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"Explaining Regional House Prices in the UK"

by

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Working Paper WP94/21
EXPLAINING REGIONAL HOUSE PRICES IN THE UK

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September 1994

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Explaining Regional House Prices in the U.K.

The last forty years have seen two episodes in which house prices in the Southern regions appreciated dramatically relative to the U.K. average. These peaks occurred in 1972-73 and 1987-89. The booms, however, turned to busts, especially the most recent, and by 1993, regional differentials had fallen below the average level for the past 25 years. An analysis of house prices between 1972 and 1991 for each of the eleven standard regions in the U.K. confirms the importance of financial and speculative factors in explaining the volatility of U.K. house prices, in addition to the market fundamentals of income, demography and housing supply.

Our study addresses three issues that Holmans (1990) has argued are particularly in need of explanation:
1. Why geographical percentage differences in house prices are so much greater than those in incomes.
2. Why the North/South percentage difference in house prices widened in the 1980s.
3. Why the South leads the house price cycle, and why its downswing was sharper than elsewhere in the economy.

The determination of house prices is best studied by estimating an inverted demand function, that is, prices expressed as a function of demand side factors and the given supply of houses. In practice, account needs to be taken of adjustment lags and the possibility that prices may not clear the market in the very short-run. All the variables in our model ... are expressed in the form of regional deviations from the UK averages.

The main determinants of the regional deviation in house prices from the UK average are: income within the region and income in contiguous regions; income inequality within the region; the lagged rate of return in the region and in contiguous regions; an index of financial liberalisation with a different impact in different regions; the mortgage interest rate weighted by the lagged debt/income ratio; the lagged mortgage stock/income ratio; the rate of acceleration of unemployment in the South East; and regional population relative to the regional housing stock (both owner-occupied and not).

One important reason to explain the first of the issues above is that the income elasticity of demand for housing on a regional basis is around 2. Thus, a 10 per cent income differential implies a 20 per cent house price differential.

However, the rise in relative incomes in the South East explains only a part of the appreciation of South East house prices. We find strong evidence for an extrapolative element in expectations: a geared rate of return measure using current interest rates and last year's capital appreciation is highly significant in explaining this year's house price change. In other words, once the housing market begins to rise, this rise tends to be self-reinforcing. For some regions, especially the South West and East Anglia
which adjoin the South East. the contiguous region rate of return effect dominates. These two regions also have a strong transmission effect from the income level in the contiguous regions. This helps to explain why the South-East leads the house price cycle.

Another reason for the self-reinforcing effect of house price upswings is the feedbacks they generate through income and consumption. We have regional evidence that incomes respond to past house price increases. This is a mixture of effects: partly costs of living, partly by curtailing regional labour supply, partly because of the role of housing collateral in financing small businesses, and partly because the feedback via wealth effects on consumption also feeds back into incomes by increasing demand for locally produced services and goods.

In addition to the rate of return effects above, interest rates have another very important effect on house prices. In our model they enter weighted by last year’s mortgage stock to income ratio. Since the Southern regions experienced sharp rises in indebtedness in the 1980s, falls in interest rates between 1986 and 1988 further stimulated house price rises, while the dramatic interest rate increases between 1988 and 1990 impacted particularly negatively on these regions. Falls in interest rates since 1990 help to explain why the South-East is now leading some house price recovery.

Financial factors also enter our model through the mortgage stock to income ratio, and through our index of financial liberalisation, both of which boosted house prices in the Southern regions, particularly. The differential impact of the index of financial liberalisation probably also proxies the rise in employment in financial services, which stimulates housing demand partly because of the prevalence of subsidised mortgages in this sector.

As far as the future is concerned, it seems that, for a given interest rate, mortgage lenders will not permit such high levels of gearing (i.e. loan to value ratios) as experienced in the late 1980s. This seems likely to lead to a small reduction in the volatility of the housing market. It is sad that the government has not done more to rejuvenate the private rented sector, which would help bring more stability to the owner-occupied housing market and the economy. This stabilisation effect works in a number of ways. One of these is that interest rate increases in the U.K have a large immediate impact on the retail price index. In the U.S.A. by contrast, where the rented sector comprises 35 per cent of the housing stock, housing costs for owner-occupiers are measured through equivalent (imputed) rents: these respond only slowly to interest rate increases, imparting more stability to the consumer price index.
1. **Introduction**

The last 40 years have seen two episodes in which house prices in London and the rest of the South East appreciated dramatically relative to the UK average. Their relative prices peaked in 1972–3 and 1987–89. The South West and East Anglia tended to follow the South East though in a less extreme form. Fig. 1 shows the log-ratios of regional house prices to the UK average. The Southern regions, which traditionally had the highest relative prices, also experienced the biggest relative gains in these booms. The booms, however, turned to busts, especially the most recent, and by 1993 regional differentials had fallen below the average levels for the period 1968–1992.

There are a variety of reasons for being interested in these developments. We have pinpointed a number of ways in which housing markets and the economy interact which have a regional dimension. We argued that these widening regional house price differentials tended to exacerbate the inflationary impact of booms in the UK. We provided evidence to suggest that these regional differentials fed into wage increases. Higher relative house prices in the South East encouraged migration of skilled and professional workers from the South East and discouraged migration to the South East. Once house price appreciation was ignited in the South East, the expected financial returns generated an investment demand for housing, which led to more housing being demanded per unit of population. In other words, speculative investment demand crowded out the demand for a roof over one’s head and so potential labour supply. High housing wealth also spilled over into high consumer demand in the South East despite the large share of expenditure taken up with servicing mortgage debt. Given the tendency for local expenditure to create more jobs in local services and retailing, this tended to exacerbate the South East boom. In this process regional mismatch increased, as reflected, for example, in bigger regional differences.

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Note 2 See Bover et al (1989), Muellbauer (1990), Muellbauer and Murphy (1990, 1991). Also see McCormick (1994) for a related analysis of the varying pattern of regional unemployment rates in the UK.

