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Rising House Prices in an Open Labour Market

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Abstract

In this paper we explore the consequences of the recent steep rise in house prices for the openness of the Irish labour market. Specifically we look at the possible effect rising house prices may have on the migration decision. Since many immigrants are in the household formation age group, and tend to be highly skilled, we argue that the boom in house prices, by reducing the attractiveness of Ireland for potential immigrants, could reduce labour supply. Thus housing emerges as an important infrastructural constraint affecting the labour market.

To formulate the role of house prices in the migration decision we use a structural model of the determination of output, labour supply and labour demand in Ireland. We modify the basic model in a number of ways: firstly we endogenise the determination of house prices using structural equations for the demand and supply of housing; secondly we separate out the user cost of housing in the migrant's cost of living index; and thirdly we endogenise the determination of consumer prices. Simulation results suggest that rising house prices, by discouraging potential migrants, could significantly reduce the growth potential of the economy, shifting the balance of labour market growth from employment to wages, with a consequent deterioration in competitiveness. The welfare effects of this differ for different groups; there are unambiguous gains for current home owners while immigrants, first time buyers and those with lower labour market skills are net losers.

Key words: Housing, labour market, migration

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1 Introduction

In real terms new house prices in Ireland doubled between 1996 and 2002. This dramatic increase resulted from a boom in the demand for housing together with a relatively inelastic supply of housing. Exceptionally high economic and employment growth, rapidly rising incomes, and an increase in the proportion of the population in the household formation age were all factors driving this rapid rise in the demand for housing. Strong inflows of migrants added to this demand, estimates suggest that in the period 1996-2002 migrants accounted for almost 10% of total housing demand (Bergin *et al.*, 2003).

The Irish labour market is exceptionally open by international standards and migration has traditionally served to ensure a very elastic supply of labour. However, the very rapid growth of the economy in the past ten years has led to pressures on the country's infrastructure, in particular in the housing market. In this paper we argue that this housing constraint affects the migration decision. The typical immigrant in recent years is in the household formation age group (Barrett *et al., 2005)*. We therefore assume that migrants will discount the cost of housing when making the economic decision to migrate.

To formally trace the economic consequences of this assumption, we use a recently developed model of the determination of output, labour supply and labour demand in Ireland (Bergin and Kearney (2004)). We develop this model in a number of ways. Firstly, we endogenise the determination of house prices by estimating structural equations for the demand for and supply of housing. The results suggest that rising average living standards lead to a more than proportionate increase in new house prices and that while the rate of housing completions over the long-run is strongly responsive to demand, the pace at which the building sector can gear up to meet very big changes in demand is limited. Secondly, we separate out rental costs in the cost of living index of the potential migrant and endogenise rents within the model. In the equation for rents, which assumes that rents will cover the user cost of housing, we find that there is almost 100% pass-through from house prices to rents in the long-run. Until the mid 1990s this change makes little difference to the elasticity of high-skilled labour supply. However since then the pace of house price inflation has far exceeded general consumer price inflation so that endogenising rents in the cost of living measure reduces the elasticity of high-

skilled labour supply through reducing net immigration. Thirdly, we endogenise the determination of consumer prices.

We simulate this model to illustrate the effects of a housing constraint on labour supply. Firstly we trace the channels through which a rise in house prices will affect the labour market. Secondly we compare the effects of a shock to world demand for Irish output under a "with housing constraint" and a "without housing constraint" assumption. The difference between these two simulations is a measure of the potential effect of house prices on Irish labour supply and its consequences for the wider economy. Our numerical results indicate that the housing constraint could knock almost one-quarter off the growth in GNP that might be expected to arise from world output growth. Furthermore it shifts the balance of labour market growth from employment to wages, with a consequent rise in the real exchange rate. While some gradual erosion in Irish competitiveness is inevitable now that the economy has reached full employment, the infrastructural deficit in housing accelerates this process beyond that which would be naturally dictated by a fully employed workforce.

The paper is structured as follows. In Section 2 we discuss the evidence underlying our assumption that house prices will affect the migration decision. In Section 3 we illustrate graphically how a housing constraint affects an open labour market. Section 4 describes the model we develop and discusses the estimation results for the housing market equations, the migration equation and the consumer price equation. Section 5 uses this model to illustrate the economic consequences of the housing constraint. Section 6 concludes.

