as to why house prices in the certain parts of the UK have a causal impact on London prices. One explanation could be linked to the fact that when house prices in regions outside London are going up, estate agents value properties in London higher than what they would have done otherwise. In other words, estate agents may be valuing properties in London by taking into account the growth rate in the value of properties in London plus the growth rate in the value of properties in certain regions of the UK. Long-run causality results also suggest the existence of Granger causal links between London prices and several in the UK.

5.2.2 Impulse response analysis

The impulse response analysis provides a more detailed picture of the responses of variables to a shock in a particular variable in the system. The results largely support and complement the findings of the Granger causality tests.

[Insert Figure 2 here]

Figure 2 depicts the responses of the different variables to various shocks at the national level. We find that a positive shock to share prices leads to a positive response from house prices. This finding is consistent with the wealth effect. However, we also find evidence of a credit-price effect as share prices also respond positively to a shock in house prices. In sum, consistent with Granger causality results, our results provide evidence of bidirectional influences between the housing and the stock markets. We note that, based on the magnitude of impulse responses, the credit-price effect appears to be bigger than the wealth effect at the national level. The responses of all the variables in the system are consistent with economic theory. A shock to GDP leads to a positive response in house prices, implying that as GDP increases, demand for houses increases and therefore prices also increase. A shock to interest rates leads to a negative response in house prices, reflecting the fact that an increase in interest rates leads to an increase in the cost of borrowing. Similar to house prices, share prices also respond positively and negatively to shocks in GDP and interest rates respectively. An increase in GDP usually leads to higher consumption which implies more demand for the goods and services firms provide and hence their share prices increase. An increase in interest rates implies an increase in the cost of borrowing for firms which would normally affect their profitability and hence share prices decrease. Shocks in house prices and share prices lead to a positive response in GDP. Increases in the value of property and gains in the stock market usually lead to more consumption and hence the positive impact on GDP. Interest rates tend to increase following positive shocks in house prices and share prices. One possible explanation is that increases in house prices and share prices may lead to overconfidence in the economy, which could lead the economy to overheat. The central bank usually increases the policy rate if it feels that the economy is overheating. It is interesting to note that the responses of house prices to movements in some of the variables such as interest rates and share prices are different in the short-run and long-run; such results have rarely been portrayed and discussed in the literature.

[Insert Figure 3 here]

At a regional level, except for the response of house prices to a shock in share prices, other responses are largely similar to those at the national level. For reasons of brevity, therefore, we have only provided the complete set of impulse responses for North in Figure 3 as representative responses. Given that regional house prices show considerable variations to a shock in share prices, their impulse responses are given in Figure C2 in Appendix C. A shock in share prices leads to a negative response in North, Yorkshire and Humberside, Scotland and Northern Ireland. North West, East Midlands, West Midlands and East Anglia show a minimal response. Outer South East, Outer Metropolitan, London, South West and Wales show a positive response to a shock in share prices. It appears that regions closer to London react positively to a positive shock in share prices; regions further away respond negatively and the regions in between show a more moderate response to share prices. In Figure 3, a positive shock to London house prices tend to have a positive impact on house prices in North; and a shock to house prices in North also leads to a positive response in London prices. These responses are similar for all the different regions.

6. Concluding Remarks

In this paper, we investigate whether statistical relationships exist between share prices and house prices in the UK. To the best of our knowledge, this is the first study to look into this issue at a regional level for the UK. We also investigate whether London house prices spill over to other parts of the UK and vice-versa. We perform both long-run and short-run analyses.

In the long-run house prices and share prices share a negative relationship. This implies that in the long-run if one of the markets is doing relatively better, there will be substitution between the two markets; in other words, investors will switch into the market where the returns are higher.