After the boom followed the early 1990s bust, with nominal house prices down as much as 25–30% from the peak in large parts of the South. This was accompanied by a repossessions and mortgage arrears crisis, particularly pronounced in the South and studied in depth in surveys of Bristol, Glasgow and Luton by Rowntree researchers.¹ Not only did this cause much personal distress and hardship but widespread negative equity analysed by Dorling (1993), raised its own mobility barriers. Initially, those with negative equity could not sell their houses without paying off their mortgage debt. Later, rules and lending practices were relaxed and lenders were able, in some cases, to lend such households more than their housing equity to enable a move to take place. But such borrowing is expensive and mortgage lenders are now asking for deposits of 10% or more to lend on standard terms. It is, for example, typical that when the deposit is less than 25% of the value of the property, the borrower is required to take out mortgage indemnity insurance to protect the lender from default. The insurance premia rise sharply as the deposit/value ratio declines. Pervasive negative net equity makes trading up very hard and impedes even horizontal moves. Not surprisingly, housing transactions volume in 1992 and 1993 has been only around half of the peak reached in 1988. Mobility for households in the South has been reduced, though households outside the South in 1993 had more favourable circumstances for migration to the South than for most of the last 40 years.

One reason for estimating a model of regional house prices is to learn about the determination of house prices in general. Studies on aggregate data suffer from a shortage of observations. Many variables are cyclical and most are trending as well. Given the correlations between them, estimated relationships may not be robust to extensions of the

¹ See MacLennan (1994) and Ford (1994).
sample. Regional data offer many additional observations that can be used to test hypotheses about house price determination. The other main reason for estimating a regional model is to address specifically regional issues. As we have seen, these have important implications for the national economy.

The most comprehensive, though non-econometric, study of regional house prices is contained in Holmans (1990). There are three stylized facts which, he argues, are particularly in need of explanation. To paraphrase him, these are:

(i) Why did the North/South percentage difference in house prices widen in the 1980s.
(ii) Why should geographical percentage differences in house prices be so much greater than those in incomes.
(iii) Why does the South lead in the house price cycle and why should its downswing be sharper than elsewhere in the economy.

Holmans brings to bear a impressive array of evidence and reasoning to illuminate these issues. We believe that the model we develop in Section 3 is largely consistent with his arguments and evidence, but makes the mechanisms more precise. It also illuminates the dynamics of regional house price determination, the role of expectations and of regional spillover effects.

Apart from offering an explanation for the relative boom and bust in the South, it also helps to answer the question of whether the South East will again lead the next house price cycle. In the short run this would have important implications for the relief of negative equity held by many who bought in the South between 1985 and 1991. In combination with a regional model for earnings and for consumption, see Muellbauer and Murphy (1994), our results also throw light on the risk there may be of the South East again becoming the economy's inflation hot spot in several years time.
2. **Theoretical background and previous work on regional house prices**

Our starting point is our own work on national house prices, Muellbauer and Murphy (1992). For recent alternative views on national house price determination, see Dicks (1990) and Meen (1990). A verbal summary of our empirical findings of the causes of the 1980s boom and the 1990s bust is as follows:

**Causes of the 1980s Boom**

1. Faster growth of disposable income, falling unemployment, especially in the South East, and a widening non–manual/manual earnings differential.
2. Faster growth of population in the main house–buying age groups.
4. Slower growth of the housing stock with a slump in social house building.
7. Low house price–to–income ratios and a low mortgage stock at the beginning of the decade, the latter the result of credit rationing and negative real interest rates.
8. Low levels of unsold stocks and high recent returns: in other words, recent trends tend to persist, contributing to overshooting.

**Causes of the Early 1990’s Bust**

Except for No 4 above, every one of the eight listed boom factors went into reverse. It is conceivable that there may have been three additional negative factors: widespread repossessions never previously experienced, the immobility of many with negative equity and extra supply from conversion of commercial property (also in unprecedented slump).
One of the elements just discussed needs further explanation. This is the geared rate of return on the house purchaser's net equity stake in a house. This is defined as follows:

\[
\frac{\text{capital appreciation} + \text{imputed rent after tax and repairs} - \text{mortgage payments}}{\text{net equity}}
\]

The rate of capital appreciation can be defined as the proportional change in house prices, $\Delta \ln h_p$, where $h_p$ is the nominal house price. Mortgage payments are given by the after-tax mortgage interest rate $\times$ size of loan, where the size of loan = lvr $\times$ value of house, and lvr is the loan-to-value ratio. Net equity is thus value of house $\times$ (1-lvr). Thus the geared rate of return =

\[
\frac{\Delta \ln h_p + \text{rate of imputed rent after tax and repairs} - (\text{lvr} \times \text{mortgage interest rate})}{(1-\text{lvr})}
\]  

(1)

The 'gearing' comes from defining the rate of return on net equity rather than on the value of the house. This entails division by the factor (1-lvr) which gears up the return, and of course, the risk. At the national level, the geared rate of return has exceeded by 20% the rate of return on liquid assets in about half the years between 1960 and 1990.
The theoretical framework is easily defined. In the short run, we can take the housing stock as given. Real house prices can then be obtained by inverting a demand function for housing. The demand for owner-occupied housing depends on the relative price of housing, real income, the non-manual/manual earnings differential, the expected rate of return on housing as an investment relative to other rates of return, mortgage interest rates, property taxes, credit availability, probably real financial wealth and population and demography. The inverted demand function gives the real price as a function of all the other variables and of the lagged housing stock. However, not only the owner-occupied stock but also the non-owner occupied stock are relevant. In the UK, demand for non-owner-occupied housing has been rationed for most of the last 25 years because of rent controls in much of the private rented sector, and subsidized local authority and Housing Association housing. As supply of non-owner-occupied housing alters, there will be spillover effects on prices of owner-occupied houses.

To this inverted demand equation for real house prices we add some short-term adjustment lags and an indicator of unsold stocks: we do not believe that house prices adjust fast enough to clear the market in the short-run. Another reason, discussed by Stein (1993), why lagged house prices affect current house prices is that, other things being equal, higher lagged prices mean that repeat buyers have more available to spend in moving up the housing ladder. High unsold stocks can reflect the reluctance of sellers to accept reductions in nominal prices.