2 House prices as a constraint on labour supply: the role of migration

The core question addressed in this paper is predicated on the assumption that, since most immigrants are in the household formation age group, and are predominantly high-skilled, they will include the cost of housing in their "should I stay or should I go" decision. In this section we discuss the evidence underlying this stylised characterisation of the migration decision.

The role of house prices as a determinant of regional migration patterns has been the subject of a number of UK studies. Gabriel et al (1992), in a study of the effects of regional house price differences on interregional population mobility, find that differences in house prices are

"important determinants of household moves and operate to offset some of the incentive to migrate to regions characterised by the most favourable labour market conditions." Bover, Muellbauer and Murphy (1989) examine the interaction between wages, the labour market and the housing market in the UK. As part of a broader range of conclusions regarding wage determination they argue that differences in regional house price to earnings ratios have an important role in determining net migration. Cameron and Muellbauer (1998) model the impact of the housing market on regional commuting and migration patterns in the UK. They find that high relative house prices discourage net migration to a region although they also note that "expected house price rises, by reducing the user cost of housing, can provide a temporary offset".

The strong demand for housing in Ireland in recent years has been driven by a rapid increase in the population of young adults and an increase in headship rates[2]. However changes in the population's age structure and household formation behaviour will influence every country's housing market. The factor that makes developments in the Irish housing market unusual is the large and relatively volatile migration flows into and out of the country. While the natural increase in the population has been positive over the period, migration has had a decisive influence on the pattern and age structure of population change. In the late 1980s there were high levels of emigration resulting in a net outflow of migrants from Ireland, peaking at 1.25% of the population in 1989. During the early 1990s this process was reversed, and since 1996 the net inflow of migrants into the country has contributed more to population growth than the natural increase. Estimates suggest that in the period 1996 to 2002 immigration added almost 6,000 units per annum to demand, equivalent to approximately 10% of total housing demand (Bergin et al., 2003).

Data on migration flows by age provide some explanation as to why migration flows contribute to housing sector demand. The bulk of out-migration is from the 15-24 year age group, 53.5 per cent in 2004. This age group is younger than the main household formation age groups, so emigrants are either leaving the parental home or rented accommodation, very often shared. The bulk of in-migration, 49.5 per cent, is in the 25-44 year age group, the key age group for independent household formation. Thus, rising house prices speak directly to a large segment of the immigrant population, while immigration, by adding to the demand for

[2] The proportion of a cohort who are heads of household.

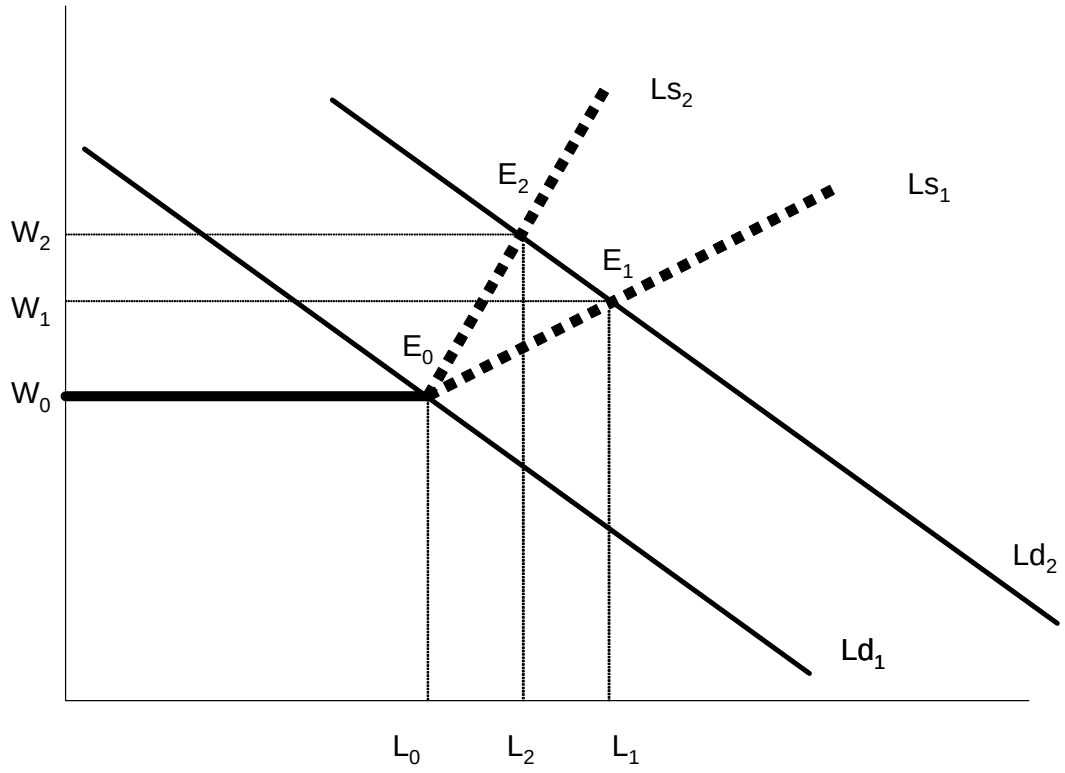
housing, will in turn lead to further increases in house prices. Furthermore Barrett and Trace (1998) find that in the mid-1990s the bulk of in-migration was skilled workers entering the labour market; this pattern has been confirmed in more recent work (Barrett et al. (2005), Minns (2005)).