We perform short-run analyses using Granger causality and impulse response functions. We find that there is a significant amount of bidirectional Granger causality between house prices and share prices at the national and regional levels in the short run and/or the long-run. In contrast to other regions, we find that most of the macroeconomic fundamentals do not influence London house prices in the short run; only house prices from other regions seem to influence London prices. One interesting implication from this finding is that London prices appear to follow a different pattern to house prices in other regions. For example, demand for properties by wealthy investors from around the world could be influencing London prices in the short-run. Only house prices from regions with a high degree of financial activity are found to Granger cause share prices in the short-run, but in the long-run Granger causality from house prices to share prices is more prevalent.

With regards to impulse response analysis, at the national level, we find that a positive shock to share prices leads to a positive response in house prices and vice versa. Therefore, in contrast to the long-run, where a substitution effect between the two markets was observed, in the short run both the wealth effect and the credit-price effect prevail. These results imply that, in the short-run, an adverse shock to any of the markets is likely to adversely affect the other market; and given the interrelationships between the two markets, the adverse shock is likely to result in a continuous downward spiral of prices in both markets. A positive shock to interest rates results in house price falls in the short-run; this finding is also in contrast to what we found for the long-run. The result, however, is consistent with the recent warning from the Governor of the Bank of England that interest rates rises could lead to a crash in house prices in the worst-case Brexit scenario. The impulse response analysis also suggests an adverse shock to London prices is likely to spill over to several regions in the UK and there is likely to be a feedback from those regions into London prices, potentially reinforcing the adverse shock. Our analysis, however, also suggests that following a shock to the stock market, not all regional house prices will respond in the same way. Generally, regions closer to London respond positively to a positive shock in share prices whereas regions further away respond negatively. The regional analysis of house prices in the UK, therefore, suggests that following instabilities in the stock and housing markets, national-level policies aimed at stabilising the housing markets may not be very effective in every region of the UK.

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Tables

Table 1: Long-run relationships

Dependent variable	Independent variables				
	SP	Y	IR	London	Constant
UK	-1.184*** [-7.189]	4.097*** [11.134]	0.065*** [4.631]	-	-28.894
North	-1.657*** [-6.313]	5.729*** [7.060]	0.096*** [4.902]	-0.408* [-1.929]	-40.556
Yorkshire and Humberside	-1.381*** [-6.261]	4.541*** [6.710]	0.084*** [5.227]	-0.090 [-0.504]	-32.010
North West	-1.484*** [-6.223]	5.689*** [7.666]	0.095*** [5.176]	-0.445** [-2.283]	-40.720
East Midlands	-0.933*** [-6.162]	3.517*** [7.502]	0.065*** [5.816]	0.099 [0.782]	-25.137
West Midlands	-1.082*** [-6.308]	4.156*** [7.795]	0.063*** [4.939]	-0.202 [-1.407]	-29.591
East Anglia	-0.521*** [-4.715]	2.054*** [5.969]	0.049*** [6.082]	0.449*** [4.829]	-14.833
Outer South East	-0.545*** [-5.338]	2.045*** [6.498]	0.045*** [6.018]	0.515*** [5.891]	-14.661
Outer Metropolitan	-0.279*** [-3.906]	1.196*** [5.394]	0.029*** [5.493]	0.639*** [10.712]	-8.706
London	-1.800*** [-5.133]	6.183*** [7.844]	0.120*** [3.885]	-	-43.894
South West	-0.933*** [-5.689]	3.402*** [6.752]	0.065*** [5.437]	0.235* [1.675]	-24.292
Wales	-1.669*** [6.581]	5.525*** [7.163]	0.094*** [5.063]	-0.261 [-1.242]	-38.932
Scotland	-2.122*** [-5.766]	7.315*** [6.344]	0.133*** [4.875]	-0.682** [-2.311]	-51.830
Northern Ireland	-1.486*** [-4.343]	3.203*** [2.977]	0.020 [0.787]	-0.012 [-0.040]	-20.404

Notes:(i) Y represents GDP, IR represents interest rates and SP represents share prices.