A schematic version of our national house price model can be written in the following form:

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4 Since local authority rents have got close to market levels, this situation may now be starting to alter for those not in receipt of Housing Benefit.
\[
\Delta \ln(hp/pc) = \beta_0 + \lambda (\beta_1 \ln ry + \beta_2 \text{awnmr}) \\
+ \beta_3 \text{grrh}_{-1} - \beta_4 \text{wrabmr} + \beta_5 \text{aflib}_{-1} \\
+ \beta_6 \ln(\text{ms/y})_{-1} + \beta_7 \ln(\text{pop/h}_{-1}) - \beta_8 \ln \text{poo}_{-1} - \ln(hp/pc)_{-1} \\
+ \beta_9 \Delta \ln ry - \beta_{10} \Delta^2 \text{use} - \beta_{11} \text{wdabmr} - \beta_{12} \text{ush}_{-1} + \beta_{13} \Delta \text{Indemo} + \beta_{14} \text{poll tax dummy} \\
+ \beta_{15} \text{"frenzy effect"}
\]  

(2)

The variables are as follows:

- \( h p \) = Department of the Environment mix adjusted index of second hand house prices
- \( p c \) = consumer expenditure deflator
- \( r y \) = real personal disposable income per head
- \( \text{awnmr} \) = ratio of non–manual to manual earnings, a 2 year moving average
- \( \text{grrh} \) = geared rate of return in housing as defined in equation (1) above, minus the building society share interest rate
- \( \text{wrabmr} \) = real tax adjusted building society share interest rate weighted by last year's mortgage stock/income ratio
- \( \text{aflib}_{-1} \) = index of financial liberalization\(^4\), a lagged two year moving average
- \( \text{ms}^* \) = nominal mortgage stock – stock of housing equity withdrawal
- \( y \) = nominal aggregate personal disposable income
- \( h_{-1} \) = end of previous year housing stock, measured as no. of dwellings
- \( \text{poo}_{-1} \) = last year's rate of owner–occupation

\(^4\) See Muellbauer and Murphy (1993).
Δ²use = rate of acceleration of the unemployment rate in the South East
wdabmr = change in tax-adj usted mortgage interest rate weighted by last year's mortgage stock to income ratio
ush₋₁ = end of previous year's stock of unsold new dwellings scaled by the number of private completions in the previous year.
ΔIndemo = rate of change of a demographic index which weights different population age groups by the share of mortgages advanced to that age group.
poll tax dummy = 1 in 1988-9, zero otherwise
"frenzy" = (fitted value of grrh)³.

Note that λ measures the speed of adjustment and that parameters β₁ to β₈ can be thought of as the long-term responses (mostly elasticities). Thus β₁ is the elasticity of real house prices w.r.t. real income, β₇ is the elasticity w.r.t. population and -β₇ that w.r.t. the housing stock. Therefore β₁/β₇ measures the response of housing demand w.r.t. real income Inry, income distribution, awnMr, the geared rate of return, grrh, the real mortgage interest rate weighted by mortgage debt/income, wrabmr, financial liberalization, aflib₋₁, ln(mₘ/y₋₁) and population lnpop. The lagged net mortgage stock to income ratio (mₛ/y₋₁) has a double role. On the one hand, together with the index of financial liberalization, it reflects mortgage availability in the recent past. On the other hand, it reflects the influences of liquid and illiquid wealth in the previous year, since the amount of mortgage debt households are willing to hold will depend on other assets. Parameters β₉ to β₁₅ reflect short-term, 'disequilibrium' responses. The rate of change of income Δlnry allows the short-term impact of income to be different from the long term. The rate of acceleration of unemployment in the South East picks up part of the leading role of the South East. The "frenzy effect" is a variant of a non-linearity suggested by Hendry (1984). Because of lumpy transactions costs, an increase in the prospective rate of return
from 5 to 10% is likely to have a smaller effect on demand than an increase from 10% to 15%. The cubic captures this non-linearity.

The starting point of our approach to modelling regional house prices is basically eq (2) expressed in terms of deviations from the UK national average. However, we find that this basic model has to be augmented by some more specific regional interaction effects which operate partly through income spillovers into contiguous regions and partly through spillovers from lagged rates of return, effectively lagged house price changes in contiguous regions. More details and the parameter estimates and their interpretation will be given in Section 3. Before turning to this we will review other econometric work on regional house prices, of which we are aware.

Forrest (1991) studies regional differences in house prices between English regions from a single cross-section of observations on individuals' dwellings. He investigates to what extent regional differences may be due to differences in the characteristics of houses and of the local environment. He finds that, to a large degree, regional differences remain after adjusting for the effects of these characteristics. Indeed, the London premium is even higher than a crude ratio of dwellings prices would suggest. MacDonald and Taylor (1993) studied regional house prices in a cointegration framework. They find that nominal house prices (in logs) using quarterly data from 1969 to 1987 are integrated of order one I(1), i.e., taking first differences makes them stationary. They then use the Johansen (1988) framework to investigate their cointegration properties, i.e., to find what linear combinations of the regional house prices are stationary. They find as many as nine cointegrating vectors. This, as they admit, is econometrics with a 'black box' flavour since no explanatory variables such as income, population or the housing stock enter the analysis. Essentially, their conclusion is that except for one region (presumably Northern Ireland?), all the other regions' house prices do not diverge systematically in the long-run. The narrowing of regional differentials since 1987 bears out this, not very surprising, view.
Reilly and Witt (1992) aim to investigate on cross-section data the hypothesis that repossessions themselves have an effect on house prices. Using annual data for 1987–1990 for 10 regions, they regress log house prices on time effects, region effects, and on income, unemployment, the age structure, repossessions relative to the owner-occupied housing stock and on a small set of interaction effects. Given that repossessions were concentrated in the South East and towards the end of the period, and reflect, in part, high debt levels, high interest charges and the very collapse of house prices being explained, it is not surprising that they find a significant effect. If there is a causal role for repossessions, it is likely to have been swamped by a combination of omitted variables and the reverse causation.

The earliest paper on UK regional house prices is a sophisticated econometric effort by McAvinacey and MacLennan (1982). However, this is a study of house price inflation rates which is not consistent with a long-run solution for house prices. One of the most important lessons of the later cointegration revolution is econometrics, see Engle and Granger (1991), has been to estimate long run solutions for related non-stationary but cointegrated variables.

Finally, a pair of papers by Giussani and Hadjimatheou (1991a,b) have aims which are much closer to our own: to develop a structural model for the evolution of regional house prices. In (1991a) they investigate the "ripple" effect using correlograms and Granger causality tests. Using the annual rate of change of London house prices, they show that changes in the South East and East Anglia are more or less contemporaneous in that the peak correlations occur at a lag of zero, while the lag in the South West is also close to zero. The other regions lag behind, generally by two quarters. Northern Ireland is exceptional in that the correlation is low at all lag lengths, and peaks after 4 quarters. Granger causality tests confirm the existence of some contemporaneous correlation between London and the three Southern regions (excluding London), and that the other regions clearly lag behind.
The authors then discuss causal mechanisms. They find that while in the 1980's London and the rest of the South East led the way in falling unemployment, during 1972–4, falls in unemployment were more uniform across the country.