There has been a significant ratcheting up in housing supply to meet the explosion in demand. There has been a new record of house completions in each year since 1995, with completions in 2003 over double the number of completions in 1995. The stock of dwellings in 2002 was 1.46 million. The number built in 2004 reached an exceptional level of almost 80,000 – around 5% of the stock. This compares to the average number built between 1999 and 2001 of around 50,000 each year, and around 30,000 a year in the mid-1990s. However an important component of this building is the rapid increase in the stock of vacant or second dwellings (Fitz Gerald (2005)) which does not alleviate underlying pressures driven by population change. In general, housing supply responds with a significant lag to changes in price, as we will see in Section 4.1. The housing stock, which is very large relative to the net additions each year, adjusts quite slowly to changes in its optimal level.

3 Measuring the "pure" housing constraint effect

The recent "Celtic Tiger" boom in Ireland has increased the slope of the labour supply curve, reduced the elasticity of labour supply and thereby changed the functioning of the labour market. In this paper we attribute this change in slope to two factors. The first factor giving rise to a less elastic supply of labour is the recent move to full employment. This has meant that the ready availability of unemployed labour has dried up, resulting in a strengthening of the trade-off between wages and unemployment in the labour market, the traditional Phillips Curve effect. The second factor is the change in the ready availability of labour through migration flows as a result of the very rapid increase in house prices, reflecting the limited endowment of housing infrastructure. In this paper we isolate the effect of the housing market, *ceteris paribus*, on the elasticity of labour supply, as illustrated in Figure 1.

Figure 1: Diagram illustrating "pure" effect of housing constraint (E_2-E_1)



Historically a feature of the Irish labour market has been its extreme openness, with migration ensuring an elastic labour supply and a weak Phillips Curve effect (Honohan, 1992 and Curtis and Fitz Gerald, 1994). The limiting case of this, an infinitely elastic labour supply curve, is shown as the flat segment of the labour supply curve, Ls, in Figure 1. One of the results of the boom in the late 1990s was that the Irish economy effectively reached full employment and a significant trade-off between wages and unemployment emerged. In the diagram this is shown as an upward sloping labour supply curve, Ls_1 beyond the full employment level L_0. Full employment also saw the emergence of infrastructural constraints as growth in output outpaced capacity. House prices rose sharply, so the decision to migrate to Ireland was now influenced, not only by relative employment opportunities and relative wages, but also by the rapid rise in house prices. This resulted in labour supply becoming even more inelastic, represented in Figure 1 by the more steeply upward sloping labour supply curve Ls_2.

Now if we assume a positive external shock to the demand for Irish output, this would increase the demand for labour, a derived demand, so that the labour demand curve would shift outwards from Ld_1 to Ld_2. If there were no housing constraint labour market equilibrium would move from E_0 to E_1, with higher wages ($W_1>W_0$) and higher employment ($L_1>L_0$).

With a housing constraint, however, the equilibrium point is E_2 with wages higher ($W_2>W_1$) and employment lower ($L_2<L_1$) than at point E_1. In this paper we attempt to isolate the "pure" effect of house prices on the labour market by measuring the gap between E_2 and E_1 and its consequences for the long-run growth potential of the economy.

