What Determines the Responsiveness of Housing Supply?

The Role of Real Interest Rates and Cyclical Asymmetries

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Abstract:
This paper offers a theoretical discussion of the price elasticity of supply. While there have been a number of attempts to estimate the responsiveness of UK supply, relatively little has been written on what determines it. A key omission is the effect of long term real interest rates. Steep falls in both the annual rent to house price ratio and long real interest rates during a period of relatively static real rents in the UK suggest that the stream of future imputed rents became discounted at successively lower interest rates between 1996 and 2007. New supply responded sluggishly to price rises during this period, but then collapsed rapidly as the market turned in 2008. This paper argues that the decline in long real interest rates contributed to rising house prices and the inelastic supply response during the long upswing, and that cyclical asymmetries inherent in the supply response have been exacerbated by changes in the financial system and increased government regulation of the planning process.

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Introduction

The goal of this paper is to resurrect interest in the question of how supply elasticities are determined. Most recent research on housing supply has focussed on the *measurement* of price elasticities, rather than *explaining* what causes them. There has been relatively little innovation in the last quarter of a century in our understanding of how supply elasticities are actually formed or what might cause them to change over time or across space. While the Barker Review (2003) has done much to raise the political profile of housing supply *per se*, it has not stimulated notable theoretical developments. On the contrary; if anything the Barker Review has served to concentrate attention on a single cause – sluggish planning system – and a fairly simple perception of how this constrains supply.

The first contribution of the current paper is to establish a direct and central role for real interest rates in the determination of housing supply. We aim to demonstrate, without recourse to market failure arguments, that there are good theoretical grounds for believing that the price elasticity of supply will vary over time due to changes in real interest rates.

Our second contribution is to explore how state intervention and market imperfections provide an additional range of drivers of PES that might also serve to explain why we appear to observe asymmetric response of the construction industry to house price signals – sluggish adjustment to rising prices, but rapid contraction in response to price falls. Existing theories (such as the labour market explanation offered by Pryce 1999) are unlikely to provide an adequate explanation of the rapid contraction in newbuild during the recent downturn, for example, where housing starts fell starts fell by 19 per cent from the June quarter of 2007 to the same quarter in 2008[1], whereas house prices fell by just 4% [2].

The paper begins with a brief summary of the existing literature (more detailed reviews can be found in Bartlett (1989), DiPasquale (1999), Blackley (1999) and Bramley et al. (1999)). We then present the case, in section two, for connecting house prices, real interest rates and the price elasticity of supply. We develop a simple algebraic model to illustrate why house price movements generated by real interest rates movements cause weaker supply responses than house price

[1] House Building: June Quarter 2008, England, Communities and Local Government, London.
[2] Nationwide mix adjusted quarterly house price index for the UK

movements caused by other factors, such as changes in the expected rental value. This provides a basis for the hypothesis that house price movements caused by changes in real interest rates are associated with a lower price elasticity of supply in countries, regions and areas where land represents a relatively high proportion of the cost of building a house.

In section three we consider the impact of real interest rates on house prices: whether long-term real interest rates declined sufficiently to explain the extraordinary rise in house prices observed between 1996 and 2007. There are drivers of demand apart from real interest rate movements that could explain sharply rising house prices. For example, house prices may rise in response to genuine demand pressures associated with immigration or increased divorce rates, or unsustainable price bubbles associated with unrealistic expectations about future price appreciation unrelated to fundamental factors determining the present value of the future stream of imputed rents. These distinctions matter because inelastic supply could not be attributed to declining real interest rates if rising house prices are not caused by declining interest rates.

Section four weighs up the competing explanations for unresponsive supply, including the explanation encapsulated in our theoretical model of the effect of interest rates on supply incentives. The fifth section of the paper explores a variety of additional reasons why we might expect supply responsiveness to vary over time and across space and focuses specifically on the issue of cyclical asymmetry in PES. Credit regime switching, asymmetric effects of price uncertainty, and the adverse selection effect of heterogeneous land plots when planning consents are non-random, are presented as potentially important theoretical reasons for believing that supply responsiveness will not only be inelastic in the short run but will also vary over the cycle.

Our findings are potentially important, particularly in countries such as the UK where the comparatively low price elasticity of supply of new houses (Malpezzi and Maclennan 2001; Barker 2003; Bramley, Pryce and Satsangi 1999) has been the subject of much concern and debate (Barker, 2003), largely because of the extraordinary rise in house prices over the last decade (Farlow 2004a,b; Himmelberg Mayer and Sinai 2005). We also hope that our work will open up new avenues of empirical investigation, particularly into the variety of possible causes we offer in explanation of the apparent asymmetry in PES.

Our approach is essentially theoretical, but rather than resorting to heavy duty mathematical proofs, which can do more to obscure than enlighten, we articulate our ideas using a mixture of simple algebraic/diagrammatic tools, and conceptual engagement with UK supply behaviour over the past decade. Thus, while our ideas are presented in the context of the UK housing market of the nineties and noughties, they should be viewed as transcending this setting both geographically and temporally.

1. Existing Literature

The early US literature (Muth 1960) assumed a simple neoclassical efficient markets view of the housing market where supply responsiveness becomes infinitely elastic in the long run. Much of the early empirical research was concerned with verifying whether this was in fact the case. Muth (1960) and Follain (1979), for example, find that supply is indeed totally elastic, though subsequent critiques by Olsen (1987) and others highlighted a number of significant methodological problems in this work, particularly on the issue of including both input prices and quantity in reduced form models such as Muth (1960), Follain (1979) and DeLeeuw and Ekanem (1971). More recent reduced form models that take into account the Olsen critique have found price elasticities to be less than infinite in the long run, particularly in the UK (see Pryce 1999, Malpezzi and Maclennan, 2001, Meen 2005; for a multiple equation approach using US data see Hwang and Quigley, 2006).

The discovery of less than perfectly responsive supply has led a limited number of studies to provide empirical evidence to support a particular explanation of why supply elasticities might vary over time or space. Malpezzi and Mayo (1997) for example, demonstrate "the effects of … regulations on market prices" and show, "using comparisons to the U.S., Thailand, and Korea, that countries with more stringent regulatory environments have a less elastic supply of housing." (p.372). Similarly, Glaeser and Gyourko (2003) compare house prices across US cites and find that "Measures of zoning strictness are highly correlated with high prices." (p.35). Estimates by Bramley (1993) and Pryce (1999) suggest that developers are averse to building on brownfield land, implying that the imposition of UK quotas to encourage builders to develop brownfield sites[3] reduced the overall responsiveness of new construction.[4] Goodman (2005) uses census data to

[3] such as the present target that 60% should be built on brownfield sites (Barker 2008, p.45).

[4] Pryce (1999) estimates that, for every 1 per cent increase in the proportion of recycled land in an area, new construction overall is found to fall by 0.3 per cent during boom periods, and by 0.9 per cent during slumps, equivalent to a decline in construction of around 0.6 per cent across both periods.

verify that central city supply of housing is less responsive than in the suburbs where there is greater availability of undeveloped land.

Others have speculated on causes of supply unresponsiveness but have not provided direct empirical verification. For example, Mayo and Sheppard (2001) show how the unpredictability of development controls can lead to land-banking and perverse supply responses to price changes. Pryce (2003) suggests that low elasticities can arise from the combination of development risk and the unintended capital market distortions caused by state intervention and the uncertainties of contamination risk. Barker (2003) establishes a link between low housing supply elasticities and shortages of skilled labour that may explain the apparently lower price elasticity of supply during a boom observed by Pryce (1999).