Related factors that have been suggested by other writers for the 1980s include the winding down of regional policy during the decade (Evans, 1989), and deindustrialization and the more rapid increase in professional and managerial employment and incomes in the South East, (Hamnett and Randolph, 1988).

Giussani and Hadjimatheou put forward a story with similarities to our own:

"... rising incomes, favorable financial conditions, and regional differences in supply elasticities over time lead to an initial widening of house price differentials, with house prices in the South increasing faster than in the rest of the country. In short, the old equilibrium is being disturbed. As a result of the excessive differentials people find it worthwhile to move from the South to the less house-expensive regions until a new equilibrium is established."

They cite evidence on inter-regional migration rates consistent with this view.

In this 1991a paper they estimate a series of regional house price equations consistent with their 1990 model for national house prices. This is rather different from ours in that the long-run house price equation is not interpretable as an inverted demand curve but is a hybrid also involving indices of construction costs, as suggested by the work of Poterba (1984). Moreover, they condition on the number of households — which would itself depend on income and housing costs, as well as on population and demography. Not surprisingly, both at the national level and regional level, they find substantially lower income effects on prices than do we and, given the number of households, a much higher sensitivity of prices to the housing stock. The long-run relationships are embedded in a short-run adjustment mechanism, which incorporates non-linearity in lagged house price changes of the kind advocated by Hendry (1984) to reflect housing market "frenzy", as well as changes in building costs and in net mortgage advances and, the acceleration of the
aggregate national mortgage stock. Moreover, the lagged rate of change of London house prices with different lag lengths for different regions represents the "ripple effect" of house price transmissions.

There are some problems with their specification. One of them is that the long-run relationship, estimated by OLS, is formulated in nominal house prices. Since the only nominal explanatory variable in levels is the construction cost index, a coefficient close to 1 is obtained for it at the national level: nominal house prices rose ten fold over their sample period, so that almost any nominal variable, say the money supply or the price of a packet of cornflakes, would have been found to have had a highly significant effect on the level of house prices. Far better would have been to deflate both house prices and construction costs by an index of consumer prices. Another problem is the use of the square of the lagged house price change (a positive effect) as well as the cube (a negative effect) in the short-run dynamics. When nominal house prices fall, as they did after the end of their sample, this MUST produce huge errors as both effects have a positive impact on the dependent variable. While their results are suggestive, we believe their model is seriously mis-specified. Their parameter estimates across regions are quite variable so that they do not attempt to impose any equality restrictions: apparently regional behaviour is quite diverse.

In their 1991b paper, Giussani and Hadjimatheou estimate a relative house price equation for the South East and the North West. This has a very different form: relative house prices are a function of relative incomes, the relative household number to housing stock ratio, an interest rate to reflect the bigger effect of interest rates in the South East, the rate of change of unemployment in each region and the lagged relative housing wealth per household. It appears that the number of households relative to the housing stock is not significant while lagged housing wealth relative to the number of households has a significant positive effect. This has the remarkable implication that an increase in the supply of houses increases the house price in a region, while an increase in the number of
households reduces it. Curiously, the rate of return, primarily driven by lagged house price changes is missing from this model, despite their emphasis on it in their 1991a paper. In the long-run, their model implies an income elasticity for house prices of 7, far beyond the realms of plausibility.

3. **A Regional House Price Specification**

   Let us begin by posing some questions about the relationship between a national and a regional model for the demand for houses. Schematically, suppose that at the national level

   \[ \ln h = \alpha_0^* - \alpha_1^* \ln \left( \frac{hp}{pc} \right) + \alpha_2^* \ln ry \]  

   (3)

   where \( ry \) represents real income and \( \alpha_1^* > 0, \alpha_2^* > 0 \). At the level of the \( i \)th region, one would expect something like

   \[ \ln h_i = \alpha_{0i} - \alpha_1 \ln \left( \frac{hp_i}{pc} \right) + \gamma_1 \ln \left( \frac{hp}{pc} \right) \]

   \[ + \alpha_2 \ln ry_i - \gamma_2 \ln ry \]  

   (4)

   where \( \alpha_1, \gamma_1, \alpha_2, \gamma_2 \) are all positive. At the level of the region, there are migration possibilities w.r.t. other regions, the latter being summarised by the national average. Migration out of region \( i \) is more likely when the regional house price index \( hp_i \) is high relative to the national average index \( hp \) and when real income is low relative to the national average, i.e. \( \gamma_1 > 0 \) and \( \gamma_2 > 0 \). The weighted average across regions \( i \) of (4) must give (3). Thus \( \alpha_0^* \) is the weighted average of the \( \alpha_{0i}, \alpha_1^* = \alpha_1 - \gamma_1 \) and \( \alpha_2^* = \alpha_2 - \gamma_2 \).

   Consider the deviation of the \( i \)th region's demand for houses from the national average:
\[ \ln h_i - \ln h = \alpha_{0i} - \alpha_{0} - \alpha_{1}(\ln h_{pi} - \ln h) + \alpha_{2}(\ln r_{yi} - \ln r) \]  

(5)

It follows that at the level of regional deviations, the responses of relative housing demand to relative house prices and incomes will be larger than the national average responses, i.e. 
\[ \alpha_{2} > \alpha_{2}^*, \alpha_{1} > \alpha_{1}^* . \]

Our price equation will be an inverted demand function

\[
\ln h_{pi} - \ln h = \left( (\alpha_{0i} - \alpha_{0}^*)/\alpha_{1} \right) - \left( 1/\alpha_{1} \right) (\ln h_i - \ln h) + \left( \alpha_{2}/\alpha_{1} \right) (\ln r_{yi} - \ln r) \quad (6)
\]

(with some adjustment dynamics). For the price equation therefore, the relative regional response of house prices to the housing stock will be clearly less than at the national level i.e. \(-1/\alpha_{1}\) instead of \(-1/(\alpha_{1}^*)\). The response to relative income is \(\alpha_{2}/\alpha_{1}\). This could be greater or less than \(\alpha_{2}^*/\alpha_{1}^*\) at the aggregate level.