(ii) Values in square brackets are t-statistics. *, ** and *** denote statistical significance at the 10%, 5% and 1% level respectively

Table 2: Granger causality tests

Panel A: UK

		Dependent variables				
		HP	SP	Y	IR	London
Independent variables	HP	-	6.87 (0.08)*	14.97 (0.00)***	5.43 (0.14)	-
	SP	9.62 (0.02)**	-	4.16 (0.25)	3.22 (0.36)	-
	Y	9.42 (0.02)**	3.56 (0.31)	-	7.34 (0.06)*	-
	IR	10.21 (0.02)**	1.42 (0.70)	0.89 (0.82)	-	-
	London	-	-	-	-	-
	ECT	[0.014] (0.07)*	[-0.120] (0.00)***	[0.015] (0.00)***	[1.275] (0.00)***	-

Panel B: North

		Dependent variables				
		HP	SP	Y	IR	London
Independent variables	HP	-	1.56 (0.66)	5.25 (0.15)	2.18 (0.53)	0.74 (0.86)
	SP	9.79 (0.02)**	-	2.38 (0.50)	5.25 (0.15)	2.19 (0.53)
	Y	7.57 (0.06)*	2.90 (0.41)	-	6.42 (0.09)*	2.74 (0.43)
	IR	9.25 (0.03)**	1.62 (0.66)	1.33 (0.72)	-	5.17 (0.16)
	London	6.73 (0.08)*	5.14 (0.16)	3.34 (0.34)	2.04 (0.56)	-
	ECT	[-0.009] (0.35)	[-0.078] (0.01)***	[0.012] (0.00)***	[1.39] (0.01)***	[0.017] (0.07)*

Panel C: Yorkshire and Humberside

		Dependent variables				
		HP	SP	Y	IR	London
Independent variables	HP	-	5.69 (0.13)	4.15 (0.25)	4.39 (0.22)	9.88 (0.02)**
	SP	13.42 (0.00)***	-	1.83 (0.61)	6.48 (0.09)*	0.97 (0.81)
	Y	1.84 (0.60)	1.80 (0.61)	-	6.32 (0.10)*	3.55 (0.31)
	IR	14.07 (0.00)***	0.73 (0.87)	1.06 (0.79)	-	3.08 (0.34)
	London	5.41 (0.14)	2.90 (0.41)	3.07 (0.38)	2.55 (0.46)	-
	ECT	[0.002] (0.87)	[-0.095] (0.01)***	[0.014] (0.00)***	[1.577] (0.00)***	[0.016] (0.14)

Panel D: North west

		Dependent variables				
		HP	SP	Y	IR	London
Independent variables	HP	-	0.83 (0.84)	8.30 (0.04)**	4.92 (0.18)	0.99 (0.80)
	SP	13.29 (0.00)***	-	3.38 (0.34)	4.74 (0.19)	1.35 (0.72)
	Y	4.90 (0.18)	2.16 (0.54)	-	6.75 (0.08)	2.36 (0.50)
	IR	10.82 (0.02)**	1.98 (0.58)	1.26 (0.74)	-	5.36 (0.14)
	London	5.05 (0.17)	5.86 (0.12)	3.54 (0.32)	2.37 (0.50)	-
	ECT	[0.004] (0.59)	[-0.101] (0.00)***	[0.012] (0.00)***	[1.414] (0.00)***	[0.013] (0.21)

Panel E: East Midlands

		Dependent variables				
		HP	SP	Y	IR	London
Independent variables	HP	-	0.73 (0.87)	4.14 (0.25)	1.47 (0.70)	0.71 (0.87)
	SP	22.20 (0.00)***	-	1.99 (0.57)	5.07 (0.17)	2.21 (0.53)
	Y	2.16 (0.54)	2.71 (0.44)	-	5.08 (0.17)	2.46 (0.48)
	IR	18.69 (0.00)***	1.47 (0.69)	0.75 (0.86)	-	6.19 (0.10)*
	London	12.32 (0.01)***	2.60 (0.46)	1.80 (0.61)	2.81 (0.42)	-
	ECT	[0.016] (0.22)	[-0.130] (0.01)***	[0.021] (0.00)***	[2.127] (0.00)***	[0.023] (0.14)

