**The Distribution of London Residential Property Prices and the Role of Spatial Lock-In**

1. **Introduction and Background**

Much of mainstream economic analysis views markets as adjusting quickly to external shocks, mainly through the mechanism of price changes. However, economics also identifies a number of conditions that lead to market failure. The New Institutional Economics shows the importance of transaction costs, which, for example, may hinder countries from adopting new, more efficient technologies. In housing economics, transaction costs affect the use, amendment and transfer of property and are embedded in the distribution and value of property rights. Although well-defined property rights are generally perceived as important for market efficiency and lead to the establishment of stable institutional structures, they also have a disadvantage. Any given hectare of developed land may belong to multiple owners. Therefore, assembling large land packages for redevelopment can be problematic, because of the difficulties of negotiating across so many parties. The problem is not new. One reasons London was not redeveloped in line with Wren’s grand design following the Great Fire was the structure of property rights, leading to a preservation of the largely mediaeval street layout. Similarly, the difficulties in agreeing compensation payments were partly responsible for the piecemeal development of London’s slum clearance programmes in the late 19th century. Finally, a stable distribution of property rights that discourages innovation or investment may lock-in sub-optimal spatial and institutional structures.

Transaction costs imply that city structures do not necessarily respond quickly to market signals and that structures can be inefficient or unsuited to the needs of modern day living. Such constraints also lead to examples of spatial lock-in; once areas have been developed, it becomes difficult to change the basic characteristics of an area. Nevertheless, urban structures do eventually change. Meen and Nygaard (2011) take an example from the East End of London, where residential structures remained largely unchanged for at least 100 years, but eventually underwent radical alteration in response to the Blitz and the policies of the London Docklands Development Corporation. They showed that historical patterns of land use and geography continue to have strong effects on house price distributions and housing supply elasticities in the Thames Valley to the east and west of London. However, often innovations have to be large in order to offset the transaction costs associated with change. For public policy this might mean that the resources required to significantly alter the trajectory of neighbourhood status will be excessive and piecemeal investments or shocks will dissipate in the longer term.

There remains, however, a dearth of empirical evidence on these issues. This is because, in order to conduct formal tests over long periods of time, it becomes necessary to compile consistent data sets for small areas from the 19th century. This is a major undertaking and one of the contributions of this paper is to reveal some results of a data exercise relating to neighbourhood social status in 1881, housing policy (slum clearance) and infrastructure development (London’s underground system). London is used as a case study, but, in principle, it is possible to compile some of the data for other major Victorian cities. The empirical part of the paper develops a simultaneous three-equation system covering modern local house price distributions, the determinants of patterns of deprivation and the factors that influenced post-World War 2 slum clearance programmes to test for persistence and lock-in. Results are compared to a reduced form house price equation, where modern prices are a function of a set of exogenous primarily 19th century regressors. The structural and reduced form models provide similar messages on the role of spatial lock-in. The headline finding is that approaching 30% of the distribution of modern house prices in Inner London can be explained by factors that were in place prior to the 2nd World War.

1. **Neighbourhood Dynamics: Insights from the Literature**

Public policy in the UK (and elsewhere) has long aimed at altering the trajectories of select (inner city, slum, artisan quarters etc.) urban areas. For such policies to succeed, they need to address a range of underlying economic, social and political drivers of neighbourhood dynamics and transaction costs. However, public policies may also become the sources subsequent transaction costs – inhibiting neighbourhood change. Three issues are considered: (i) the causes of initial area development and persistence; (ii) patterns of neighbourhood segregation; (iii) the dynamics of neighbourhood change.

* 1. **Initial Development and Persistence**

Increasing returns models (Krugman 1991, Fujita *et al* 1999) may generate path dependence and spatial lock-in, determined by initial conditions. The natural advantages of any area, e.g. closeness to natural resources, ports, transport hubs, or soil fertility, ensure that such locations are able to establish an advantage, which they sustain over long periods of time, because of the externalities associated with agglomeration. Spatial lock-in is particularly likely where the transaction costs associated with change are high (Krugman 1991a).

A further question is whether initial agglomerations preserve their position after the initial sources of advantage become irrelevant for subsequent development. Empirical studies of this form have used much longer data sets than typically appear in time-series econometrics. Long data sets allow research to consider two key questions: (i) the extent to which spatial structures persist; (ii) the extent to which structures change in response to large external, exogenous shocks. The latter also allows studies to identify the possibility of multiple equilibria following large. The work of Davis and Weinstein (2002, 2008) and Bosker *et al* (2007) concentrate on the effects of World War 2 bombings on population structures of cities. Nitsch (2003) concentrates on changes in the population of Vienna following the break-up of the Austro-Hungarian Empire.

Nitsch finds that Vienna’s declining population after WW1 stabilised at a level higher than expected from its underlying characteristics. He interprets this as evidence of spatial lock-in. Davis and Weinstein conclude that the spatial distribution of bombed Japanese cities recovered in the post-war period, despite the widespread destruction. The tests are based on a random walk model. If population growth exhibits a random walk, then temporary shocks, such as a war, have permanent effects. But Davis and Weinstein (2002) reject the random walk and observe that, by 1960, US bombing had little effect on city size – suggesting persistence in historical city structures. Their 2008 paper tests for multiple equilibria, but found no support. By contrast, Bosker *et al* (2007) find evidence of two stable equilibria in Germany, i.e. wartime bombing altered the equilibrium population distribution. Using a different approach and looking at the Vietnam War, Miguel and Roland (2010) suggest that US bombings had little permanent effect on local poverty rates.

* 1. **Neighbourhood Segregation**

There have been few empirical studies of long-term neighbourhood change in the UK. The most relevant here is the work of Orford *et al* (2002), who highlight the stability of spatial poverty patterns over the last century, although they find a degree of convergence. In terms of theoreticalmodels, a consistent result across different approaches is that segregated communities are the most likely outcome, whether by ethnicity, income or housing tenure, even if discrimination or physical controls are ignored.