Our work on national data suggests \(1/\alpha_{1}^* \approx 1.7\) and \(\alpha_{2}^*/\alpha_{1}^* \approx 2.4\). Thus \(\alpha_{1}^* \approx 0.59\), \(\alpha_{2}^* \approx 1.41\). We can expect \(\alpha_{1}\) and \(\alpha_{2}\) in (5) to be below these respective values.

We will impose a great deal of common structure on our regional house price equations. But in some respects it is necessary to allow for asymmetries and other region–specific effects. One is to allow some of the parameters, e.g. the intercept and the effect of the rate of acceleration of unemployment in the South East, to have different effects in different regions. The other is to allow some contiguity effects: we allow income

---

4Assuming that a national consumer price deflator is used to convert nominal income \(y_i\) into real income \(r y_i\), then \(\ln r y_i - \ln r = \ln y_i - \ln y\).
in the neighbouring regions to matter, and we allow the geared rate of return in the
neighbouring regions as measured by the lagged rate of change of house prices minus lvr
times the mortgage rate, all scaled by (1-lvr) where lvr is the loan-to-value ratio in the
region itself, to matter. We allow the relative weights given to own income vs.
neighbouring income and own vs. neighbouring rate of return to vary with different regions,
but constrain the total income and rate of return effects to be the same across regions.
Thus we have regional transmission mechanisms both via income and via lagged house
price changes. One would expect these to be most pronounced where there is considerable
commuting between regions, as there is between East Anglia and the South East, and
between the South West and the South East.

We find that earnings data from the New Earnings Survey are more successful than
per capita disposable income from the regional accounts in explaining house prices. This is
consistent with the evidence in Holmans which suggests that regional differences and
tendencies for an increased divergence are more distinct in the former than the latter. Why
this should be remains a bit of a puzzle. 7 However, the earnings figures are gross and do
not take account of tax whose regional incidence is likely to have altered. The log ratio of
personal disposable income to total personal income is an approximate measure of the tax
adjustment. We can test the extent to which it is empirically relevant for adjusting gross
earnings.

The mortgage stock/income ratio appears in (2) both directly, and in weighting
interest rates. We estimate regional mortgage stocks by combining several data sources.
The Family Expenditure Survey gives regional shares of mortgage payments which should
approximately reflect each region's share in the mortgage stock. However, the FES data
are subject to considerable volatility and probably to response bias. Other sources are the

7 Among the differences are the residence and tax—record base of personal disposable
income at the regional level vs. the place—of—employment base of the NES, the inclusion of
property income, pension and other social security income and the inclusion of part—time
earnings which we do not incorporate into our earnings index.
Household Surveys which are used to benchmark the FES data. We do not have regional
data on equity withdrawal, and so use gross mortgage stock data.

Our financial liberalization index has been computed at the national level but may
have a different impact on different regions. We also allow the rate of acceleration of
unemployment in the South East to affect each region's deviation from the national
average. This is one aspect of the leading role that may be played by the South East. A
positive economic shock for South East, will, in the short run, drive up relative house
prices in the South East and perhaps in East Anglia and the South West and lower prices
elsewhere relative to the UK average.

We do not have data on builders' unsold stock of houses by region. The unsold
stock/completions ratio which appears in (2) is probably particularly concentrated in the
South East, at least in the aftermath of the 1972–3 and 1986–89 booms. In some
specifications, we allow it to enter with a different weight in each region: we expect
positive coefficients away from the South East and negative coefficients in or near the
South East.

We suspect that regional differences in the movement of demographic structure are
not measured accurately enough to incorporate in our model.\footnote{The published data in Regional Trends suffer from discontinuities.}

Our model for the regional deviation for the UK average looks as follows:
\[ \Delta \text{lnhp}_i = b_{10} + \lambda (b_1(1-\theta_{11})\text{rln}e_{i} + \theta_{11}\text{rln}e_i^*) \\
+ b_2 \text{r(nme}_{i}/\text{m}e_{i}) + b_3 ((1-\theta_{21})\text{rgrrh}_{i} + \theta_{21}\text{rgrrh}_{i}) \\
+ b_4 \text{rwabmr}_{i} + b_{5i} \text{afib}(-1) + b_6 \text{ln(ms/e)}_{-1} \\
+ b_7 (\text{rln(pop/h}_{-1})_{i} - \theta_3 \text{rlnpop}_{-1}i) - \text{rlnhp}_{-1i} \\
+ b_9 ((1-\theta_{11})\Delta \text{rnl}e_{i} + \theta_{11}\Delta \text{rnl}e_i^*) + b_{10i} \Delta^2 \text{use}_{i} + b_{11i} \text{rwdabmr}_{i} + b_{12i} u_{sh_{-1}} \\
+ b_{15i} \text{rgrrhse}_{-1} \]

(7)

This equation is defined for each of the 11 regions of the UK. However, since we expect the weighted average across regions of \( b_{10}, b_{5i}, b_{10i}, b_{12i}, \) and \( b_{15i} \) to be zero, we use these restrictions to eliminate the Northern Ireland parameter in each case.

The variables are defined as follows: an 't' prefix denotes taking the deviation relative to the UK average. House prices \( h_{p} \) are given by the regional mix adjusted DOE index, normalized at 100 in 1985. Earnings are defined by April New Earnings Survey figures for average full-time male earnings. These figures are adjusted by a tax factor derived from the regional accounts so that

\[ \text{ln}e_{i} = \ln(\text{gross earnings})_{i} + \text{rln(pdi/\pi)}_{i} \] where \( \text{pdi} = \text{personal disposable income} \) and \( \pi = \text{personal income in region } i. \) The hypothesis that \( \tau = 1 \) was tested, found acceptable and therefore imposed.

The regional contiguity effect \( \text{rln}e_{i}^* \) is defined as the weighted average of \( \text{rln}e_{j} \) where \( j \) is a region contiguous to the \( i \). For example, the South West is contiguous with the South East, East Midlands and Wales. The weights are the 1980 regional value shares in the total owner occupied housing stock. \( \text{nme/me} \) is the ratio of non-manual to manual earnings. The geared rate of return in housing relative to the return in liquid assets, \( \text{grrh} \) is defined as
\[ \frac{\Delta \ln h p_{-1j} + 0.03 - (lvr_j)abmr}{1 - lvr_j} - bsr \]

and \( rgrhh \) is the deviation relative to the UK average. Note that \( bsr \) drops out of this deviation as does most of the variation in the mortgage rate \( abmr \) given similar loan to value ratios across regions. This definition assumes that there is a large extrapolative element in expectation of house price changes.