4 Including house prices in the migration decision

To estimate this "pure" housing constraint effect on labour supply we use a small structural model of the determination of output, labour demand and labour supply in Ireland, described in detail in Barrett, Fitz Gerald and Nolan (2002) and Bergin and Kearney (2004) and summarised in Box 1. In this model the demand for Irish output is sensitive to world demand and international wage competitiveness. Significant increasing returns to scale in production capture the dramatic increase in the size of the Irish economy in recent years, the so-called 'Celtic Tiger' effect. The rapid increase in educational levels over the past thirty years, which has led to a steady increase in the stock of high-skilled labour, is measured using a newly developed index of human capital. This index is endogenised within the model to capture the effect of human capital accumulation on productivity levels, as proposed in the new growth theory literature. Finally the model includes a parameter capturing the rate of skilled-bias technical change in the demand for labour, reflecting the world-wide rise in demand for high-skilled labour (Nickell and Bell, 1995). Ireland captured its share of this rise through new foreign investment (Barry and Bradley, 1997) and a general move towards more skill-intensive production.

The model is completed by a set of structural equations for the labour supply decision, separately distinguishing between high-skilled and low-skilled labour supply. Estimates of the participation decision are calibrated from detailed microeconomic analysis of labour supply responses for different education levels (Doris, 2001). It is assumed that all migration is high-skilled (Barrett *et al.* 2005), where the migration decision is modelled as a function of the Irish take home wage relative to the UK. Migration flows ensure that the high-skilled labour market clears. There is no migration in the low-skilled labour market, during periods of low labour demand the low-skilled labour market does not clear as the welfare system sets a floor on wage rates and the unemployment rate rises. This mechanism is captured in the model by a switch between market clearing and no market clearing above a threshold replacement ratio.

The model estimates indicate that the demand for Irish output is relatively sensitive to Ireland's international competitive position. There is strong evidence in favour of increasing returns to scale in production and skill biased technical change in labour demand. The openness of the labour market through migration has led to a highly elastic supply of high-skilled labour.

We modify this model in a number of ways so that we can estimate the potential effect of a housing constraint on labour supply. Firstly we add equations for housing demand and housing supply, which together determine equilibrium house prices. Secondly we alter the original migration equation so that the rental prices enter separately into the domestic cost of living measure facing migrants. A separate equation is included which models rents as a function of house prices and the after-tax real interest rate facing landlords. This means that whenever house price inflation exceeds general consumer price inflation, net immigration will be lower in this modified "housing constraint" migration equation. Finally we endogenise consumer prices in the model. This represents a departure from the traditional assumption of Ireland as a pure price-taker on world markets and captures the feed-back effects of wage pressure in the labour market on the domestic price level.

All the parameters in the model are converted to their steady-state value so that simulations with the model give the equilibrium response to a shock. This means that in the simulation results both the labour market and housing market clear and the effect of transitory migration, migrants who stay for one or two years, is netted out.

Box 1: The structure of the Bergin and Kearney (2004) model

1. The demand for output:

The demand for output is a function of world output and relative unit labour costs[3]:

$$Q = f(Q_W, c_i)$$

2. The demand for labour:

The demand for labour is derived from a CES cost function allowing for increasing returns to scale:

$$\log \tilde{L} = \frac{1}{\mu}\log Q - \frac{1}{\mu}\log A + \frac{\sigma}{1-\sigma}\log(1-\delta) + \frac{\sigma}{1-\sigma}\log\left[\left(\frac{R}{W}\right)^{1-\sigma}\left(\frac{\delta}{1-\delta}\right)^{\sigma} + 1\right]$$

3. The relative demand for high-skilled labour:

The relative demand for high-skilled labour is modelled separately from total labour demand again assuming cost minimisation behaviour using the translog cost function:

$$S_{LH} = \alpha_H + \alpha_{HL}\frac{\log(W_L)}{\log(W_H)} + \alpha_{HT}T$$

4. Human capital:

Human capital accumulation (*HK*) is a simple weighted average of high-skilled (L_H) and low-skilled (L_L) labour:

$$HK = \omega_H L_H + \omega_L L_L$$

5. The supply of high-skilled labour:

The high-skilled participation decision is modelled as a function of the real high-skilled consumption wage and a time trend :

$$\left(\frac{NH}{POPH}\right) = f\left(\log\left(\frac{WH}{PC}\right), T\right)$$

The high skilled population is a function of the natural increase and net immigration, where migration is assumed to be driven by lagged changes in the relative wage between Ireland and the UK.[4]

$$POP_{H,t} = NI_{H,t} + 0.75M_t + POP_{H,t-1}$$

$$M_t = f(relw_{t-1})$$

The model assumes a fixed frictional unemployment rate so that these equations together determine the changes in the wage rate necessary to clear the market.