First, the standard monocentric model implies that spatial distributions of households depend on the income elasticity of housing demand relative to the income elasticity of the marginal valuation of commuting time (Muth and Goodman 1989). If the former is large relative to the latter, high-income groups are more likely to be concentrated in the suburbs than in the inner city. However, Wheaton (1977) suggests that the two elasticities are similar in size, in which case mixing becomes more likely. Second, extensions by Brueckner *et al* (1999) to include endogenous and exogenous neighbourhood effects lead to multiple equilibria, where wealthier households may live in either the centre or suburbs, but their results do not change the fundamental finding of segregation. Third, Evans (1976) demonstrates how segregation is more likely to occur when household preferences are interdependent. Fourth, segregation arises in the literature on self-organising cities, using techniques from complexity theory. Schelling (1971) showed that even mild preferences about the characteristics of your neighbours (e.g. ethnic or social status) lead to more highly segregated communities than would be expected. Later extensions to a stochastic world (Young 1998) demonstrate the important property that models with social interactions exhibit segregation as the stochastically stable state.

At the policy level, this has at least four implications: (i) it is difficult to generate mixed communities through government policy interventions; (ii) heavy concentrations of highly skilled workers in certain areas are likely to be the norm; (iii) the statuses of areas can change through a sequence of random shocks, but these changes are unlikely to take place frequently; (iv) a series of random shocks can establish the initial position of an area, independently of the original natural advantages.

* 1. **The Dynamics of Neighbourhood Change**

If transaction costs are important, then dynamic neighbourhood models need to have the properties that (i) spatial structure can remain stable and segregated for long periods of time, but (ii) can eventually change either in response to a combination of random events or in response to the four types of innovations outlined in the Introduction. Cellular automata (CA) possess these characteristics; dynamic change – notably tipping, phases of transition and thresholds – can occur in response to a combination of random events. However, simulations on CAs in Meen and Meen (2003) suggest that tipping is a rare event, arguably even rarer than is observed in practice. If so, non-random factors need to be sought that may generate change.

Social interactions models have similar properties (Durlauf 1997, Blume and Durlauf 2001) and, in particular, exhibit neighbourhood tipping and thresholds. Galster and collaborators (Quercia and Galster 1997, Galster and Zobel 1998, Galster *et al* 2000, Galster 2002) investigate the evidence for thresholds, which may generate poverty traps. Durlauf (2006) suggests that, formally, poverty traps are limiting cases of economic immobility or are states in which the persistence of economic conditions is arbitrarily long. Furthermore, if there is a high degree of segregation within the city some neighbourhoods become trapped in the upper tail of the poverty distribution. For these areas, persistence in spatial structures is likely and very large changes required to bring areas to the take-off point However, as shown in later sections, although slum clearance programmes may also bring areas to the threshold, it is, by no means, certain – the outcome depends on the replacements for the slums.

* 1. **Summary of the Issues**

In the short term, changes in local prices are highly correlated.[[1]](#footnote-1) There is little evidence that the distribution of prices changes quickly; rather all local price movements are dominated by a common stochastic trend. Although individual households may move from deprived areas as they become richer, the overall spatial patterns of segregation and poverty in the UK appear to have changed little over the course of the last thirty years, despite the thrust of government policy to improve spatial mixing, (see Meen *et al* 2005, Dorling *et al* 2007). The literature review suggests good reasons why this is the case – most economic theories support segregation as the norm and mean reversion is the most common finding in the empirical literature. The presence of transaction costs also implies that change is likely to be slow. But, some theories suggest that change eventually does occur, although the timing is unpredictable and may be non-linear. However, long data sets are required to find evidence.

The question therefore becomes to what extent history explains housing market variables in London? Prices are chosen because, generally, they adjust quickly in neo-classical models – large effects from history are thus unexpected. If neoclassical assumptions do not hold (i.e. prices do not adjust quickly) then the factors that determine historic property prices ought to explain current property prices as well. The strength over time of the determinants of property prices is again related to the magnitude and/or frequency of innovations that under assumptions of slow adjustment processes determine individuals’ perceptions and expectations.

1. **Determining Local House Prices**

National and regional models of house prices are commonplace in the UK (see Meen 2001 for a summary). Typically, these are derived either from reduced form housing demand and supply functions or from a life-cycle approach. In practice, both lead to a similar set of regressors. At the other end of the spectrum, hedonic models determine the prices of individual properties in terms of the structural characteristics of the dwellings and the neighbourhood. A small number of studies, e.g. Bramley and Leishman (2005), attempt to integrate different spatial scales. But, in these traditional approaches, the possibility of simultaneous equation bias arises. For example, in national models, the elasticity of house prices with respect to income is generally found to be high, but, in principle, could be biased upwards if higher house prices generate increases in demand in the economy, and consequently incomes, through collateral or wealth effects. In hedonic models, it is possible that the structural and neighbourhood characteristics could be functions of local house prices. To overcome the problem, Galster (2003) sets out a simultaneous model of home ownership, mobility, neighbourhood character, housing wealth and socio-economic status. Furthermore, Galster and Zobel (1998) highlight the problems of simple cross-section hedonic house price studies that find a negative relationship between individual house prices and the proportion of poor in any neighbourhood. Macro structural weaknesses in an area, unrelated to the current level of poverty, may reduce house prices so that poor households can move into the area – high levels of deprivation might equally be caused by low house prices. The model that is put forward here does not cover all the variables suggested by Galster, but is a joint model of three key variables - local house prices, deprivation and slum clearance programmes. Potential endogeneity is considered by integrating information from long periods in history.