The regional contiguity effect \( rgrh_j^* \) is defined as the weighted average over the \( j \) contiguous regions of

\[ \frac{(\Delta \ln h p_{-1j} + 0.03 - (lvr_j)abmr)}{1 - lvr_j} \text{ minus } \frac{\Delta \ln h p_{-1} + 0.03 - (lvr)abmr}{1 - lvr} \]

where the latter expression refers to the UK as a whole. Note that in the interest rate term, \( rwabmr \), the common UK inflation rate cancels out in taking the regional deviation from the national average. The regional model thus cannot distinguish between real and nominal interest rate effects. More generally, taking the regional deviation eliminates any variable common to all regions which enters with the same coefficient everywhere.

Note further that instead of \( b_8 \ln p o o_{-1} \) as in (2), we have parameterized the relative rate of owner occupation effect as \( b_7 \theta_3 \ln p o o_{-1} \). \( \theta_3 \) proved hard to estimate precisely, though we could accept the hypothesis \( \theta_3 = 0.7 \) which is in the range we found on aggregate data. As explained above, we have omitted a regional demographic change effect and so no \( b_{13} \) parameter appears.
Finally, one new variable has been included in eq. (7) which was not present in eq. (2). This is rgrrhse(−1), the lagged relative rate of return in the South East. This is included in order to represent any aspects of a house price shock transmitted from the South East to other regions with a lag and not otherwise reflected in the regional contiguity effects rgrrh_i*.

However, at this stage no regional "frenzy effects" were included to see how far a successful model could be developed without these additional complications.

Equation (7) for the 11 regions of the UK was estimated in TSP as a system of seemingly unrelated equations for annual data from 1972 to 1991. Results are shown in Table 1 for the specification which results after a number of simplifying assumptions were tested and accepted. After the intercepts, let us discuss the estimated parameters of eq. (7) in sequence. Standard errors are given in parantheses after the parameter estimates. \( \lambda \), the adjustment parameter is estimated at 0.51 (0.03) compared with estimates in the region of 0.65 for the aggregate UK model. Somewhat slower adjustment at the regional level may be a symptom of measurement error or extra noise at the regional level. The long-run income elasticity \( b_1 \) is estimated at 1.8 (0.2) compared with UK estimates around 2.4 to 2.5. This is consistent with the theory set out above. The \( \theta \)'s were estimated subject to the restrictions \( 0 \leq \theta_{11} < 0.7, 0 < \theta_{21} \leq 1 \) and where the boundary conditions were violated or easily satisfied, they were imposed. The biggest income contiguity effect is in East Anglia where commuting to London and the South East is common. There is also a substantial one in the South West. On a priori grounds, a coefficient of \( \theta_1 \) for the South East exceeding 0.4 seemed implausible and the restrictions could be accepted. The contiguity effect is absent in Wales, the North and the Midlands.

The income distribution effect, \( \hat{\beta}_2 = 0.22(0.10) \), measured via the ratio of non-manual to manual earnings is almost identical to our UK estimate, but not accurately determined. The overall rate of return effect is measured by \( \hat{\beta}_3 = 0.51(0.037) \) which is roughly twice our UK estimate. Mainly this is because our UK model also includes a
non-linear "frenzy" effect which is strongly correlated with the rate of return and is absent in the regional model. This "frenzy" effect represents the effects of transactions costs: if the rate of return substantially exceeds the transactions costs hurdle, it is likely to operate substantially more powerfully. In part, the difference may also be the result of the regional transmission mechanism which imparts more weight to regionally distinct lagged house price changes. If this is so, it suggests the use of lagged house price changes in the South East to model aggregate UK house prices also.

The contiguity effects for the rate of return, as represented by the $\theta_2$'s, are (with the exception, for some reason, of the West Midlands) strong everywhere outside the South East. This is evidence in favour of ripple effects originating in the South East (and possibly the West Midlands).

The interest rate effect weighted by the mortgage stock/income ratio measured by $b_4 = -8.6(1.2)$ is much bigger than the corresponding levels effect for our UK model. In fact, in terms of fit, there is not much to choose in the latter between a levels and a difference specification, though, if specified in levels, there appears to be a considerable nominal interest rate component for the aggregate data. On the face of it, the regional data appear to come down heavily in favour of a levels specification, suggesting some need be re-specify the aggregate UK model.

The next variable to appear in eq. (7) is the financial liberalization index with coefficient $b_5$. There is evidence that this did not have a uniform effect throughout the country but had a disproportionate positive effect in the South East and in Scotland, perhaps because of the importance of the financial services sector in these regions, though curiously enough not in East Anglia or the South West. The index experienced a small, short-lived rise in 1972–3 and then rose strongly from 1981–88 with a temporary set back.

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9 This may be because, according to our data, the relative mortgage stock to income ratio was rising strongly in the South West along with the relative population/lagged housing stock ratio, thus already providing plenty of uplift to relative prices.
in 1983–4. The lagged mortgage stock/income ratio has an effect $b_6 = 0.21(0.11)$ which is very consistent with that found at the aggregate UK level.

One very clear prediction of the theory is that the price elasticity of demand should be higher at the regional level than at the national level. There are greater substitution possibilities between regions than between nations where distance, language and customs create greater barriers. The inverse of this elasticity $b_7 = 1.21(0.30)$ is indeed lower at the regional level than our national estimates which suggest a figure around 1.9.

As far as the income dynamics are concerned, $b_9 = 0$ produces a substantially lower trace, i.e. better fit, than a freely estimated negative value of around 0.5 produced by TSP. TSP computes SUR estimates by running OLS first, computing an estimated covariance matrix which is then held fixed in all subsequent iterations. It seems that the OLS estimates, which give small noisy, regions as much weight as big low variance regions such as the South East, prefer some smoothing of income over time, which appears to be redundant in iterated GLS.

The regional data prefer a one year lag on the rate of acceleration of the South East’s unemployment rate, while the national data appear to prefer no lag. The sign pattern on $b_{10i}$ suggests a positive effect on the relative house price in Scotland, the North, the North West and Yorkshire and Humberside, with the opposite effect on the remaining regions. In other words, an unemployment shock in the South East drives up, with a one year delay, relative house prices in the four most northern regions and Northern Ireland and drives down relative house prices in regions closer to the South East.