[3] The variable definitions are as follows: Q is Irish output, Q_W is world output, c_i is unit labour costs in country I, $\tilde{L} = L * HK$, HK is an index of human capital, L is labour, R is the cost of capital, W is the average wage, S_{LH} is the share of high-skilled wage bill in the total wage bill, W_H is the high-skilled wage rate, W_L is the low-skilled wage rate, PC is the consumer price index and T is a time trend, POP_H is the high-skilled population, NI_H is the natural increase in the high-skilled population, M is net immigration, and relw is the wage in Ireland relative to the UK.

4 It is assumed that all migration is high-skilled, with approximately 75% of migrants being in the 15-64 age group.

6. The supply of low-skilled labour:

The low-skilled participation decision is modelled as a function of the real low-skilled consumption wage and a time trend.

$$\left(\frac{N_L}{POP_L}\right) = f\left(\log\left(\frac{W_L}{P_C}\right), T\right)$$

In the model if the replacement ratio is above a specified threshold then the low-skilled wage rate is determined by the replacement ratio, otherwise by market clearing.

4.1 Housing demand and housing supply

The demand for housing uses an inverted demand function specification. This specification draws on the work of Murphy (1998) who modelled Irish house prices using an inverted demand equation where house prices are determined by real disposable income, the per capita housing stock, a proxy for the user cost of housing (mortgage interest rate less the change in house prices), and the percentage of the population aged 25-34. More recent empirical studies of the determinants of house prices have used similar formulations.[5]

In equation (1) real new house prices (defined as new house prices (*PHNEW)* deflated by the personal consumption deflator *(PC)*) are modelled as a function of the contemporaneous change in real income per head, the lagged level of real income per head, the housing stock (*HSTOCK)* per head of the total population (*POPT)* and the real mortgage rate.

Because this equation is embedded within a simple structural labour market model, real GNP per person in the working age population (*POPH+POPL*) is the measure of income per head used in the house price equation[6]. The denominator controls for the effect of changes in the age structure of the population on the demand for housing. In deriving the real cost of capital for housing (*rr*) house price inflation is proxied by the rate of inflation in the price of second-

[5] Kenny (1999) models housing demand based on the price of housing, incomes and the mortgage interest rate. Kenny uses real GNP as the income variable and argues that "since the change in real GNP can be decomposed into a component which reflects growth in per capita income and a component which reflects population growth, the effects of population growth are to some extent modelled via the income variable." Roche (2001) provides a similar analysis for the Dublin housing market. Average new house prices in Dublin are modelled using an inverted demand equation using expected real disposable income, expected real mortgage rates and a demographic variable as regressors.

[6] This is a much cruder measure than disposable income, nevertheless the estimation results using GNP are similar to those using real disposable income.

hand houses. The price of second-hand houses is used as an instrument because of problems of simultaneity using new house prices[7]. The final equation specification and estimation results are shown as equation (1), estimated 1979-2000:

$$\log\left(\frac{PHNEW}{PC}\right)_t = \underset{(2.0)}{2.9} + \underset{(1.7)}{0.59}\,\Delta\left[\log\left(\frac{GNP}{POPH+POPL}\right)\right]_t + \underset{(3.6)}{1.12}\log\left(\frac{GNP}{POPH+POPL}\right)_{t-1} - \underset{(2.4)}{1.68}\log\left(\frac{HSTOCK}{POPT}\right)_t - \underset{(4.0)}{0.43}(rr) \quad (1)$$

R2=0.99; Std. Error = 0.02; DW=2.01;RHO(1)=0.71;

The coefficient on the change in income measures the responsiveness of house prices to income volatility and suggests a rapid pass through of short run changes in income. Per capita real income is highly significant with an elasticity greater than one. This suggests that rising average living standards lead to a more than proportionate increase in new house prices. The housing stock variable can be considered as capturing a 'scarcity' effect – given a rapid growth in the population, as witnessed in the 1990s, and the inevitably slower growth in the stock of houses. Finally the real mortgage rate is significant and correctly signed.