Among the various explanations that have been put forward, no study to date has proposed a fundamental role for long term real interest rate movements in determining the price elasticity of supply (PES) of housing, and only cursory attention has been paid to the issue of cyclical asymmetries in PES. Interest rates are sometimes included as part of a larger system of equations (Hwang and Quigley, 2006) but the causation is usually assumed to arise from the impact on house-builders' borrowing costs. In contrast, we argue here that interest rates may be an important driver of the price elasticity of supply itself, and may explain why, for example, "price elasticities have fallen to zero in all regions since the 1990s" (Meen, 2005, p.963), not just in regions where planning controls are strongest. In the model developed below we deviate from existing studies by (1) offering a parsimonious explanation of house price rises that recognizes that serially correlated house price movements are consistent with market efficiency when the term structure of interest rates is not flat and (2) with respect to the impact of interest rate movements on the price elasticity of supply. We also emphasize, in our consideration of the effect of market imperfections and state intervention, the potentially important role of credit regime switching, the asymmetric effect of price uncertainty, and the adverse selection effect of heterogeneous land plots when planning consents are non-random, and all of which have been neglected in the existing literature on the determination of PES and are worthy, we believe, of further investigation.

2. Connecting Prices, Real Interest Rates and the PES

Average house prices in England and Wales rose from £71,386 in 1996 to £229,162 in 2007[5], but only a small fraction this price rise can be attributed to general price inflation. Inflation alone would have raised the average house price from £71,386 in 1996 to £96,584 in 2007. That is, the average house owner in England and Wales received a tax free real capital gain well in excess of £100,000. It is clear that factors other than the rise in the general price level were responsible for the rise in house prices during this period.

A clue to the extraordinary rise in house prices over this eleven year period is provided by the fact that private market rents grew at a much slower pace, from £382 to £565[6] per month between 1996 and 2007. The 2007 private market rent was 1.48 times the 1996 rent, but after removing the effect of general price inflation, the 2007 real rent was only 1.09 times the 1996 rent. The ratio of annual rent to house price collapsed from 6.4% in 1996 to 3.0% in 2007. This collapse in the annual rent to house price ratio is important because it signals the likelihood of real interest rate effects.

Buying a house is equivalent to purchasing the right to live in a house without paying rent. That is, the equilibrium market value of a house is equal to the future stream of rents that house purchase enables the buyer to avoid. The dramatic fall in the annual rent to house price ratio during a period of relatively static real rent suggests that the stream of future rents became discounted at

[5] Table 503 Housing market: simple average house prices by new/other dwellings, type of buyer and region, United Kingdom, from 1986 at http://www.communities.gov.uk/documents/housing/xls/140951.xls
[6] Average private monthly rental data is provided by Communities and Local Government See Table 731 at http://www.communities.gov.uk/documents/housing/xls/141452.xls. For average annual house price data see Table 503 http://www.communities.gov.uk/documents/housing/xls/140951.xls

successively lower interest rates as this decade progressed. If rising house prices had been caused by factors other than falling interest rates, for example, an increased number of households due to immigration or rising divorce rates, rents should have increased in the roughly same proportion as house prices.

There is a prima facie case for attributing much of the phenomenal rise in real house prices to the large decline in long real interest rates over this ten-year period. This view reflects Weeken's (2004) equilibrium asset pricing model that relates house prices to rents via real interest rates. The innovation in our paper, however, is to suggest that the decline in long real interest rates over this period may have also contributed to the inelastic supply response. To illustrate this point, we develop the following theoretical model.

The quantity of new houses supplied by the developer Q_s is positively related to the price P, and negatively related to the cost of building a new house C. This is shown in Eq.1 as:

$$Q_s = f(P,C) \qquad \frac{\partial Q_s}{\partial P} > 0, \frac{\partial Q_s}{\partial C} < 0. \tag{1}$$

The price P is the equilibrium market valuation of a new house that is equal to the discounted sum of the future stream of rents that house purchase enables the buyer to avoid, shown as a perpetuity in Eq.2 as:

$$P = \frac{h}{r} \tag{2}$$

where h is the annual rental net of maintenance to prevent depreciation, and r is the real interest rate.

The cost of building a new house C consists of two components, the first being the cost of the land and the second being all other construction costs excluding land. Eq.3 expresses the value of the land L used to build the house as sum of the future stream of foregone alternative (l) land rental use as a car park or for agriculture or the real option value of holding the land, discounted at the real interest rate r,

$$C = \frac{l}{r} + W \qquad (3)$$

where W refers to all other construction costs including labour and materials. It is however important to note that Eq. 3 differs from some of the conventional models typically used for empirical analysis. For example, Eq. 3 treats land values as being independent of house prices whereas Mayo and Sheppard (2001) point out that land values expressed as a form of option are potentially endogenous through residual valuation. This endogeneity is ignored in the present analysis in order to avoid undue complexity at this stage, but we return to this issue in section 3.

Assuming a linear supply curve where the supply response to a change in C is the identical negative of the supply response to an equal change in P, and substituting Eq.2 and Eq.3 into Eq.1 gives:

$$\begin{aligned} Q_s &= a + b[P - C] \\ &= a + \frac{bh}{r} - \frac{bl}{r} - bW \end{aligned} \qquad (4)$$

Eq. [4] shows that falling real interest rates would raise both house prices and land prices. Eq. [4] also shows that falling interest rates would increase the profitability of land development because h must exceed l for any development to occur. Consequently developers have a speculative incentive to postpone land development during a period of falling interest rates. More generally, the real option of postponing land development derives its value from the possibility that the present value of profit from future development may exceed the profit from immediate development. . Mayo and

Sheppard (2001) show how stochastic delays in planning approval create incentives to postpone development.

In the present context, uncertainty about future profit caused by stochastic movements in real interest rates may likewise create an incentive to delay development. Systematic speculation about future house price inflation caused by past house price rises associated with successive reductions in real interest rates could strengthen the incentive to delay development even to the point of a backwards bending supply curve. However, neither of these two effects is explicitly modelled in the capitalised rents shown in Eq [4].

The elasticity of supply E_{QS} with respect to price is by definition:

$$E_{QS} = \frac{\partial Q_s}{\partial P} \cdot \frac{P}{Q_s} \qquad (5)$$

The magnitude of E_{QS} differs, depending on whether $\frac{\partial Q_s}{\partial P}$ in Eq. 5 is caused by a change in r or a change h. The two cases are considered below:

Case 1 Partially differentiating Q_S with respect to P in Eq.4, $\frac{\partial Q_s}{\partial P}$ for a change in h where r is constant gives

$$\frac{\partial Q_s}{\partial P} = \frac{\partial Q_s}{\partial h} \cdot \frac{\partial h}{\partial P} = \frac{b}{r} \cdot r = b \qquad (6)$$

Case 2 Partially differentiating Q_S with respect to P in Eq.4, $\frac{\partial Q_s}{\partial P}$ for a change in r where h is constant gives

$$\frac{\partial Q_s}{\partial P} = \frac{\partial Q_s}{\partial r} \cdot \frac{\partial r}{\partial P} = \frac{b\left[l-h\right]}{r^2} \cdot \frac{-h}{P^2} = \frac{bh[h-l]}{r^2 P^2} = b\left[1-\frac{l}{h}\right] \qquad (7)$$

The ratio of Case 2 to Case 1 is equal to $\frac{1-\frac{l}{h}}{1}$ *(8).*

That is, the magnitude of the term $\frac{\partial Q_s}{\partial P}$ in the price elasticity of supply equation Eq. 5 is smaller for a price rise caused by a change in the real interest rate, and the reduced magnitude of this price elasticity of supply compared with the price elasticity of supply associated with a house price rise caused by *h* depends on the ratio of $\frac{l}{h}$.