Panel F: West Midlands

		Dependent variables				
		HP	SP	Y	IR	London
Independent variables	HP	-	8.91 (0.03)**	8.07 (0.05)**	5.07 (0.17)	6.32 (0.10)*
	SP	21.58 (0.00)***	-	5.08 (0.17)	5.22 (0.16)	0.23 (0.98)
	Y	16.33 (0.00)***	3.42 (0.33)	-	4.66 (0.20)	3.36 (0.34)
	IR	13.43 (0.00)***	2.37 (0.50)	0.65 (0.89)	-	5.74 (0.12)
	London	18.27 (0.00)***	3.01 (0.39)	1.69 (0.64)	1.32 (0.72)	-
	ECT	[0.024] (0.05)**	[-0.156] (0.00)***	[0.014] (0.01)***	[1.810] (0.00)***	[0.006] (0.69)

Panel G: East Anglia

		Dependent variables				
		HP	SP	Y	IR	London
Independent variables	HP	-	2.71 (0.44)	2.42 (0.50)	1.95 (0.58)	5.83 (0.12)
	SP	7.42 (0.06)*	-	3.90 (0.27)	5.01 (0.17)	0.32 (0.96)
	Y	4.35 (0.23)	3.33 (0.34)	-	6.05 (0.12)	4.22 (0.24)
	IR	20.63 (0.00)***	0.91 (0.82)	0.01 (0.99)	-	3.85 (0.28)
	London	8.71 (0.04)**	1.00 (0.80)	1.80 (0.62)	3.06 (0.38)	-
	ECT	[0.015] (0.48)	[-0.127] (0.08)*	[0.030] (0.00)***	[3.117] (0.00)***	[0.029] (0.20)

Panel H: Outer South East

		Dependent variables				
		HP	SP	Y	IR	London
Independent variables	HP	-	0.44 (0.80)	3.79 (0.15)	0.96 (0.62)	8.74 (0.01)***
	SP	3.59 (0.17)	-	4.27 (0.12)	3.30 (0.19)	0.35 (0.84)
	Y	9.63 (0.01)***	0.80 (0.67)	-	1.95 (0.38)	4.11 (0.13)
	IR	7.97 (0.02)**	1.25 (0.54)	0.34 (0.84)	-	1.74 (0.42)
	London	3.53 (0.17)	0.41 (0.81)	0.78 (0.68)	0.34 (0.84)	-
	ECT	[0.032] (0.05)**	[-0.166] (0.02)**	[0.029] (0.00)***	[2.88] (0.00)***	[0.037] (0.08)*

Panel I: Outer Metropolitan

		Dependent variables				
		HP	SP	Y	IR	London
Independent variables	HP	-	4.88 (0.18)	0.53 (0.91)	1.58 (0.66)	20.51 (0.00)***
	SP	1.97 (0.58)	-	3.63 (0.30)	3.95 (0.27)	0.20 (0.98)
	Y	1.87 (0.60)	3.33 (0.34)	-	7.24 (0.06)*	5.35 (0.15)
	IR	8.60 (0.04)**	0.99 (0.80)	0.19 (0.98)	-	1.26 (0.74)
	London	6.70 (0.08)*	2.34 (0.50)	1.95 (0.58)	1.48 (0.69)	-
	ECT	[0.018] (0.47)	[-0.241] (0.32)	[0.049] (0.00)***	[3.892] (0.01)***	[0.061] (0.06)*

Panel J: London

		Dependent variables				
		HP	SP	Y	IR	London
Independent variables	HP	-	7.10 (0.07)*	3.88 (0.27)	2.55 (0.47)	
	SP	2.04 (0.56)	-	3.47 (0.32)	3.55 (0.31)	
	Y	2.67 (0.44)	3.09 (0.38)	-	8.70 (0.04)**	
	IR	4.94 (0.18)	1.71 (0.64)	0.97 (0.81)	-	
	London					-
	ECT	[0.013] (0.04)**	[-0.059] (0.01)***	[0.007] (0.00)***	[0.516] (0.07)*	