The next variable to appear in eq. (7), the weighted change in the mortgage interest rate, proved to be insignificant. This does not necessarily mean that changes in interest rates are irrelevant in the UK model but that they are not weighted by anything that varies over regions. Then their effect washes out of equations in regional deviation form. The unsold stock variable $ush_{-1}$ is also insignificant suggesting that it has a relatively uniform effect across regions.
Finally, the lagged relative rate of return in the South East, $\text{rgrrhse}_{-1}$ is retained. Apart from an anomalous but insignificant positive effect in the North and North West, it has generally negative effects, seen in $b_{15i}$ away from the South East and positive effects in the South East, East Anglia and the South West.

The residual plots shown in Figure 2, as well as some evidence of positive serial correlation, suggest clear evidence that there are some elements still absent from the model. The residual plots in regions distant from the South East (except Northern Ireland) all show negative residuals in 1987–8 and positive ones in 1989. This suggests that much of the action in those years did not originate in those regions. We suspect that the non-linear frenzy effects which are a feature of our 1992 UK house price paper may be the explanation. Note that for 1987–8 there are corresponding positive residuals in the South East equation, which a South East "frenzy" effect is likely to pick up.

Figure 1 plots for each region the fitted values of the main elements in the long run solution against the relative house price index being explained. These elements are the effect of income, rate of return, the mortgage debt/income weighted interest rate and population relative to housing stock. These plots suggest the volatility of differential regional movements of house prices cannot be explained by fundamentals of income, population and housing stock — though these do have important long run effects. Movements in interest rates, scaled by debt, and in the lagged rate of return and, to a degree, in the different regional impact of financial liberalization are critical in explaining house price volatility in the UK. Making the above model more complete by including regional "frenzy" effects is likely to reinforce these conclusions that finance and speculative portfolio considerations explain much of the volatility of UK house prices.

There are a number of other aspects of the specification which remain to be investigated. It would be of interest to incorporate a more explicit treatment of income and rate of return expectations. It would be worth investigating whether the speed of adjustment differs by region. The structure of the covariance matrix of residuals and the
pattern of coefficients may suggest grouping regions into three broader aggregates: perhaps the South, the Midlands and the Rest. If this were supported by the data, one could then reconsider the specification of a UK house price model in the light of such a more aggregated regional model.

4. **Summary and Conclusions**

Our study addresses three issues that Holmans (1990) has argued are particularly in need of explanation:

1. Why geographical percentage differences in house prices are so much greater than those in incomes.
2. Why the North/South percentage difference in house prices widened in the 1980s.
3. Why the South leads the house price cycle, and why its downswing was sharper than elsewhere in the economy.

The determination of house prices is best studied by estimating an inverted demand function, that is, prices expressed as a function of demand side factors and the given supply of houses. In practice, account needs to be taken of adjustment lags and the possibility that prices may not clear the market in the very short-run. All the variables in our model are expressed in the form of regional deviations from the UK averages.

The main determinants of the regional deviation in house prices from the UK average are: income within the region and income in contiguous regions; income inequality within the region; the lagged rate of return in the region and in contiguous regions; an index of financial liberalisation with a different impact in different regions; the mortgage interest rate weighted by the lagged debt/income ratio; the lagged mortgage stock/income ratio; the rate of acceleration of unemployment in the South East; and regional population relative to the regional housing stock (both owner-occupied and not).
One important reason to explain the first of the issues above is that the income
elasticity of demand for housing on a regional basis is around 2. Thus, a 10% income
differential implies a 20% house price differential.

However, the rise in relative incomes in the South East explains only a part of the
appreciation of South East house prices. We find strong evidence for an extrapolative
element in expectations: a geared rate of return measure using interest rates and last
year's capital appreciation is highly significant in explaining this year's house price change.
In other words, once the housing market begins to rise, this rise tends to be
self-reinforcing. For some regions, especially the South West and East Anglia which
adjoin the South East, the contiguous region rate of return effect dominates. These two
regions also have a strong transmission effect from the income level in the contiguous
regions. This helps to explain with the South East leads the house price cycle.

Another reason for the self-reinforcing effect of house price upswings is the
feedbacks they generate through income and consumption. We have regional evidence
discussed in the companion paper on regional consumption that incomes respond to past
house price increases. This is a mixture of effects: partly costs of living, partly by
curtailing regional labour supply, partly because house prices may reflect expectations of
income growth, partly because of the role of housing collateral in financing small
businesses, and partly because the feedback via wealth effects on consumption also feeds
back into employment and incomes by increasing demand for locally produced services and
goods.

In addition to the rate of return effects above, interest rates have another very
important effect on house prices. In our model they enter weighted by last year's mortgage
stock to income ratio. Since the Southern regions experienced sharp rises in indebtedness
in the 1980s, falls in interest rates between 1986 and 1988 further stimulated house price
rises, while the dramatic interest rate increases between 1988 and 1990 impacted
particularly negatively on these regions. The sharpness of the downswing in the South thus
has much to do with the sharpness of the boom there, the high level of gearing and the dramatic interest rate rise. Falls in interest rates since 1990 help to explain why the South-East is now leading some house price recovery.

Financial factors also enter our model through the mortgage stock to income ratio, and through our index of financial liberalisation, both of which boosted house prices in the Southern regions, particularly. The differential impact of the index of financial liberalisation probably also proxies the rise in employment in financial services, which stimulates housing demand partly because of the prevalence of subsidised mortgages in this sector.

As far as the future is concerned, it seems that, for a given interest rate, mortgage lenders will not permit such high levels of gearing (ie., loan to value ratios) as experienced in the late 1980s. This seems likely to lead to some reduction in the volatility of the housing market. It is unfortunate that the government has not done more to rejuvenate the private rented sector, which would help bring more stability to the owner-occupied housing market and the economy. This stabilisation effect works in a number of ways. One of these is that interest rate increases in the UK have a large immediate impact on the cost of mortgages and so the cost of living as reflected in the retail price index. In the US and Germany by contrast, where the rented sector comprises respectively 35 and 55% of the housing stock, housing costs for owner-occupiers are measured through equivalent (imputed) rents based on free market rents: these respond only slowly to interest rate increases, imparting more stability to the consumer price index.