At one extreme, where land values are so low that there is a negligible foregone alternative in terms of real option value of holding the land, or land rental use as a car park or for agriculture, $\frac{l}{h}$=0, and the price elasticity of supply is not reduced at all. At the other extreme, where land values are so high that the foregone alternative in terms of real option value of holding the land, or land rental use as a car park is equal to the house rental, $\frac{l}{h}$=1, and the price elasticity of supply is zero. Therefore the price elasticity of house supply is lower where interest rate movements cause the change in house prices. The general relationship between the price elasticity of supply for houses and the real interest rate can be derived.

$$\frac{\partial E_{QS}}{\partial r} = \frac{\partial E_{QS}}{\partial P} \cdot \frac{\partial P}{\partial r} \qquad (9)$$

Substituting Eq. [7] into Eq.[5] gives

$$E_{QS} = b\left[1-\frac{l}{h}\right]\cdot\frac{P}{Q_S} \qquad (10)$$

$$\frac{\partial E_{QS}}{\partial P} = \frac{b}{Q_S}\left[1-\frac{l}{h}\right] \qquad (11)$$

Substituting Eq.[11] into Eq.[9] yields the general relationship between the price elasticity supply and the real interest rate:[7]

$$\frac{\partial E_{QS}}{\partial r} = \frac{b}{Q_S}\left[1-\frac{l}{h}\right]\cdot\frac{P^2}{-h} = \frac{-bP^2}{Q_S h}\cdot\left[1-\frac{l}{h}\right] \qquad (12)$$

The simple model used to derive the algebraic case for expecting the price elasticity of supply (PES) to be lower when rising house prices has been caused by a decline in the real rate of interest (rather than demographic or income factors, for example) does not address the issue of expectations of house price capital gains.

Poterba (1984, 1992) provides the standard asset market valuation model for owner-occupied house market. The one period user cost of housing U may be calculated as

$$U = P\cdot(i+\tau+\delta-\pi_G-\pi_H) \qquad (13)$$

where P is the house price index, i is the foregone market interest rate that the home owner could have earned in the money market, incremented by the property tax rate on owner-occupied houses τ and the rate of depreciation and maintenance δ, less the general rate of inflation rate π_G less the expected rate of real capital appreciation π_H. In equilibrium the expected user cost of owning a

[7] The limiting case of a perfectly price elastic supply curve for houses (b=□) appears to present a paradox. A perfectly elastic supply curve means that any shift in the demand for houses, however caused, would be accommodated without any change in price. Nevertheless, house prices should rise in response to a reduction in the real interest rate, because the price of a house is the discounted present value of the future net rental stream. This apparent inconsistency would be resolved by a reduction in the market rent so that any positive demand shift would leave house prices unchanged yet house prices would be the capitalised rent at the lower interest rate.

house should equal the cost of renting R, and defining the real interest rate I as the market interest rate as i - $\pi_{G,}$ the user cost may be expressed as:

$$R = P \cdot (I + \tau + \delta - \pi_H) \qquad (14)$$

and by re-arranging *(14)*

$$P = \frac{R}{I + \tau + \delta - \pi_H} \qquad (15)$$

Equation (15) expresses the asset value of a house given the market rent, the real interest rate, depreciation and maintenance costs and expected future real house price appreciation.

Asset-market equilibrium requires the price of a house to equal the discounted value of its net future service flow. Accordingly, a more general expression of (15) is given by

$$P_t = E\left[\sum_{j=1}^{\infty} \frac{R_{t+j}}{\Pi_{i=1}^{j}\left(1 + I_i + \tau_i + \delta_i\right)^i}\right] \qquad (16)$$

where $E[\bullet]$ denotes the expectation operator. There is an important advantage of reformulating (15) as (16). In (15) it is impossible to calculate P without some conjecture about expected future house price appreciation because π_H is an exogenous variable. However, in (16) *real* expected house price appreciation on the house price is endogenously determined by the term structure of spot interest rates. Consequently the equilibrium price P can be calculated because spot interest rates are observable in financial markets.

It is worth noting that user cost may imply expectations of real house price appreciation that differ from those derived from the term structure of real interest rates when imperfect capital markets create distortions in the life-cycle pattern of asset and consumption accumulation (see Ranney, 1981). Our analysis proceeds on the assumption that these life-cycle effects will be self-cancelling with respect to average prices over the whole population. Nevertheless these effects will clearly not be self cancelling during periods when the demographic structure of the population is not stable (see DiPasquale and Wheaton, 1994; Levin, Montagnoli and Wright, 2009).

This approach suggests that the observed rapid house price appreciation between 1996 and 2007 may be interpreted as the fully anticipated equilibrium outcome of a downward sloping term structure of real interest rates, an unexpected shift or change in the slope of the term structure of real interest rates, growth in the real rent, a speculative price bubble or some combination of these five possibilities. In the next section we therefore empirically examine the term structures of real interest rates and changes in real rents in an attempt to reject the hypothesis that UK house price rises were driven by declining shifts and slopes of the term structures of interest rates. A bubble explanation for rapidly rising house prices would be more plausible if shifts and changes in the slope of the term structure of interest rates could be rejected as a possible explanation for the price rises. We proceed to examine the role of falling real interest rates with respect to raising house prices and reducing the responsiveness of supply to those rising prices in sections 3 and 4 respectively below.

3. Were House Price Rises Driven by Falling Real Interest Rates?

Weeken (2004) and Ayuso and Restoy (2003) used equilibrium asset pricing models to show how rents and real interest rates determine house prices. Average mix-adjusted house prices in England and Wales rose 212% from £69,275 to £216,096 in the eleven years between June 1996 and June 2007[8]. After adjusting for general price inflation, real house prices rose 130% over this period.

[8] See Table 508 on http://www.communities.gov.uk/documents/housing/xls/141275.xls

However, only a small part of the 130% real increase in average house prices could be explained by the 9% real increase in private rents over the same period.

There are two reasons for attributing much of the rise in house prices to the decline in real interest rates over this period. First, if rising house prices had been caused by factors other than falling interest rates, for example, an increased number of households due to immigration or rising divorce rates, rents should have increased in the roughly the same proportion as house prices. Second, a comparison of the ex ante term structures of real interest rates in 1996 and 2007 reveals a collapse in real interest rates between 1996 and 2007 that was sufficiently large to explain the rise in house prices over these eleven years.

Real interest rates declined sharply between 1996 and 2007. In June 1996 the five-year real spot interest was 3.64% and the 20-year forward real interest rate was 4%. In June 2007 the five-year real spot interest was 2.65% and the 20-year forward real interest rate was 0.53%. This unanticipated decline in the term structure of real interest rates would raise the price of a hypothetical 7% inflation-indexed UK government perpetuity[9] from £176.76 to £535.63 between these two dates, raising the value of £69,275 worth of indexed bonds purchased in June 1996 to £209,761 in June 2007.

An average house purchased in June 1996 for £69,275 had a resale value of £216,096 in June 2007. However, £69,275 worth of 7% inflation-indexed UK government perpetuities purchased in June 1996 would have had a resale value of £209,761 in June 2007. A decline in real interest rates sufficient to raise the price of an index-linked perpetuity from £69,275 to £216,096 was enough to account for the rise in house prices from £69,275 to £209,761. This conclusion requires the assumption that the value of the annual rental stream from the house to be equivalent to the annual after-tax coupon payments from the 7% indexed bond.