Four classes of variable that affect the location choices of individual households may be identified, (i) the characteristics of the households themselves, both demographic and economic, (ii) features of the neighbourhood, for example local amenities, (iii) the combined characteristics of the current inhabitants of each neighbourhood and, (iv) the characteristics of nearby locations. This paper concentrates only on the first three. Using the model in Haurin *et al* (2003) and Meen (2009), the following (owner-occupier) housing demand function for household (*i*) in each location can be specified:[[2]](#footnote-2)

 (1)

where:

*Hdi* = owner-occupier housing demand by household (*i*) in each neighbourhood

*xi* = a vector of individual characteristics of (*i*), both economic and demographic

 = average owner-occupation rate in each neighbourhood

 = average characteristics of individuals in each neighbourhood

 = a vector of physical characteristics in each neighbourhood (including amenities and the price of housing)

 = error term

The equation includes three terms, which are forms of social interaction, consistent with the discussion in Section 2.2, i.e. where individual behaviour depends on the characteristics of neighbours and neighbourhoods. The first is the average owner-occupancy rate and the second average neighbourhood population characteristics, both of which are potentially endogenous. The third represents contextual effects, which, with the exception of price, are exogenous. These include the impact of history on the structure of the neighbourhood. In the reduced form of (1), the coefficients on the group effects are not separately identified. Furthermore, equation (1) suffers from a correlated unobservables problem. Since, in practice, the  are unlikely to be able to capture the full-range of relevant characteristics, any correlation between the unobservables, captured in the error term, and the neighbourhood indicators is likely to overstate the influence of the latter. Although instrumentation of the neighbourhood indicators potentially provides a solution, in practice, finding valid instruments is not straightforward since, in many instances, the chosen instruments will still be correlated with the error term.

Equation (2) defines the average individual characteristics of the neighbourhood, whereas (3) and (4) gives the average owner-occupation rate in each area (assuming the mean error is zero). This is now related to the average characteristics of individuals in the neighbourhood and the characteristics of the area itself.

 (2)

 (3)

or

 (4)

Since one of the area characteristics is price, (*PN*), the vector *zN* may be partitioned into , giving (5).

 (5)

If the housing stock  is fixed in each area in the short run, the price equation for each neighbourhood is given by equation (6), adding an error term.

 (6)

But equation (6) shows that there are five parameters with only three estimated coefficients. The structural parameters are, hence, unidentified and it is not possible to distinguish the separate influence of the neighbourhood characteristics from the average characteristics of the individuals. Furthermore, issues of endogeneity arise. As noted earlier, on cross-section data, a finding of a negative relationship between house prices and poverty cannot, by itself, be taken as evidence of causality. This suggests the need to estimate *PN* and jointly by FIML. FIML produces efficient estimators when estimating a system of equations and is a common technique for estimating simultaneous-equation models (Green 2003). As above, is assumed to represent exogenous contextual variables and , as a stock variable, can reasonably be treated as exogenous since new additions are a small percentage of the stock.



Therefore in the second equation of the model, (7), the average characteristics of individuals in an area, which, in practice, are measured by the level of deprivation are expressed as a function of a second set of contextual variables, and the impact of government policy on the area, . The former include infrastructure variables and the latter the impact of slum clearance programmes. In practice, the former relate to developments in the 19th century rather than contemporary changes and are, therefore, treated as exogenous. But policy is treated as endogenous. In (8), slum clearance policy is assumed to have an autoregressive element, i.e. programmes tend to be concentrated in areas where previous clearances also took place and is also a function of a third set of exogenous (historical) variables, . Equations (6)-(8) are estimated jointly and the reduced form price equation gives prices as a function of , *j=1...3* and .



(7)



(8)



where (*-n*) refers to time (*n*) periods ago.

1. **Construction of the Data**

The tests of persistence require information on exogenous neighbourhood characteristics dating back to the 19th century, the century in which the population of London was booming and the capital experienced major technological changes. Through equations (6)-(8), it becomes possible to test the influence of each on 21st century price distributions.

**4.1 Social Status in the 1881 Census**

The 1881 census identifies individual addresses and occupations that can be used to classify individuals into five social classes based on the official 1950 classification of occupations (Long 2005; the first skills based classification): professional occupations (class i); intermediate occupations (class ii); skilled occupations (class iii); partly skilled occupations (class iv); and, unskilled occupations (class v). While feasible this is a very labour intensive task and a sample, described below, was taken. In order to construct the aggregated data, the 1881 addresses have to be assigned to current MSOAs (the level at which house prices are available). This is requires detailed study of 19th and 21st century maps. In a few cases, the assignment was not feasible and re-sampling became necessary.

In order to construct the sample 19th century parishes are divided into five groups – North, South, East, West and Central. From each, a sample of approximately 210 household heads is taken, recording addresses and occupations (254 heads of households were traced in the larger southern group). Each head is required to be male and between the ages of 18 and 35.[[3]](#footnote-3) In addition, the names and occupations of immediate neighbours either side of the sampled household head are recorded. The neighbours are not required to conform to the age and gender requirements. Including neighbours, this provides information on 6,430 household heads. Given the original 1086 heads in the sample, most dwellings, particularly in the poorer areas, have multiple heads. Of course, taking into account dependents as well, the residential densities are much greater than these figures suggest. The final sample covers 201 MSOAs out of the (Inner) London total of 394.

Table 1, columns 2-8, shows the total sampled household heads in each zone in 1881 and the numbers and shares in each of the social classes. The total numbers are fairly evenly balanced, although numbers in the East are rather smaller than in the other areas. Unsurprisingly Class (iii) dominates in all areas with approximately 57% of household heads falling into this category across the sample as a whole, with the share varying between 48.4% in the East and 63.1% in the North. The absolute numbers and shares in class (i) are small, but heavily concentrated in the West and “better” parts of the central zone. All zones have significant numbers of residents in classes (iv) and (v). The limits to cheap public transport in 1881, despite the rapid growth in rail and omnibus networks by this stage, still meant that the working classes relied on foot transport and, therefore, lived close to their places of employment. Despite the widespread dispersion of classes (iv) and (v), the greater concentrations of class (v) in the East (23.8%) and South (18.5%), compared with the London average of 15.5%, is noticeable. Given the concentrations of polluting industries and dock-related activities in these zones, these outcomes are scarcely surprising and conform to expectations. The final column (panel B) presents comparable figures for 2001 and shows that the shares in the lowest social classes have fallen in all areas.