Panel K: South west

		Dependent variables				
		HP	SP	Y	IR	London
Independent variables	HP	-	1.20 (0.55)	3.26 (0.20)	4.68 (0.10)*	9.12 (0.01)***
	SP	5.70 (0.06)*	-	4.13 (0.13)	3.17 (0.20)	0.54 (0.77)
	Y	7.14 (0.03)**	1.44 (0.49)	-	2.42 (0.30)	3.58 (0.17)
	IR	5.48 (0.06)*	1.98 (0.37)	0.19 (0.91)	-	2.04 (0.36)
	London	7.30 (0.03)**	4.00 (0.14)	0.16 (0.92)	0.45 (0.80)	-
	ECT	[0.019] (0.09)*	[-0.116] (0.01)***	[0.018] (0.00)***	[1.643] (0.00)***	[0.024] (0.07)*

Panel L: Wales

		Dependent variables				
		HP	SP	Y	IR	London
Independent variables	HP	-	0.11 (0.94)	5.51 (0.06)*	3.93 (0.14)	0.04 (0.98)
	SP	5.23 (0.07)*	-	1.34 (0.51)	3.40 (0.18)	2.46 (0.30)
	Y	2.13 (0.34)	0.75 (0.69)	-	1.39 (0.50)	0.97 (0.61)
	IR	4.39 (0.11)	1.44 (0.49)	0.39 (0.82)	-	4.68 (0.10)*
	London	0.81 (0.67)	3.01 (0.22)	1.32 (0.50)	0.10 (0.94)	-
	ECT	[0.008] (0.40)	[-0.078] (0.00)***	[0.012] (0.00)***	[1.060] (0.00)***	[0.016] (0.07)*

Panel M: Scotland

		Dependent variables				
		HP	SP	Y	IR	London
Independent variables	HP	-	1.73 (0.63)	3.00 (0.39)	12.62 (0.01)***	2.63 (0.45)
	SP	2.90 (0.40)	-	2.47 (0.48)	3.86 (0.08)*	2.30 (0.51)
	Y	1.67 (0.64)	3.20 (0.36)	-	7.53 (0.06)*	2.86 (0.41)
	IR	6.88 (0.08)*	1.24 (0.74)	1.42 (0.70)	-	3.94 (0.27)
	London	6.89 (0.08)*	6.17 (0.10)*	2.98 (0.40)	3.31 (0.35)	-
	ECT	[-0.010] (0.08)*	[-0.056] (0.01)***	[0.007] (0.01)***	[0.868] (0.00)***	[0.013] (0.04)**

Panel N: Northen Ireland

		Dependent variables				
		HP	SP	Y	IR	London
Independent variables	HP	-	16.30 (0.00)***	7.18 (0.07)*	1.27 (0.74)	3.72 (0.29)
	SP	6.67 (0.08)*	-	6.17 (0.10)*	3.97 (0.26)	0.89 (0.83)
	Y	1.92 (0.59)	10.15 (0.02)**	-	10.88 (0.01)***	2.68 (0.44)
	IR	5.87 (0.11)	1.52 (0.68)	6.51 (0.09)*	-	10.65 (0.01)***
	London	3.37 (0.33)	9.94 (0.02)**	13.53 (0.00)***	1.74 (0.63)	-
	ECT	[-0.015] (0.12)	[-0.104] (0.00)***	[-0.005] (0.08)*	[0.414] (0.20)	[0.00] (0.94)

Note: HP represent house prices, Y represents GDP, IR represents interest rates and SP represents share prices. ECT represents the error correction term and its value is given in square brackets. Values in the tables are based on a Chi-squared test. Values parentheses are p-values. *, ** and *** denote statistical significance at the 10%, 5% and 1% level respectively