[9] This security does not exist but it is possible to construct an equivalent synthetic bond from available Bank of England real spot and forward interest rate data. The 7% gross coupon rate is chosen to make the net income from the bond roughly equivalent to the foregone opportunity cost of imputed rent less depreciation from house purchase. The price of the synthetic 7% inflation index-linked UK government perpetuity was £176.76 in 1996:06. This price was calculated using Bank of England real spot interest rates for the first 20 years along the term to which was added a perpetuity with the first payment starting at year 21, calculated using the 20 year forward real interest rate, that was discounted back to 1996:06.

4. Did Real Interest Rates Reduce The Responsiveness Of Supply?

Why did the steep rise in house prices not motivate builders to build substantially more houses? Having established that falling real interest rates are likely to have been a major factor in driving up UK house prices since the mid-nineties, we now consider whether this was accompanied by inelastic supply, and whether this in turn was also exacerbated by changes in real interest rates. The real average mix-adjusted house price for all dwellings in England in 2007q2 was 228% of the 1996q2 price[10], yet private market completions for the corresponding quarters only rose from 28,574 to 38,874. That is, a 128% real rise in house prices elicited a 36% rise in completions, an implied a price elasticity of supply of +0.28. The necessary conditions are satisfied for an interest rate effect on the price elasticity of supply over this decade. There was a steep rise in house prices, a sharp fall in real interest rates, and a highly inelastic supply response from the construction industry. However, satisfying necessary conditions is insufficient to conclude that the supply non-responsiveness was caused by the interest rate effect discussed above because there are alternative possible explanations.

The theory of residual value raises the possibility that the cost of land might be determined by house prices which would cast doubt on the model presented above. The issue is whether the developer or the land owner receives the surplus, if any, inherent in the operation and ownership of real estate see Fisher and Lentz (1990); Fisher and Kinnard (1990). Land residual theory suggests that excess productivity should run with the land as an immobile factor of production, in which case the developer would always earn a normal profit, whereas the analysis presented above argues that it should be regarded as profit to the developer. We test for the legitimacy of our approach by

[10] Mix-adjusted house price data Table 508 is available at
http://www.communities.gov.uk/documents/housing/xls/141275.xls
The retail price index is available at http://www.statistics.gov.uk/downloads/theme_economy/Rp02.pdf
The completions data Table 213 is available at http://www.communities.gov.uk/documents/housing/xls/140894.xls

checking for profit markup variation over the decade under examination. However, it is important to use the appropriate definition of profit.

The rise in house prices raised builders' profit mark-ups and higher profit margins should have increased the economic incentive for builders to build more houses. Wellings (2006) documents that the top eleven quoted building companies enjoyed steadily rising average trading margins on house sales turnover that virtually doubled from 9.8% in 1995 to 19.3% in 2004. There is, however, an important distinction between accounting profit and economic profit.

Part of the accounting profit margin can be attributed to the rise in the value of building land over historic cost. This is relevant because a revaluation of building land would have permitted the accounting profit attributable to the rise in building land to be enjoyed without actually building any houses. It is the incremental profit margin from building compared with not building that determines builders' profit motivation to build more houses. Accounting profit margins do not show this economic profit margin. The value of residential land with planning permission rose much faster than house prices. Table 1 shows that 2007 new house prices rose to 262% of the 1996 level but 2007 building land prices rose to 483% of the 1996 level. The cost of land with residential planning permission rose much faster than house prices over this eleven-year period.

This may explain why builders did not respond to increasing accounting profit mark-ups on building. Builders did produce a sharp supply response to the rise in the economic profit margin. Table 1 shows that after taking account of changes over time in the cost of building land, building densities and construction costs, the incremental profit margin for building a house only started to rise dramatically in 2003, and completions rose sharply thereafter. This implies that builders do respond to an economic profit incentive to increase supply and that the correct diagnosis of the house market supply failure does not lie with builders' non-response to economic profit motivation but rather with the steep rise in land prices with planning permission for residential development.

A frequently stated hypothesis, exemplified by Barker (2006), is that the planning system placed excessive restrictions on the supply of land made available for development, thereby causing a steep rise in building land prices. However, there are at least three separate explanations for the excessive rise in the price of building land, each of which calls for a different policy response. It is important to correctly attribute the rise in land prices between the different explanations in order to identify the optimal policy response.

The first explanation for the rise in building land costs is the decline in interest rates. The steep unexpected fall in long real interest rates between 1996 and 2007 raised the prices of all high-duration assets including building land. We use the price increase of the 7% index-linked default risk-free government perpetuity discussed above over this ten-year period as a benchmark in order to show how the rise in building land prices could be attributed to falling real interest rates.

Table 1 shows that the 2007 price per hectare of building land with planning permission was 483% of the 1996 price, 357% at constant prices. However, the calculated real price of a synthetic index-linked 7% perpetuity rose in response to the same interest rate decline from £176.76 in 1996 to £535.63 in 2007. That is, the real price of building land in 2007 was 357**%** of the 1996 price while index linked bonds were 303% of the 1996 price. The steep rise in indexed bond prices was caused by the unexpected fall in real interest rates over this period. On this basis (100*203/257) 79% of the rise in building land prices during this decade can be explained by the unprecedented steep unanticipated fall in real interest rates over the same time period, leaving a 11% residual real rise in the price of building land explicable by shortage factors not associated with lower interest rates. This is consistent with the 9% rise in real private sector rents over this eleven year period because real rents are independent of interest rates effects on asset values.

The appropriate policy response to very low interest rates making house prices unaffordable depends on whether exceptionally low real interest rates will be a temporary or permanent feature of the macroeconomic environment. If low interest rates are temporary then house prices may be expected to stabilise and/or fall as interest rates rise. In this case the political agenda would shift from the non-affordability predicament faced by would-be house-buyers towards the negative equity predicament of house-owners with large mortgages. However, if low interest rates are to be a permanent feature, the capitalised value of affordable rents will continue to be unaffordable for would-be house-buyers. Very large subsidies would be required to lower house prices (the capitalised value of future rental stream) in order to make them more affordable in a low-interest rate environment. The effect would be equivalent to the government attempting to lower long bond prices - it is not possible.

There is a second mechanism by which low interest rates may have increased the price of land. The real option value to builders of holding land with planning permission instead of building on it increases when the cost of carry is reduced by very low interest rates. Consequently, there is a theoretical possibility that builders rather than the planning system may be responsible for the constriction on the supply of land available for building that drove up land prices to levels beyond those warranted by the effect of falling interest rates on the capitalised value of land. However, there a number of reasons for doubting the economic significance of this interest rate effect.

First, the real option incentive for builders to hoard land when interest rates are low implies that builders buy more land when land prices are high. This is not plausible. The real option effect is likely outweighed by builders' economic incentive to increase the size of their land banks when land prices are low. Second, the real option value of holding large land banks has been reduced because planning permissions expire after three years since the 2004 Planning and Compulsory Purchase Act. The Royal Town Planning Institute has attempted to provide some evidence on the amount of land available with planning permission held by builders by looking through the annual reports of the major house builders. The figures from this exercise show that outstanding permissions are held by the top ten house builders for nearly 225,000 homes, which using their own existing rates of building, gives 2.7 years supply (see http://www.rtpi.org.uk/download/1708/Opening-up-the-debate-June-2007.pdf).