**[Insert Table 1]**

**4.2 Slum Clearance Programmes**

The modern slum clearance movement in London began with the Torren’s Act (1867) and Cross Act (1875) and, for London, was consolidated with the creation of the London County Council in 1889 and the passing of the Housing of the Working Classes Act 1890 (Yelling 1981). Under the slum clearance movement the notion that economic obsolescence, in light of high demand and rental values, would incentivise market forces to redevelop poor quality housing was set aside for concerted, eventually area based, clearance programmes (Yelling 1981).[[4]](#footnote-4) Area based slum clearance was abolished in 1974 (Yelling 2000).

The London Metropolitan Archives retains copies of the majority of slum clearance representations made by the LCC from the 1930s onwards and include detailed maps made by medical officers at the time. Maps of earlier slum clearance activity are found in Stewart (1900) and Gomme (1913). The maps depict individual houses identified by medical officers as well as procedural data and some amendments in lieu of landlord objections.[[5]](#footnote-5) However, not all slum clearance was carried out by the LCC. Private landlords in Improvement/Redevelopment Areas also undertook some demolition and a number of slum clearance schemes were carried out by the London Boroughs. The data considered here only include LCC and earlier Metropolitan Board of Works schemes.

This paper utilises the individual representation maps stored at the London Metropolitan Archives as well as Stewart (1900) and Gomme (1913). Historic Ordnance Survey maps were used to derive slum clearance representation polygons that subsequently were overlaid onto present day MSOA polygons in order to calculate the proportion of an MSOA’s area that had been affected by LCC slum clearance. Table 2 shows summary statistics for the three main legislative slum-clearance periods before World War 2; the post-war period is divided into three periods following Yelling (2000). While at first glance there appears to have been a reduction in the size of the average representation it should be noted that representations made prior to the 1930s are largely individual schemes whereas representations from the 1930s frequently involve multiple representations in close proximity within an improvement/redevelopment area. The table shows the increase in activity from the 1930s.

**[Insert Table 2]**

In total, 1190 polygon shapes were completed. The final results for the central areas of London are shown in Figure 1 and demonstrate the concentration of schemes in the East and South. Although some MSOAs (particularly in the West) have experienced no clearances under the different Acts, 35% of the land area in the East End MSOA of Tower Hamlets 009 was redeveloped under the different schemes.

**[Insert Figure 1]**

* 1. **The Tube Network**

The construction of railway lines significantly affected the built-up environment of the suburbs (with the destruction of much artisan and cheaper housing), but property prices and parliamentary reluctance largely stopped developments in wealthier and central areas of London. In 1859 the Metropolitan Railway Company (MRC) and the City Corporation reached an agreement for an underground line running from Paddington to Farringdon thus avoiding the compulsory purchase of property along the line (Inwood 1998; White 2008). The inner circle was completed in the mid 1880s – a period that also experienced substantial extensions of the network into the suburbs by the MRC and District Line (DL). In 1908 the ‘underground system’ of several independent operators was marketed jointly for the first time. The underground infrastructure data used in this paper are based on cross-referencing the 1908 joint marketing map against the 1906-1939 (2nd revision) edition of the 1:2500 OS County Series. Points were created for each station and operator. For each MSOA centroid the distance to the nearest station point is calculated in meters.

**4.4 Rateable values and property prices in 1881**

For path dependency to exist, the variables that determine current spatial variation in property prices must be proven to hold in earlier periods as well. A comparable local property price indicator for 1881 does, however, not exist. Instead rateable values are used as proxies for property values. Rateable values for registration districts are sourced from the London County Council’s (LCC) annual statistical compilation – ‘London Statistics’. The rateable value was the annual rent a tenant might be expected to pay less any maintenance, insurance and related costs (LCC 1938:467). Under the assumption that the market value of real estate is related to the discounted rental value, these provide a proxy for market values of properties. Additionally, private renting was the dominant tenure in 1881, making rateable values (reflecting rents) more informative. Aggregate rateable values in each registration district are divided by the housing stock in each registration district, sourced from the 1881 census, but are not decomposable into residential and non-residential elements.

The rateable values data is at a higher level of spatial aggregation. The average size of a Registration District was 10.82 sq. km2 compared to 0.78 sq.km2 for modern MSOAs. This reduces the number of observations, but potentially also reduces identification issues arising from functional housing market areas in practice spanning multiple MSOAs. Due to the spatial limitation of the 1881 social status variable a complete set of data could only be constructed for 28 registration districts (out of 30 for whom rateable values can be identified). The excluded areas are Woolwich and Lewisham.

1. **Estimation Results**

The model consists of the three equations (6)-(8), estimated across the sample MSOAs in Inner London. In terms of the variables discussed in Section 4, the precise estimated form of the model is given by (9)-(11) and the reduced form by (12).

(9)

(10)

(11)

(12)

*CITY* = Distance from central London (metres)

*Hs* = Housing stock (000s)

*IMD* = Index of Multiple Deprivation for 2004

*PH* = Median house price in the MSOA in 2006 (£)

*SC81* = Proportion of residents in each of the five social classes in 1881

*SLUM19th* = % of MSOA demolished under 19th century acts

*SLUM30s* = % of MSOA cleared under 1930s acts

*SLUMpostwar* = % of MSOA cleared under post-war programmes

*TUBE08* = distance to nearest tube station in operation in 1908

*TUBE81* = distance to nearest tube station in operation in 1881

*i*  = MSOA index

(9)-(11) are estimated jointly by FIML and the implied reduced-form house price equation (12) is also estimated separately for comparison purposes. Some discussion is necessary on the relationship between the theoretical price equation (6) and the estimated version (9). In (6), separate regressors are included for the average characteristics of individuals living in the area, and the physical characteristics of the area, . As noted above, the individual coefficients are not separately identifiable. Since this research is not primarily interested in the separate effects, it is reasonable to include a composite measure that incorporates elements of both, e.g. the Index of Multiple Deprivation. Meen (2009) estimates a similar relationship, including relative housing stock and household income, on local authority data. This is repeated on MSOA data for 2006 as equation (13).