Figures

Figure 1: Graphical representation of variables

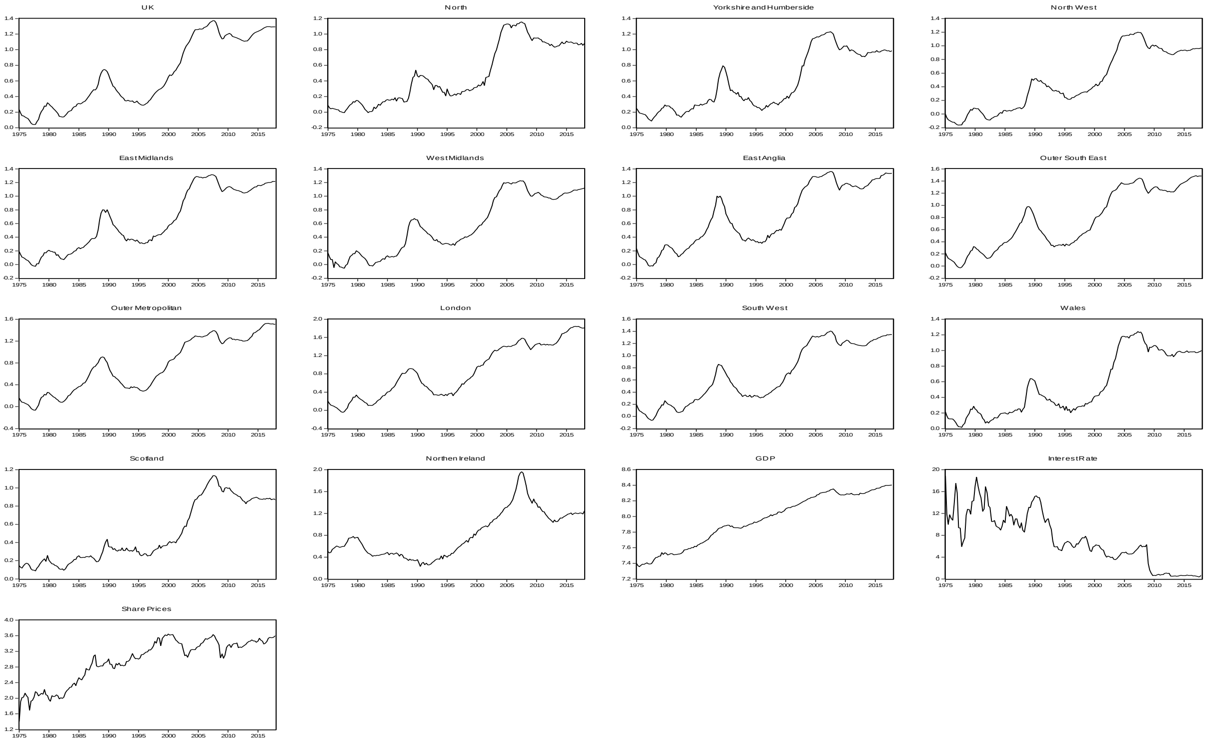


Figure 2: Impulse responses for the UK

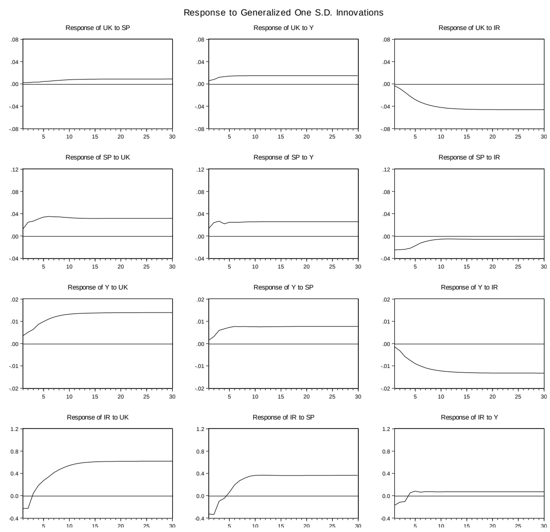
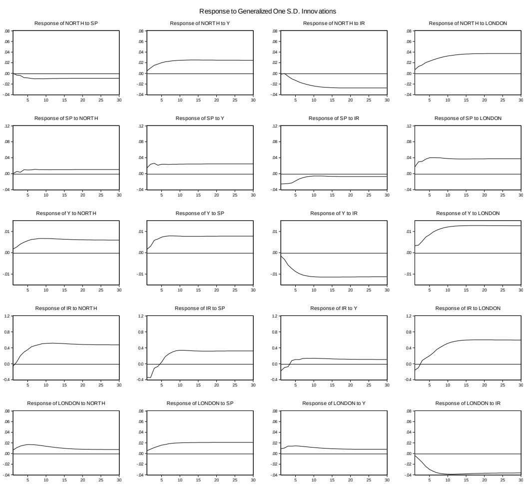