It would appear that the three-year planning permission expiry legislated in the 2004 Planning and Compulsory Purchase Act effectively placed a three-year ceiling on land banks. Even if land holdings had increased by 10% over a decade, this would have resulted in a supply constriction of 1% per year, leaving 99% of planning applications granted that would not have been hoarded. Therefore the hoarding explanation is highly unlikely to have played a significant role in reducing land supply.

The third explanation for the excessive rise in the price of building land is that the planning system caused an excessive rise in building land prices by constricting the supply of building land. However, the preliminary analysis above suggests that the interest rate effect is likely to be the major cause of rising house prices. The rental yield fell by over three percentage points between 1996 and 2007, and this can be explained in terms of falling real interest rates over this period. Nevertheless, there may be a separate rise in house prices associated with increasing shortage that has nothing to do with interest rate movements. This would be revealed by both rising real rentals over this eleven year period and a rise in the price of building land in excess of the rise in real index-linked risk-free perpetuities.

The 9% rise in the real price of private rentals over this period does suggest rising positive excess demand for housing. We also noted earlier that the real price of building land in 2007 was 357% of the 1996 price, and the real price of a 7% index-linked perpetuity was 303% of the 1996 price. That is, the price of land rose faster than the hypothetical inflation-indexed linked perpetuity. We interpret these two findings as indicators that planning restrictions also contributed to the weak supply response to rising house prices.

The planning constriction explanation for the rise in building land prices reflects the demand for land with planning permission as a derived demand. A rise in house prices shifts the demand curve to the right for land with planning permission. This raises land prices to the point where builders make a normal profit on their building activities. Unless the number of hectares of land granted planning permission per year responds to the rise real house prices the increased cost of building land weakens the supply response and house prices remain high.

Rising land prices

The analysis thus far suggests that the low house price elasticity of supply can be attributed to both falling interest rates and planning restrictions. What is the relative strength of these two effects? One approach to answering to this question is to estimate the value of $\frac{l}{h}$ in Eq.(11). If the foregone alternative land rental l is a negligible proportion of the income stream from house rental h in Eq.(11), the interest rate effect on the price elasticity of supply, although theoretically valid, would be largely irrelevant in explaining the low house price elasticity of supply. From Eq.(3),

$$\begin{aligned} P_L &= \frac{l}{r} \\ \therefore \frac{\partial P_L}{\partial r} &= \frac{-l}{r^2} \\ \therefore E_{P_L.R} &= \frac{-l}{r^2} \cdot \frac{r}{P_L} = -1 \end{aligned} \tag{17}$$

The mean private rental over the nine English regions between 1996 and 2007 was £87.46 per week, that is £181,918 per hectare per year at 40 units per hectare[11] (see Table 1). The mean ex ante real 15 year spot rate for British Government index-linked gilts between 1996 and 2007 was 2.30%[12]. The mean price of land with planning permission over the nine regions between 1996 and 2007 was £2,181,293 per hectare. Substituting these values into Eq.(17) and setting $l = m \cdot h$ gives

$$\begin{aligned} &\frac{-m \cdot 181{,}918}{0.0230} \cdot \frac{1}{2{,}181{,}293} = 1 \\ &\therefore m = 0.28 \end{aligned}$$

Therefore $\frac{l}{h} = 0.28$. Substituting this value into Eq.(11) shows that where the price rise is caused by falling interest rates, the price elasticity of supply is 0.72 times the price elasticity of supply

[11] Data obtained from communities.gov.uk see Tables 715 and 731
http://www.communities.gov.uk/housing/housingresearch/housingstatistics/housingstatisticsby/rentslettings/livetables/

[12] Data for inflation-indexed government fifteen year real spot interest rates at 30 June each year were obtained from the Bank of England website at http://213.225.136.206/statistics/yieldcurve/index.htm.

where the price rise is caused by excess demand with no change in the interest rate. It would appear that the interest rate effect makes a relatively small contribution to explaining the low price elasticity of supply. Consequently the interest rate effect on price elasticity of supply should be regarded as an additional rather than an alternative to the planning explanation for the low price elasticity of supply. Falling real interest rates have two effects. First, there is a rise in house prices as the lower discount rate increases the present value of expected future rents avoided by house ownership. Second, there is a rise in the cost of building land, and this increased cost of building a house depresses the price elasticity of supply for houses when the house price rise is caused by falling interest rates.

Our empirical analysis assumes that households are indifferent between living in rented and owner-occupied house, based on a no-arbitrage house-price model in which equilibrium house rents and prices are connected by real interest rates. However, Ortalo-Magne and Rady (1999) argue that younger households always prefer owner-occupation to rental, and that lack of liquidity and credit constraints prevent this group moving from rented to owner-occupied housing during the early stages of their life. Their model shows how financial liberalisation in the 1980's explains the increase in owner occupancy rate of young households during that boom. That period of financial liberalisation is now history, but the credit constraint mechanism could be re-activated by auto-correlated reductions in the interest rate.

Falling interest rates between 1996 and 2007 raised the valuation of owner-occupancy defined as the discounted present value of future rents avoided. Higher house prices require a larger down payment deposit for any given maximum ratio of loan to property value. The larger down payment represent a constraint for younger households wishing to switch from renting to home ownership, and this in turn would constrain the number of first time buyers entering the market. These important features of actual house markets would not however alter the generality of our findings.

5. Market Imperfections and the Effect of Regulation on PES

If the price elasticity of supply was eroded by falling long term real interest rates between 1996 and 2007, why did the construction sector contract so rapidly in the first half of 2008 in response to relatively modest falls in house prices (given that real interest rates did not suddenly rise)? We offer five complementary drivers of the price elasticity of supply which also have the potential to cause PES to vary over the cycle:

(i) *The One-Way Effect of Planning Constraints*

(ii) *Credit Regime Switching*

(iii) *Housing Market Disequilibrium and Price Index Failure*

(iv) *Asymmetric Impact of Price Uncertainty*

(v) *Adverse Selection Effects of Non-Random Consents and the Heterogeneity of Land*

(i) The One-Way Effect of Planning Constraints

Planning regulations that restrict a positive supply response during a period of rising demand are unlikely to restrict the negative supply response during a period of falling demand. At its simplest level, then, a constraint on the amount of land available for development will be most binding during an upswing. Unless there is a corresponding constraint to limit the fall in supply during a downswing, one would expect output to be more sensitive to price as the market slows.

(ii) Credit Regime Switching

The rise of Buy-to-Let mortgages associated with small-scale landlordism dominated new construction in 2005-2007. Undeclared discounts offered by developers on off-plan purchases essentially allowed investors to take out a 100% mortgages (RICS, 2008; Warner 2008). However, the collapse of RMBS markets following the US subprime crisis led to a credit famine for UK borrowers seeking highly leveraged mortgage products, precipitating a sharp fall in demand for new

BTL construction. Moreover, subsequent warnings from the Financial Services Authority and the Council of Mortgage Lenders (RICS, 2008; Warner 2008), in conjunction with widespread media coverage, have alerted mortgage lenders to BTL mortgage fraud, and made it unlikely that prospective BTL landlords will again be able to secure finance on the basis of undeclared discounts and highly leveraged loans, which in effect removes the financial model on which much recent inner city development has been based.

This particular story of credit expansion and collapse is indicative of a more general pattern for credit cycles to correspond to (and even drive) cycles in the real economy. Asymmetrical price elasticity of supply observed during the downturn during 2008 may be the consequence of the contraction of loanable funds raising householders' and builders' discount rates far above the market interest rates observed on bonds.