(13)

(9.9) (3.1) (1.2) (6.2)

R2 = 0.67; Equation Standard Error 0.198; t-values in brackets; *Y =* household income; *HH =* number of households.

At first sight, the equation provides a competent fit, it explains two-thirds of the variation in prices and *IMD* and *Y* are statistically significant with expected signs. The ratio of dwellings to households is insignificant at the 5% level and might suggest that, at fine spatial scales, housing shortages have little effect on prices as households can easily substitute between different locations. But relative to standard national and regional house price models, the goodness of fit is, arguably, spurious at MSOA level, because of endogeneity. Low income and deprived households may choose to live in low priced areas. The problem becomes more acute, the smaller the areas modelled. Equation (13) provides a useful benchmark, but estimating the system (9)-(11) or the reduced form (12) avoids the endogeneity problem, although the fit will inevitably be superficially poorer. Furthermore, (9)-(13) allow us to concentrate on the central issue – the role of path dependence. If the historical variables and *IMD* were included in an OLS regression, the former are likely to be insignificant, because *IMD* is itself path dependent – this does, however, not mean that history is unimportant.

To emphasise the issues, in the reduced form all regressors are dated prior to the Second World War and can reasonably be treated as exogenous. As an additional test of validity of the historic variables, equation (12) is estimated for rateable values in 1881. In order to control for the variation in type of housing across London (rateable values are aggregates) the natural log of the residential housing stock is added to the specification. Distances to the City and nearest underground station now relate to the centroids of registration districts in 1881 and the City and the underground network, as it existed in 1881. Slum clearance relates to slum clearance prior to 1881. Social status in 1881 is aggregated from MSOA level to registration district level.

Local measures of deprivation in England show notable stability in spatial poverty patterns over the last twenty years (see Dorling *et al* 2007). As a test of whether patterns are even longer lasting, equation (10) specifies the 2004 *IMD* as a function of the set of primarily 19th century variables – 1881 social statuses, the distribution of tube stations and different periods of slum clearance programmes. The equation also includes distance to the centroid, which is time invariant. Distance to tube stations might be expected still to exert an influence on modern prices, because they improve access. But remember that this is the tube network in 1908, rather than today.

The third equation (11) attempts to explain post-war slum clearance programmes (1945-75). This tests for evidence of autocorrelation in the programmes, so that, if the coefficient is positive, post-war programmes may be concentrated in areas that had already undergone some clearance activity in earlier years. Alternatively, the coefficient may be negative, indicating that such areas have experienced lower levels of subsequent clearance. In addition, social status in 1881 is included. Excluding insignificant variables Table 3 compares OLS estimates for equations (9)-(11) with the FIML estimates. The price equation shows a larger negative coefficient (-0.672) than in (13) because of the exclusion of (significant) income. But the R2 is similar at 0.6 because income is also a component of the *IMD*. The simplification, therefore, has little effect on the overall results.

**[Insert Table 3]**

As expected, allowing for simultaneity produces important differences between the estimates. In particular, the elasticity of house prices with respect to deprivation is higher under FIML, although the significance falls. But, in general, the coefficients on the hypothesised exogenous variables in the system remain similar under the two methods.

The key results are, first, house prices are sensitive to deprivation, even allowing for simultaneity. This is no surprise and is consistent with earlier work on local authority districts across England. However, as noted above, it is not possible to identify the separate impacts of different forms of group effects. Second, although significant in the OLS version, the FIML results indicate that distance from the centroid has no significant effect. Although the standard monocentric model suggests that prices fall with distance and this is supported in Meen and Nygaard (2011) it should be remembered that the sample here only covers Inner London and not the suburbs. Third, areas close to the 1908 tube stations have low levels of deprivation – the improved communications laid down in early part of the 20th century still exert an influence. Fourth, the post-war slum clearance programmes increased deprivation. Rather than reducing poverty, they promoted deprivation, because of their replacement with largely mono-tenure social housing estates. Fifth, given the positive coefficient, post-war slum clearances took place primarily in the same MSOAs as pre-War programmes. In addition, the areas experiencing the highest levels of clearance were those containing the highest proportions of household heads in class (v) in 1881.

The effects of persistence can be seen more clearly from the reduced form price equation in column (4). Here the distance to the centroid is borderline significant at the 5% level and the historical variables are generally significant; distance to the 1908 tube network is a particularly important predictor, as well as 1930s clearance programmes. 1881 social class plays a role, but is more clearly evident in that areas of very high social status in 1881 (class i) still experience relatively higher prices today. By contrast, social class (v) in 1881 has only a limited effect, suggesting a degree of convergence in prices over time. The values in square brackets are the reduced form coefficients derived from the equations in column (3). An F-test can be used to reveal significant differences between the reduced form coefficients. The F-test of coefficient equality (excluding the constant) yields F5,95 = 1.114. Consequently equality between the two coefficient sets cannot be rejected.

The model demonstrates that the modern distribution of house prices exhibits a degree of long-term persistence, even using a limited number of historical indictors. But the reduced form price equation gives an R2 of 0.28, so that, clearly, either additional historical indicators are required, for example road networks or even the underlying geology, or later influences affect prices. It should, however, be remembered that, even including contemporaneous variables, the R2 is only 0.67 in (13), which may be a better comparator than the maximum value of one.