Figure 3: Impulse responses for North



APPENDIX A

Let z_t denote a $m \times 1$ set of variables, which are not integrated of an order higher than one, then the cointegrated VAR may be represented in vector error correction form as:

$$\Delta z_t = \sum_{i=1}^{k-1} \Gamma_i \Delta z_{t-i} + \Pi z_{t-1} + deterministic\ components + \varepsilon_{3t} \tag{A1}$$

where Γ_is and Π are coefficient matrices and ε_{2t} is a vector of Gaussian error terms. Let $r = rank(\Pi)$, then if $0 < r < m$,the matrix Π can be partitioned into $m \times r$ matrices α and β such that $\Pi = \alpha\beta'$ and $\beta' z_t$ is I(0) (Johansen and Juselius, 1990). r is the number of cointegrating relationships and each column of β is the cointegrating vector. The trace test and the maximum eigenvalue tests are used to establish the number of cointegration relationships. Equation A1 will also be employed for the short-run analysis; in other words for conducting Granger causality tests and for producing impulse response functions. Assuming that the system of equations (A1) consists of four variables p_t, q_t, s_t and w_t and that one of the equations in the system can be expressed as follows:

$$\Delta p_t = \textstyle\sum_{i=1}^{m} \beta_{1i}\, \Delta p_{t-i} + \sum_{i=1}^{m} \beta_{2i}\, \Delta q_{t-i} + \sum_{i=1}^{m} \beta_{3i}\, \Delta s_{t-i} + \sum_{i=1}^{m} \beta_{4i}\, \Delta w_{t-i} + \beta_5\, ect_{t-1} + \varepsilon_{4t} \tag{A2}$$

where ect represents the residuals from the long-run cointegration relationship represented by Equations 1 or 2. The joint significance of the β_2 terms implies short-run Granger causality running from q_t to p_t; the joint significance of the β_3 terms implies short-run Granger causality running from s_t to p_t and so on. The Wald test is used to test for the joint significance of the β terms; the null hypothesis is that a given variable does not Granger cause the dependent variable. Long-run causality from q_t, s_t and w_t to p_t is investigated by the testing the statistical of significance of β_5 with a *t*-test. Causality relates to cause and effect relationships between variables. In the literature, however, the Granger causality has often been used to test for causality and although it is somewhat related to the concept of causality it specifically tests whether previous lags of a variable are good predictors of the dependent variables, as the explanations above indicate.