An alternative view of the world is that lenders may not, in fact, raise interest rates during periods of credit contraction. The possibility of equilibrium credit rationing was most famously expounded by Stiglitz and Weiss (1981) on the basis that raising interest rates could cause adverse selection – higher lending rates would screen out low risk projects which have insufficient returns to make the project worthwhile under the higher interest rate. Therefore, lenders avoid raising the interest rate to clear the market and ration the supply of credit instead. Excess demand for credit becomes an "equilibrium" position because the adverse selection effect counterbalances forces that would otherwise lead interest rates to adjust upwards to clear the market.

We might therefore conceive of the credit cycle as being comprised of phases of regime switching: there is a regime of unconstrained lending during boom times (the price of credit falls due to outward expansion of credit, and in any case, lenders are sufficiently confident of their position to care little about adverse selection), but a regime of equilibrium credit rationing during downturns when, even if developers are willing to pay a higher rate of interest to secure the necessary funds for development, no such funds will be forthcoming. This line of reasoning leads us to conclude that credit market imperfections are potentially very important determinants of the responsiveness of new supply, yet they have tended to be overlooked in the empirical literature (Chan 1999 is the only study we are aware of to test for the effect of credit availability).

(iii) Housing Market Disequilibrium and Price Index Failure

Empirical models of housing supply usually assume housing market equilibrium. In this state of the world, house prices have a fairly straightforward interpretation, and so does their relationship with housing supply. Things are made considerably more complex, however, if the average selling price does not actually reflect the price that would clear the market. There is very strong evidence to suggest that during a downturn, for example, homeowners are reluctant to sell if the selling price falls below the price they paid for the property (Genesove and Mayer 2001) or if the equity generated is insufficient to cover removal costs (Genesove and Mayer 1997). This loss aversion leads sellers to keep houses stay on the market for longer rather than except a reduced price. Unfortunately, published house price indices do not typically control for selling times.

Thus, a fourth explanation for steep falls in new construction in response to modest falls in house prices (for example, comparing the June quarter of 2008 with the same quarter of the previous year, starts fell by 19 per cent and completions fell by 13 per cent[13], whereas house prices fell by just 4% [14]) is that the observed price reductions likely understated the true equilibrium price reductions. Transactions-based price indices do not adequately reflect the true fall in house values during a downswing – the fall in transactions is often much greater than the fall in average transacted price, and this is due to loss aversion among existing homeowners.

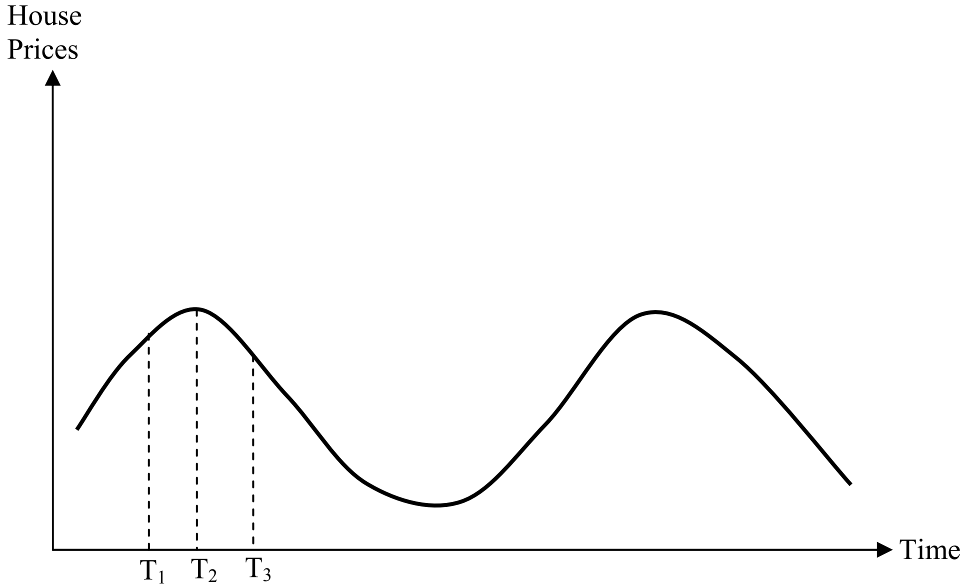
(iv) Asymmetric Impact of Price Uncertainty

Time is not costless. Delays and inefficiencies in the planning and construction process imply a sluggish supply response. They also mean that many development opportunities cease to be profitable and hence do not progress at all. This is illustrated in the figure below. If the decision

[13] House Building: June Quarter 2008, England, Communities and Local Government, London.
[14] Nationwide mix adjusted quarterly house price index for the UK

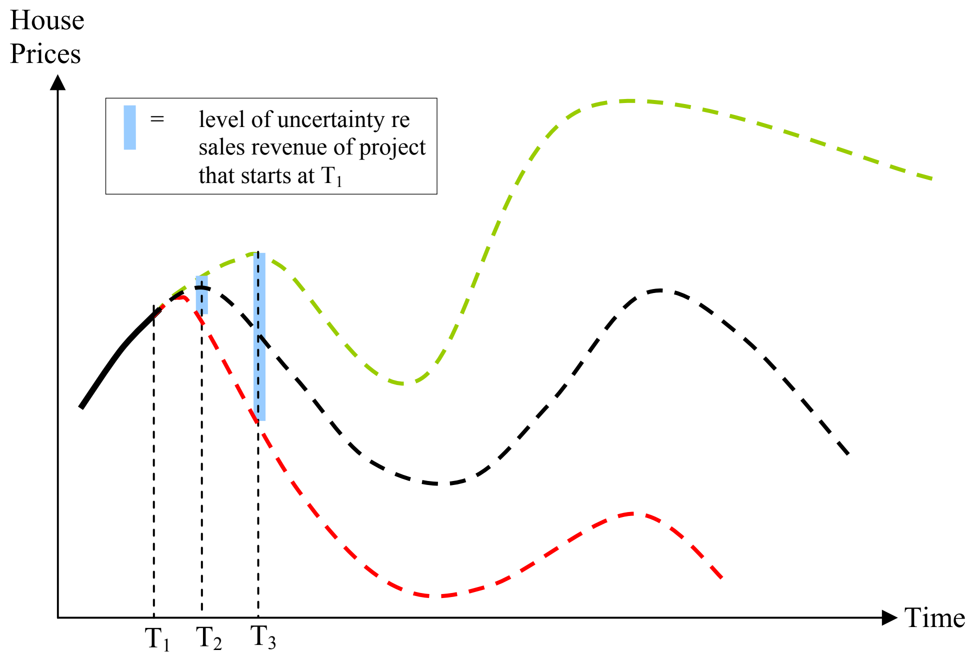
whether or not to develop takes place during an upswing at point T_1, the project will go ahead if it can be completed and sold by T_2. If, however, government regulations delay completion until T_3, the project will not be profitable because, by the time the product is ready to come to market, the boom has past and prices are in decline.

Figure 1 The Timing of Development & the Housing Cycle



We hypothesize further that the impact of construction lags rapidly escalates with the length of the lag because of the compound nature of temporal uncertainty. The future is uncertain, and the further into the future we look, the greater the uncertainty. Additional delays in the development process will ratchet up uncertainty very quickly. In Figure 1 above, at T_1 developers do not know for certain whether the current upswing will continue until T_2, let alone T_3. The situation facing developers is depicted in Figure 2 below where the central forecast estimate is represented by the black dotted line. Even if this central estimate proves to be correct, developers will not know this until after the event. Uncertainty means that there is a spectrum of forecast error – represented by the red and green dotted lines depicting the lower and upper 95% confidence bounds. The risk associated with commencing the development process at T_1 is much greater if the development lag is T_1 to T_3 rather than T_1 to T_2. Every layer of government regulation that introduces delays to the development process rapidly increases the risk of development. Note that firms will face a spectrum of possible future trajectories of this kind whether their expectations are backward-looking, forward-looking, rational or of bounded rationality. Only in a world of perfect foresight and perfect information would developers be able to make decisions about new construction without uncertainty about the future.