It may also be the case that the equation fits better in some parts of the capital than others. Inspection of the residuals of the reduced form price equation indicates that prices are consistently under-predicted in Kensington and Chelsea and there is a particularly large error in one MSOA (Westminster 019). The under-prediction in some of London’s most expensive neighbourhoods *may* reflect additional contemporaneous influences and/or agglomeration economies associated with the continued shift to service and knowledge based economic activity since the 19th century (e.g. the expansion the prime rent zone to the West End since the late 1970s). However, excluding the western MSOAs from the sample, in which these lie, has little effect on the results for the remaining areas. As a further test, the sample is divided into MSOAs that lie north and south of the river. As Figure 1 shows, there are approximately three times as many observations in the former and this affects the results. Nevertheless, as Table 4 indicates, there remain considerable similarities. The main difference is that 1881social status has no significant effect south of the river. A likely reason for this is the lesser concentration (and incidence) of Londoners in social class (i) south of the river. This also explains why the distance variable becomes insignificant on the north side of the Thames, but remains significant on the south side. North of the Thames the concentration of Londoners in social class (i) is to the west and north west of the City of London – given the limited spatial coverage (compared to modern London) distance (north of the city) does not fully show the expected land-price gradient. The overall lower social status and slower economic restructuring south of the Thames *may* explain why slum clearance did not generate the same spatial dynamic as north of the river.

**[Insert Table 4]**

Finally, Table 5 shows the estimation results from the 1881 equivalent of the reduced form equation (12). Due to measurement differences in the dependent variables the results in Table 5 are indicative rather than directly comparable to results in Table 3 and 4.

**[Insert Table 5]**

Columns 2 and 3 only differ in terms of the *CITY* variable; in this case a logarithmic version of distance improves the regression fit and diagnostics. At the 5% level, this is the only significant variable in this specification indicating that that average property values were higher in the inner city. Social class (i) is borderline significant at the 10% level. As detailed in Section 4.3 high property prices inhibited the expansion of surface rail through much of the Western part of London. The earliest underground network is, however, disproportionately concentrated in a small number of registration districts to the west of the City. The bivariate correlation between distance to the underground network in 1881 (*tube81)* and social class (i) is moderately high (*r*=-.50). Slum clearance and social class (v) are not significant, but only 23 MBW schemes had been carried out by this time. In column 4, given the collinearity with social class (i), the underground variable is dropped from the specification, which improves the significance of the former. An alternative (column 5) to dropping the underground indicator is to remove the collinear element of the variable by substituting ln *tube81* with the residual of a regression of ln *tube81* on social class (i). Differences between Columns (4) and (5) are small, suggesting little bias from dropping the underground variable. Although not a feature of equation (12), column 6 includes the natural log of the residential housing stock in1881 (*HOUSING)*. The theory in equation (12) and (13) suggests a role for the variable, which, at this higher level of spatial aggregation, significantly improves the fit of the specification and takes the expected negative coefficient. However, its inclusion reduces the magnitude of the social class (i) coefficient, but increases the size of the social class (v) coefficient. The latter is now close to the 10% significance level. Given the small number of schemes at this stage the slum clearance variable remains insignificant. Table 5 confirms that the historic variables are significant determinants of property prices in 1881 as well. This provides a basis for transaction costs and property rights type explanations to generate persistence in spatial structures.

1. **Conclusions**

Much of mainstream economic analysis assumes that markets adjust smoothly, through prices, to changes in economic conditions. This paper, however, tests the proposition that housing markets exhibit a degree of path dependence, consistent with the effects of non-negligible transaction costs in the monitoring, protection and redistribution of property rights. Using local areas of Inner London as a case study, support is found for the proposition that variables measured in the second half of the 19th century and the first half of the 20th century continue to exert an influence on modern local house prices. These include the impact of pre World War 2 Slum Clearance programmes, 19th century social status and underground networks and can explain some 28 per cent of variation in modern house prices. It is, however, also clear that while path dependence is present, London’s economy and communication technology has substantially changed over the past century giving rise to unmeasured agglomeration economies and life-style variables that additionally affect modern house prices.

Tests require the construction of novel data sets, which include the use of individual records from the 1881 census and data from the Metropolitan Board of Works and London County Council slum clearance programmes. This is painstaking work, but leads to the development of a three equation model for house prices, deprivation and slum clearance programmes, which can be estimated jointly to allow for potential simultaneity and can also be estimated as a reduced form price equation. The results are consistent under the two methods. As a further test, the 19th century variables are used as regressors in a model to explain 1881 rateable values in London. Again consistent results are obtained.

It is, of course, not the case that historical indicators alone determine modern property prices – *merely that history still has some impact*. The suggestion of this paper is that large shocks, which are infrequent, are necessary to overcome the transaction costs that typify urban housing markets – transactions costs lock spatial markets into historically-determined patterns. From a public policy point of view this has significant implications for housing and regeneration policies. The analysis suggests that large shocks are necessary to alter the trajectory of neighbourhood development, but the outcome of large shocks – such as slum clearance – are contingent on the interactions with the sources of transaction costs (e.g. expectations, social interactions, local institutions of governance etc.) in the (re)production of a post-shock neighbourhood. Furthermore, the areas that are most in need of investment in the short-term may ultimately be the areas where conventional regeneration policies, such as replacement of the housing stock, will be ineffectual in the longer term, unless the policies manage to engage with the sources of transaction costs that determine the dynamics of spatial adjustment.