Our analysis of volatile regional house prices and the earnings and consumption feedbacks that exacerbate this volatility strongly support the conclusion of MacLennan (1994) that too many potentially vulnerable households and individuals have been pushed into owner-occupation. Owner-occupation can be very risky, particularly when households take on heavy debt burdens. House price risks, repossession risks and unemployment risks are correlated for individual families. For example, when a large loc
employer closes down, local unemployment rises. As the same time, the local housing market weakens, increasing the risk of repossession. Even without repossession, it is more difficult for the owner—occupiers among newly unemployed to move as they have lower deposits to put down on housing elsewhere.

A healthy private rented sector would enable the potentially more vulnerable households to reduce these risks and preserve this ability to move in response to job loss. Risks would be shared with more heavily capitalized and diversified landlords thus reducing both the level of individual risk and the volatility of the macroeconomy which the mortgage arrears, negative equity and repossessions crises have exacerbated. In a world of greater international competition, individuals are likely to have less secure jobs and be more likely to have to experience unemployment spells, relocate or retrain. In such a world, a healthy private rented sector brings even greater benefits.
References


Giussani, B and G Hadjimatheou, (1991a), "Modelling Regional House Prices in the UK", *Papers in Regional Science*.


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NOTES:
1. KEY: NN (North);NW (North West);YH (Yorkshire and Humberside);WM (West Midlands);EM (East Midlands);EA (East Anglia);SE (South East);SW (South West);WW (Wales);SC (Scotland);NI (Northern Ireland).
3. Estimated using Seemingly Unrelated Regression technique.
4. Standard Errors computed from quadratic form of analytic first derivatives (Gauss).
5. Trace=191.
### Table 2: Regression Output for Regional Components of Equation (5)

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Note: The table displays the regression output for regional components of Equation (5) for the North-West and North-East regions, showing the actual, fitted, and residuals values for each year from 1972 to 1991. The residuals are calculated as the difference between the actual and fitted values, indicating the error in the model's predictions.
### Table 1: Mean of dependent variable: .141358E-02

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### NORTH DATA

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Sum of squared residuals: 7423128-02  
Durbin-Watson statistic: 1.6185

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### SOUTH DATA

Mean of dependent variable: 557082-02  
Std. error of dependent var.: 335423  
Sum of squared residuals: 7423128-02  
Durbin-Watson statistic: 1.6185

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### VALUE

Mean of dependent variable: 335423-02  
Std. error of dependent var.: 335423  
Sum of squared residuals: 7423128-02  
Durbin-Watson statistic: 1.75438

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FIGURE 1 (A)-(K): MAJOR REGIONAL VARIABLES.

KEY TO VARIABLES IN THE FOLLOWING REGIONAL PLOTS:

ESTIMATED EQUATIONS:

\[
\text{EQN. DLHRI.} = \\
B0 + \text{LAMBDA} \cdot (B1 \cdot (1 - \text{THETAI}) \cdot \text{LRME} + \text{THETAI} \cdot \text{CEARN}) + \\
B2 \cdot \text{RENM} + B3 \cdot (1 - \text{THETA2}) \cdot \text{RGRH} + \text{THETA2} \cdot \text{CONT}) + \\
B4 \cdot \text{WABMR} + B5 \cdot \text{AFLIB}(-1) + B6 \cdot \text{LMRTGY}(-1) + \\
B7 \cdot (\text{LRPOP} \cdot \text{LRH}(-1) - \text{THETA3} \cdot \text{LRPOO}(-1) - \text{LRHP}(-1)) + \\
B15 \cdot \text{RGRHSE}(-1) + B10 \cdot \text{DSDURS}(-1)
\]

WHERE = NN (NORTH), NW (NORTH WEST), YH (YORKSHIRE AND HUMBERSIDE), WM (WEST MIDLANDS), EM (EAST MIDLANDS), EA (EAST ANGLIA), SE (SOUTH EAST), SW (SOUTH WEST), WW (WALES), SC (SCOTLAND).

\[
\text{EQNNI DLHRPNI} = \\
-(B0NN*0.036 + B0NW*0.093 + B0YH*0.067 + \\
B0EM*0.058 + B0WM*0.083 + B0EA*0.034 + B0SE*0.0417 + \\
B0SW*0.092 + B0WW*0.039 + B0SC*0.065)*0.016 + \\
\text{LAMBDA} \cdot (B1 \cdot \text{LRME} + B2 \cdot \text{RENM} + \\
B3 \cdot \text{RGRH} + B4 \cdot \text{WABMR} + \\
-(B5NN*0.036 + B5NW*0.093 + B5YH*0.067 + \\
B5EM*0.058 + B5WM*0.083 + B5EA*0.034 + B5SE*0.0417 + \\
B5SW*0.092 + B5WW*0.039 + B5SC*0.065)*0.016) \cdot \text{AFLIB}(-1) + \\
B6 \cdot \text{LMRTGY}(-1) + \\
B7 \cdot (\text{LRPOP} \cdot \text{LRH}(-1) - \text{THETA3} \cdot \text{LRPOO}(-1) - \text{LRHP}(-1)) + \\
-(B1NN*0.036 + B1NW*0.093 + B1YH*0.067 + \\
B1EM*0.058 + B1WM*0.083 + B1EA*0.034 + B1SE*0.0417 + \\
B1SW*0.092 + B1WW*0.039 + B1SC*0.065)*0.016) \cdot \text{RGRHSE}(-1) + \\
-(B10NN*0.036 + B10NW*0.093 + B10YH*0.067 + \\
B10EM*0.058 + B10WM*0.083 + B10EA*0.034 + B10SE*0.0417 + \\
B10SW*0.092 + B10WW*0.039 + B10SC*0.065)*0.016) \cdot \text{DSDURS}(-1)
\]

WHERE NI = NORTHERN IRELAND.

VARIABLES FOR FIGURES 1 (A)-(K):

\[
\text{VHP} = \text{LRHP}. \\
\text{VB1} = B1 \cdot (1 - \text{THETAI}) \cdot \text{LRME} + \text{THETAI} \cdot \text{CEARN}. \\
\text{VB3} = B3 \cdot (1 - \text{THETA2}) \cdot \text{RGRH} + \text{THETA2} \cdot \text{CONT}. \\
\text{VB4} = B4 \cdot \text{WABMR}. \\
\text{VB7} = B7 \cdot (\text{LRPOP} \cdot \text{LRH}(-1) - \text{THETA3} \cdot \text{LRPOO}(-1))
\]

WHERE = REGIONS AS ABOVE.