Figure 2 The Rapid Accumulation of Uncertainty Associated with Development Lags



Our supply function (1) then becomes expectations-dependent:

$$Q_{st} = f(E(P_{(t+x)}), C_t) \qquad (1')$$

The greater the time lag, x, the greater the uncertainty associated with $E(P_{t+x})$.

Two questions arise at this point: (1) why should this imply asymmetry, and (2) are there reasons to believe that x has increased over time? With regard to the first question, an increase in x is likely to make developers slower to respond to an upturn in prices – only when an upswing is well underway will the lower bound of the confidence interval be higher than their reservation expected profit threshold. The great bulk of construction therefore takes place during the mid to late stages of the upswing when there is greatest optimism about the state of the market.

Developers are very sensitive, however, to the prospect of a downturn because the construction lag multiplies the risk of large losses if prices do indeed fall. So PES, the sensitivity of supply to current prices, increases rapidly during the start of downswing (large falls in the number of new dwellings relative to small falls in price). PES then plummets to zero as the market begins to recover (no increase in new construction in response to current price increases). Finally, PES rises slowly during the upswing as it becomes increasingly certain that prices will continue to rise.

Uncertainty also acts as a barrier to entry: the greater the delays, risks, and pitfalls associated with housing development, the greater the advantage large, experienced developers have over small, new developers. This has three effects: (a) it increases the potential for large developers to extract greater surplus from the lobbying process; (b) it increases the potential for strategic behaviour, which in turn increases the chances that local developers will restrict supply in response to price rises (to further inflate prices), rather than raise output; (c) it directly restricts the entry of new firms during an upswing thus dampening the overall supply response. Outcomes (b) and (c) both imply reductions in the price elasticity of supply. (c) also implies asymmetry: small firms only enter the industry when the risks appear to be low (i.e. after a prolonged upswing) but rapidly leave the industry when expected profits fall because there are few barriers to exit.

There is good reason to believe that the uncertainties and delays in the construction process that are so detrimental to the responsiveness of new supply to current price changes may have increased over time. A number of significant government regulations and guidance notes have been introduced in recent years that have potentially added considerably to the complexity, uncertainty, and cost of development. These include the requirement to prioritize brownfield over greenfield development, to avoid developments below 30 dph (dwellings per hectare) and encourage developments above 50 dph[15]; and the introduction of S106 agreements, which allow local planning

[15] See the revised Planning Policy Guidance, PPG3, in 2000; see also Barker 2008 and Whitehead 2008.

authorities to seek contributions from developers towards infrastructure costs[16]. A number of further significant regulations are on the horizon:

- *Zero-carbon Homes* – the "Building a Greener Future: Policy Statement" (CLG Summary, July 2007) confirmed "the Government's intention for all new homes to be zero carbon by 2016 with a major progressive tightening of the energy efficiency building regulations - by 25 per cent in 2010 and by 44 per cent in 2013 - up to the zero carbon target in 2016".[17]

- *Community Infrastructure Levy* (CIL) will "would enable local authorities to apply a levy to all new developments (residential and commercial) in their area, subject to a low de minimis threshold. Where appropriate the local planning authority would use a CIL to supplement a negotiated agreement, which may be required for site specific matters, including affordable housing." (CLG, 2007, p. 9).

- *Lifetime Homes* – along with a range of other measures proposed in CLG (2005) consultation paper, will require that builders meet a set of internal adaptability standards in the construction of new houses to ensure that a home can be adapted for use of an elderly or disabled person;

- *Water regulations* – a set of proposals set out in the CLG (2005) consultation paper which seeks to reduce the resource burden of residential dwellings, for example, by establishing a minimum standard of water efficiency on newbuild that reduces anticipated water usage to no more than 125 litres per head per day (CLG, 2005, p. 19).

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[16] See Section 106 of the Planning Act 2004
[17] Quotation taken from the online summary of CLG (2007) to be found at: www.communities.gov.uk/publications/planningandbuilding/building-a-greener

- *Sustainable Urban Drainage Systems* (SUDS) – Defra (2007) considered a range of options to redress the low take-up of SUDS. Interventions are likely to take the form of financial incentives or mandatory rules.

These proposals are all well intended. Unfortunately, however, "planning policy itself is still too often justified with reference to benefits, but an inadequate recognition of potential costs" (Barker 2008, p.48). For example, such interventions are likely to add to the *complexity* of the building process and raise the level of expertise and experience required to be a successful developer. This makes it harder for small firms, and raises a hurdle that prevents new firms entering the industry. It also increases the propensity towards market concentration:

> "The length of time taken to reach an implementable permission, the increasingly burdensome requirements for information, and the complexity of negotiations over S106 agreements and other planning obligations all tend to favour larger companies for significant developments. The sluggish growth of new supply in the late 1990s and early 2000s also stimulated mergers and takeovers among the larger firms, as this was the only route to increase company output. As a result, the UK house-building industry is relatively concentrated, with the top ten firms producing more than a third of output in 2006." (Barker 2008, p.41)

Regulations can also lead to increased *uncertainty*, each new layer of bureaucracy increasing the number of pitfalls associated with the development process itself. The more barriers that housing policy introduces (Section 106, CIL, ZCH, Lifetime Homes, Water Regulations, SUDS etc.), the more opportunities there are for failure, and the greater the chances that attempts to increase the supply of new houses in response to price rises will be forestalled. Larger, more experienced, developers are likely to be more able to foresee such pitfalls and manage the increased risks through diversification.

(v) Adverse Selection Effects of Non-Random Consents and the Heterogeneity of Land

Land supply is a curious omission from most empirical estimates of PES, usually due to data issues (see Poterba, 1984, for example, who acknowledges the importance of land but neglects to include it the econometric specification for this very reason). And fewer studies still consider the quality or variety of land when analyzing the responsiveness of new supply – if any distinction is made at all, it is usually limited to a dichotomous categorization of land as either brownfield or greenfield (as in Pryce, 1999). Yet the heterogeneity of land could be an important driver of price elasticities, particularly when the granting of planning consents is not a random allocation across land types. This, we argue, can cause falling uplift to have an adverse selection effect on the quality and location of land available for residential development at a given point in time.

Suppose, other things being equal, that increased regulation suppresses the value of uplift – the difference in the value of land with and without planning permission. Uplift is a crucial variable because, while the UK land planning system is restrictive, it is not based on fixed quota allocations. In general, any land owner can put forward any plot of land in her possession for consideration for change of use. Some land plots will have a much lower probability of gaining planning permission than others, but the option to submit an application is there nonetheless. Given that there is a significant cost entailed in applying for planning permission, it is only worthwhile applying if the expected returns outweigh the cost. If the land owner is risk neutral, the application will only go ahead if:

$$G_i U \geq c \qquad \text{where } U = Hr - Ar = \text{uplift} \qquad (17)$$

where c is the cost of submitting a planning application, G is the perceived probability of planning permission on plot i, Hr is the value of the land with planning permission, and Ar is the value of the land without planning permission. An increase in Hr, the price of housing land, will entice more landowners into the lottery of planning application. If the price of housing land is high enough, even land owners with very little chance of gaining planning permission will apply. This suggests that long-term shifts in the demand curve for housing land will eventually cause shifts in the supply curve for housing land, LS. Suppose we denote the level of uplift just enough to entice the owner of plot i as U_i^* = the value of U such that:

$$G_i U = c \tag{18}$$

The uplift threshold is therefore determined by,

$$U_i^* = c/G_i \tag{19}$$

One of the unknowns is the distribution of Ui^* across the existing stock of land. It is complicated further by the fact that there is not one single price of land, *Hr*, but an entire spectrum, varying by the distance to the central business district (determined by the trade-off of access and space), and the unique, complex bundle of amenities associated with every location.