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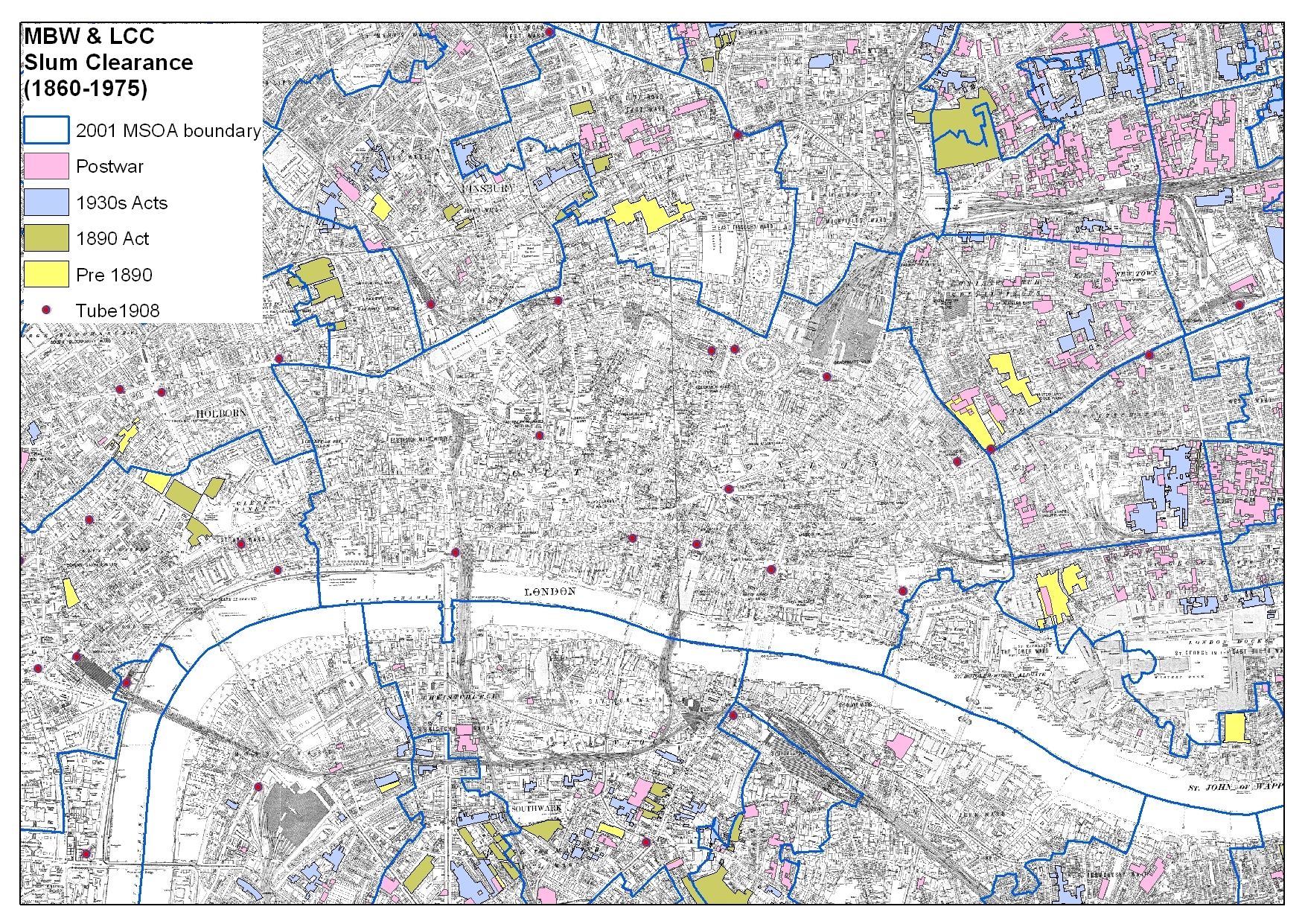
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Source: Slum clearance representation maps (author’s calculation) are based on copies of LCC representation maps stored at the London Metropolitan Archives and are derived from Historic Ordnance Survey County Series 1:2500 1st revision (1893-1915) and 2nd revision (1906-1939) from EDINA Digimap and Landmark information Group. Tube stations are derived from the same historic OS maps. The 2001 MSOA boundaries are based on data provided through EDINA UKBORDERS with the support of the ESRC and JISC and uses boundary material which is copyright of the Crown.

***Figure 1*. Slum Clearance Programmes 1860-1975**

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***Table 1.* Household Heads in Each Zone by Social Class, 1881 (numbers and percentages)**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Total Number** | **Class  (i)** | **Class  (ii)** | **Class  (iii)** | **Class  (iv)** | **Class  (v)** | **Sum  (iv &v)** | **Sum (iv &v) 2001** |
| North | 1328 | 6 | 119 | 838 | 206 | 160 | 366 | - |
| West | 1211 | 46 | 158 | 658 | 197 | 153 | 350 | - |
| South | 1248 | 11 | 142 | 665 | 199 | 231 | 430 | - |
| East | 1071 | 4 | 143 | 518 | 151 | 255 | 406 | - |
| Central | 1573 | 16 | 144 | 965 | 251 | 197 | 448 | - |
| All Areas | 6430 | 82 | 705 | 3644 | 1004 | 995 | 1999 | - |
|  | **Percentages** |  |  |  |  |  |  |  |
| North | 100 | 0.5 | 9.0 | 63.1 | 15.6 | 12.0 | 27.6 | 13.4 |
| West | 100 | 3.8 | 13.0 | 54.3 | 16.3 | 12.6 | 28.9 | 10.5 |
| South | 100 | 0.9 | 11.4 | 53.3 | 15.9 | 18.5 | 34.5 | 14.7 |
| East | 100 | 0.4 | 13.4 | 48.4 | 14.1 | 23.8 | 37.9 | 15.8 |
| Central | 100 | 1.0 | 9.2 | 61.3 | 16.0 | 12.5 | 28.5 | 14.3 |
| All Areas | 100 | 1.3 | 11.0 | 56.7 | 15.6 | 15.5 | 31.1 | 13.4 |