APPENDIX B

Table B1: ADF unit root tests

Regions	ADF test statistic - level (*p*-value)	ADF test statistic – first difference (*p*-value)
UK	-2.44 (0.35)	-4.90 (0.00)***
North	-2.82 (0.19)	-4.55 (0.00)***
Yorkshire and Humberside	-2.66 (0.25)	-4.69 (0.00)***
North West	-2.24 (0.46)	-4.74 (0.00)***
East Midlands	-2.67 (0.25)	-4.66 (0.00)***
West Midlands	-2.00 (0.59)	-7.50 (0.00)***
East Anglia	-2.85 (0.18)	-4.55 (0.00)***
Outer South East	-3.04 (0.12)	-4.10 (0.00)***
Outer Metropolitan	-2.86 (0.17)	-3.78 (0.00)***
London	-2.76 (0.21)	-4.42 (0.00)***
South West	-2.62 (0.27)	-5.74 (0.00)***
Wales	-2.51 (0.32)	-4.90 (0.00)***
Scotland	-1.84 (0.68)	-5.84 (0.00)***
Northern Ireland	-2.07 (0.55)	-4.79 (0.00)***
Y	-1.25 (0.89)	-7.45 (0.00)***
IR	-3.46 (0.05)**	-11.90 (0.00)***
SP	-3.15 (0.10)*	-14.23 (0.00)***

(i) The ADF test in levels included a constant and a trend in the specification; whereas the ADF test in first difference included only a constant. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively.

(ii) The Schwarz information criteria was used to determine the appropriate lag length

Table B2: Cointegration tests

Regions	Cointegration tests		VAR lag length
	Trace test (p-value)	Maximum Eigenvalue (p-value)	
UK	58.022 (0.00)***	30.598 (0.02)**	4
North	70.108 (0.05) **	34.060 (0.05)**	4
Yorkshire and Humberside	69.988 (0.05)**	34.590 (0.04)**	4
North West	75.704 (0.02)**	34.474 (0.04)**	4
East Midlands	72.852 (0.03)**	36.300 (0.03)**	4
West Midlands	75.580 (0.03)**	34.074 (0.05)**	4
East Anglia	73.460 (0.03)**	33.776 (0.05)**	4
Outer South East	70.810 (0.04)**	35.649 (0.03)**	3
Outer Metropolitan	69.890 (0.05)**	33.159 (0.06)*	4
London	48.226 (0.05)**	24.606 (0.11)	4
South West	68.801 (0.06)*	34.894 (0.04)**	3
Wales	75.794 (0.02)**	34.407 (0.02)**	3
Scotland	77.876 (0.01)***	37.702 (0.02)**	4
Northern Ireland	78.950 (0.01)***	31.435 (0.10)*	4

The null hypothesis is that there is no long-run relationship between house price and its determinants as specified in Equations 1 and 2. *, ** and *** denote statistical significance at the 10%, 5% and 1% level respectively.

APPENDIX C

Figure C1: Average house prices in different regions

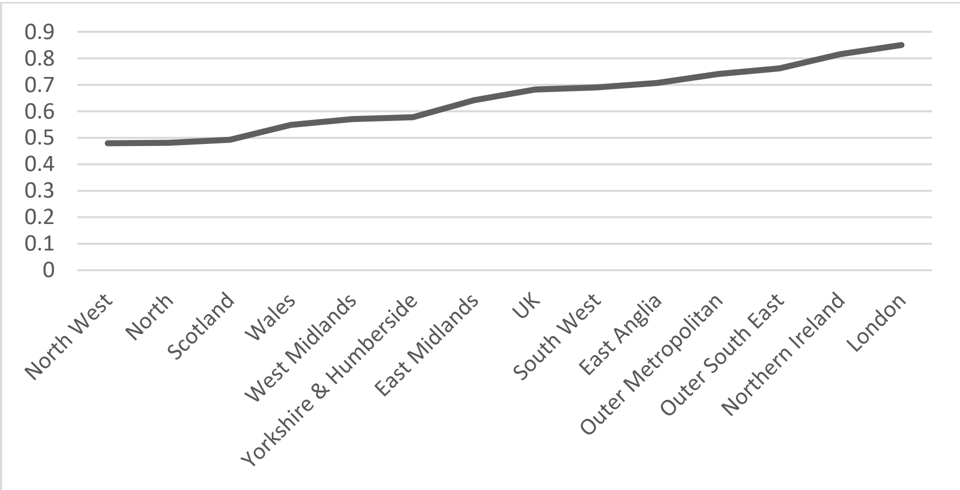


Figure C2: Responses of regional house prices to a shock in share prices.