The same is true for the price of land in alternative use – there will not only be separate markets for each alternative use (due to the market segmentation caused by the planning system) but a spectrum of prices across space determined by access to transport, soil quality, proximity to factor markets, consumers etc. Equation (19) will therefore no longer hold if we relax the assumption of a single land market price for housing and a single land market price for land in alternative use. U_i^* would vary across land plots even if both G and c were constant across all land plots.

Now to the adverse selection effect. When uplift levels are low, landowners with low approval probability, G, are likely to be screened out of the market (it is simply not worth their while applying if U is low). A reduction in uplift caused by new regulations is likely to increase the proportion of land parcels that have high approval probability (high G). To have a high G is not a purely random outcome: a plot of land is more likely to be approved for residential development if it is brownfield land, or if it is a small pocket of private vacant land located in already built-up areas. So a reduction in U may not only reduce the number of plots coming onto the market, but also reduce the average "quality" of land coming through the planning system, where quality is defined here as having attributes (particularly location and size and ease of development) attractive to developers. And if there is fall in the availability, quality and location of land for development, developers will have to spend more time and resources identifying an appropriate plot of land. The supply response to rising house prices will take longer if available plots are small, poor quality and scattered across the urban landscape than if there are large areas of greenfield land in prime locations readily available. Dispersed and fragmented plots reduce the potential for economies of scale, and are also more susceptible to the *Site Assembly Problem* (Eckart, 1985).

Our argument, then, is that increased building regulations (such as the requirement for newbuild to be zero carbon or to be of a particular density, or the power of local authorities to extract contributions from devlopers towards infrastructure costs) depress uplift margins, which in turn screens out applications for planning permission from owners of the best quality land, and this reduces the average quality and spatial coherence of the land that is actually available for development at a given moment. This in turn increases search time (it takes longer for developers to find a suitable plot in response to house price increases) and reduces construction efficiency (it takes more time to build a given number of houses if the plots are scattered across the city rather than concentrated in a single coherent location).

The adverse selection effect just described may also lead to cyclical asymmetries. For example, if falls in house prices also lead to falls in uplift, then the corollary of the above theory is that there will also be an adverse impact on the quality of land coming onto the market, which will exacerbate the reduction in new construction. It may also contribute to credit rationing: if lenders know that the quality of land available for residential construction declines during a downturn, they will be more reluctant to lend during this phase of the cycle as they know that this will contribute to the risk that development projects fail to make sufficient returns to repay the debt. And they will be reluctant to raise interest rates to clear the market because of the additional adverse selection effects this will cause (see (ii) above and Stiglitz and Weiss 1981). Moreover, the credit rationing effects of adverse selection arising from non-random consents may vary across space due to geographical variations in land types, a possibility that has not, to our knowledge, been explored in the literature (Chan 1999 is a time series study and so does not consider the possibility of credit rationing have a spatially varying effect on PES).

Conclusion

The lion's share of previous work on the price responsiveness of new construction of houses has been devoted to estimating the PES rather than thinking about what causes it. This paper has attempted to redress the bias towards empiricism in the housing supply literature by offering a theoretical discussion of the determinants of PES in the context of the UK housing market over the past decade. We have juxtaposed explanations arising from market imperfections/state intervention, along side those that show how price elasticity can vary even in a world of efficient markets.

We presented first a simple theoretical rationale to demonstrate that, in the absence of restrictive planning and market imperfections, changes in long real interest rates, will cause both house price rises and a low elasticity of supply. We offered some initial empirical evidence to support this hypothesis for the eleven year period between 1996 and 2007.

We then considered how a range of market imperfections can interact with planning constraints and building regulations to shape the responsiveness of supply to price changes. We argued that these may lead to *cyclical asymmetry* in PES – the apparent tendency for the quantity supplied to respond very slowly to outward shifts of demand, but rather rapidly to inward shifts. Taken together, these different drivers of PES may suggest that the paradox of cyclical asymmetricy may be explained by a combination of inward shifts of the supply curve, and changes in slope of the supply curve, when the demand curve shifts inwards. For example, the credit crunch could simultaneously cause inward shifts of both demand and supply – while also affecting the slope of the supply curve (the PES).

Hopefully our ideas will open up fresh avenues of theoretical and empirical investigation. For example, one implication of this paper is the need to develop a fully fledged analytical model of the housing market that permits the slope of the supply function to be endogenous – contingent on factors that are conventionally associated with driving secular (long interest rates) and cyclical (mortgage availability) changes in demand. Further research is also required in order to verify, and quantify, the different explanations for the observed price elasticity of supply over a longer time span than the single decade we examined.

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Table 1 Profit Per Dwelling and Completion Rates

ENGLAND	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Average new dwelling price	86945	96114	102121	117746	128976	138703	163236	194295	221682	225787	229798	227375
Average valuation residential building land with PP per hectare	816828	921288	1098965	1223258	1514834	1873027	2208962	2609001	3114430	3311667	3538359	3944900
Dwellings per hectare	25	25	25	25	25	25	27	34	39	40	41	45
Land cost per home	32673	36852	43959	48930	60593	74921	81813	76735	79857	82792	86301	87664
*Resource cost index of house-building (1995=100)	102	106	108	111	117	121	125	132	138	147	156	164
Average non-land cost per dwelling	46,666	48,496	49,411	50,784	53,529	55,359	57,189	60,391	63,136	67,254	71,372	75032
Profit per dwelling = Hp - Lp - W	7,606	10,766	8,751	18,032	14,854	8,423	24,077	57,169	78,689	75,741	72,125	64,679
Profit per dwelling (markup on unit cost)	10%	13%	9%	18%	13%	6%	17%	42%	55%	50%	46%	40%
private enterprise completions	123,616	121,165	127,835	121,194	124,466	116,644	115,701	124,457	130,096	139,132	144,937	145,383

Data Sources: Average new dwelling price Table 504 http://www.communities.gov.uk/documents/housing/xls/140954.xls; Average valuation residential building land with PP per hectare Table 563 http://www.communities.gov.uk/documents/housing/xls/141389.xls; Dwellings per hectare Land Use Change in England update January 2008 Figure 2 http://www.communities.gov.uk/documents/planningandbuilding/pdf/679228.pdf ; See also Table P231 Land Use Change: Density of new dwellings built, by region, 1989 to 2007 http://www.communities.gov.uk/documents/planningandbuilding/xls/822906.xls; Resource cost index of house-building (1995=100) (2007) Quarterly Building Price & Cost Indices (HOCOS) , Department for Business Enterprise & Regulatory Reform, http://www.parliament.uk/deposits/depositedpapers/2008/DEP2008-0131.pdf; Housing starts and completions Table 209 http://www.communities.gov.uk/documents/housing/xls/323495.xls .