***Table 2.* Slum Clearance Activity in London 1860-1973, (square metres)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Representation period** | **Number** | **Average (m2)** | **St.Dev (m2)** | **Total area (m2)** |
| Pre 1890 | 31 | 7,390 | 6,993 | 229,076 |
| 1890s acts | 34 | 7,942 | 13,830 | 270,025 |
| 1930s acts | 207 | 6,890 | 7,471 | 1,426,280 |
| Post war (1945-54) | 96 | 4,634 | 7,068 | 444,895 |
| 1955-1964 | 587 | 3,482 | 4,451 | 2,043,770 |
| 1965-1975 | 235 | 4,118 | 5,456 | 967,774 |
| Total | 1,190 | 4,523 | 6,158 | 5,381,819 |

***Table 3.* Estimation of Equations (9)-(12)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable** | **OLS** | **FIML** | **Reduced Form: ln(PH)** |
| **Eqn (9,12): ln(*PH*)** |  |  |  |
| *Constant* | 14.964 (108.6) | 17.451 (20.5) | 13.484 (81.5) [13.583] |
| ln*(IMD)* | -0.672 (17.2) | -1.381 (5.6) |  |
| **Eqn.(10): ln(*IMD*)** |  |  |  |
| *Constant* | 3.181 (16.6) | 2.715 (13.2) |  |
| *CITY* | -3.80E-05 (3.6) | -4.75E-0.06 (0.6) | 1.87E-05(2.0) [6.57E-06] |
| ln*(TUBE08)* | 0.066 (2.3) | 0.109 (3.5) | -0.145 (5.9) [-0.151] |
| *SLUMpostwar* | 0.044 (5.7) | 0.047 (3.1) |  |
| **Eqn. (11): *SLUMpostwar*** |  |  |  |
| *Constant* | 1.234 (3.8) | 1.280 (2.6) |  |
| *SLUM30s* | 0.629 (6.9) | 0.543 (5.8) | -0.034 (3.5) [-0.035] |
| *SC81 (class i)* | -0.067 (1.8) | -0.073 (1.2) | 0.011 (2.8) [0.005] |
| *SC81 (class v)* | 0.034 (2.3) | 0.037 (2.6) | -0.001 (0.6) [-0.002] |
| R2 |  |  | 0.28 |
| Eqn. standard error |  |  | 0.292 |

*Note*: *t*-values in round brackets (columns 2 and 4) and z-values (column 3).

***Table 4.* Estimation of Equation (12) – North and South of the River**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable** | **All MSOAs** | **North of the River** | **South of the River** |
| **ln(*PH*)** |  |  |  |
| *Constant* | 13.484 (81.5) | 13.428 (66.2) | 13.419 (42.3) |
| *CITY* | 1.87E-05 (2.0) | 1.26E-05 (1.1) | 4.48E-05 (2.9) |
| ln*(TUBE08)* | -0.145 (5.9) | -0.113 (4.1) | -0.177 (3.7) |
| *SLUM30s* | -0.034 (3.5) | -0.034 (3.0) | -0.023 (1.2) |
| *SC81 (class i)* | 0.011 (2.8) | 0.013 (2.9) | -0.0005 (0.1) |
| *SC81 (class v)* | -0.001 (0.6) | -0.004 (1.8) | 0.0034 (1.8) |
| R2 | 0.28 | 0.29 | 0.32 |
| Eqn. standard error | 0.292 | 0.297 | 0.248 |
| No. of observations | 201 | 147 | 54 |

*Note*: *t*-values in round brackets

***Table 5.* Estimation of Equation (12), 1881 – Rateable Values**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Col.2** | **Col.3** | **Col.4** | **Col.5** | **Col.6** |
| *Constant* | 6.03 (4.92) | 6.63 (6.59) | 6.13 (11.2) | 6.02 (10.2) | 9.39 (7.60) |
| *CITY* | -0.00013(-2.07) |  |  |  |  |
| ln(*CITY*) |  | -0.252 (-3.73) | -0.272 (-4.74) | -0.252 -3.73) | -0.223 (-4.2) |
| ln (*TUBE81*) | -0.196 (-1.29) | -0.081 (-0.60) |  | -0.081 (-0.60)\* |  |
| *SLUM* *pre 1881* | -0.032 (-0.19) | 0.058 (0.41) | 0.092 (0.72) | 0.058 (0.41) | 0.021 (0.181) |
| *SC81 (class i)* | 0.115 (1.19) | 0.138 (1.79) | 0.170 (3.12) | 0.160 (2.78) | 0.136 (2.78) |
| *SC81 (class v)* | -0.016 (-0.98) | -0.019 (-1.33) | -0.018 (-1.28) | -0.019 (-1.33) | -0.022 (-1.77) |
| ln( *HOUSING)* |  |  |  |  | -0.368 (-2.86) |
| R2 | 0.439 | 0.590 | 0.583 | 0.589 | 0.696 |
| Eqn. standard error | 0.549 | 0.469 | 0.463 | 0.469 | 0.404 |
| Breusch-Pagan | 2.23 (0.14) | 0.07 (0.79) | 0.01 (0.93) | 0.07 (0.78) | 0.00 (0.99) |
| Ramsey | 2.20 (0.12) | 1.55 (0.23) | 1.45 (0.26) | 1.55 (0.23) | 1.32 (0.30) |

*Note*: *t*-values in round brackets except for Breusch-Pagan and Ramsey tests which report Chi2 and F-values, respectively, and associated *p*-values in round brackets. \* ln(*Tube81*) in column 5 is the residual value from a regression of *SC81 ( class i)* on ln(*TUBE81*).

1. See Meen and Nygaard (2011), who also suggest that, outside London, prices in local areas that were overvalued in 2003 grew slightly more slowly between 2003 and 2006. [↑](#footnote-ref-1)
2. The spatial subscript is suppressed for convenience. [↑](#footnote-ref-2)
3. These restrictions were imposed in order to aid a further part of the project, which traces the history of these heads between 1851 and 1901. [↑](#footnote-ref-3)
4. For three decades following 1900 attention switched from slum clearance/inner city development towards further suburban development. [↑](#footnote-ref-4)
5. The individual representation maps cannot be shown here, because of copyright. [↑](#footnote-ref-5)