The housing supply equation, which estimates the number of house completions (*HCOMP*), is modelled as a function of the volatility in new house prices and the level of new house prices. This latter variable is intended to proxy the impact of rising profit margins in the housing sector on the supply of houses. Equation (2) shows the equation results estimated for 1973-2000.

$$\log(HCOMP)_t = \underset{(2.1)}{-3.4} + \underset{(0.6)}{0.22}\,\Delta\left[\log\left(\frac{PHNEW}{PC}\right)\right]_t + \underset{(2.3)}{0.39}\log\left(\frac{PHNEW}{PC}\right)_t + \underset{(5.2)}{0.7}\log(HCOMP)_{t-1} \quad (2)$$

[7] An equation modelling second hand house prices is included in the model as follows:

$$\log\left(\frac{PHOLD}{PC}\right)_t = \underset{(9.6)}{5.94} + \underset{(9.1)}{1.83}\log\left(\frac{GNP}{POPH+POPL}\right)_{t-1} - \underset{(2.8)}{0.40}(rr)$$

R2=0.98; Std. Error = 0.04; DW=1.10;RHO(1)=0.88;

R2=0.92; Std. Error = 0.08; DW=2.21;RHO(1)=0.38;

This equation includes a lagged dependent variable, the estimated coefficient of 0.7 suggesting considerable inertia in the response of housing supply to changes in demand. While the short-run coefficient on the 'mark-up' variable is below 0.40, the implied steady-state coefficient is greater than one (1.3). This suggests that the rate of housing completions over the long-run is strongly responsive to demand, but that the pace at which the building sector can gear up to meet changing demand is slow. The coefficient on real house price volatility is not significant.

Finally the model includes an equation for the housing stock (*HSTOCK*) based on the housing stock in the previous period, housing completions in the current period, and assuming depreciation of 0.5% a year:

$$HSTOCK_t = 0.995 * HSTOCK_{t-1} + HCOMP_t \quad (3)$$

4.2 Linking house prices and rents

Following Green and Malpezzi (2003) and Gallin (2004) we assume that over the long run rents should cover the user cost of the house:

$$PRENT = PHNEW * (r + m + d + \lambda - gr)$$

Where PRENT[8] is an index of rental prices, r is the real interest rate, m is a fixed maintenance cost, d is the depreciation rate, λ is a risk factor and gr is the real appreciation in house values. We estimate this equation in logs as shown in equation (4) where $rr=r-gr$ and assuming that the sum of maintenance, depreciation and risk is 20%, this figure ensures a positive user cost throughout the estimation period. We further assume full income tax deduction on user costs, where *t* is the average rate of income tax. The estimated equation is as follows:

[8] PRENT is derived from the national accounts consumption tables.

$$\log(PRENT)_t = \underset{(-34.5)}{-10.9} + \underset{(32.7)}{0.96} * \log(PHNEW)_t + \underset{(1.5)}{0.02} * \log((rr + .2) * (1 - t))_t \quad (4)$$

R2=0.99; Std. Error = 0.05; DW=0.89;

There is almost complete pass-through of house prices to rents so that this equation provides a direct link between house prices and the migrant's cost of living index.

4.3 The migration decision

In the Bergin and Kearney (2004) model the high skilled population (POP_H) is modelled as a function of the natural increase (NI_H) and net immigration (M), where migration is assumed to be driven by lagged changes in the relative wage between Ireland and the UK (*relw*). It is assumed that all migration is high-skilled, with approximately 75% of migrants being in the 15-64 age group. This reflects the fact that high-skilled workers are mobile and will migrate if labour demand is low.[9]

$$POP_{H,t} = NI_{H,t} + 0.75M_t + POP_{H,t-1} \quad (5a)$$

$$M_t = f\left(relw_{t-1}\right) \quad (5b)$$

The relative wage term in the migration equation captures the private returns to working in Ireland relative to the UK, with private returns defined as the after-tax wage deflated by the consumer expenditure deflator. To introduce a "housing constraint" effect to the migration decision we decompose this *PC* deflator into a weighted average of consumer prices net of rents *PCX* and rents, *PRENT*[10]. We assume that the cost of housing for migrants, similar to

[9] Fahey, Fitz Gerald and Maître (1998).

[10] We experimented with the precise formulation of the cost of housing term. We tried including the ratio of house prices in Ireland to UK house prices (following the methodology used by Cameron and Muellbauer (1998), Bover, Muellbauer and Murphy(1989)) as an additional variable in the migration equation, however the results were counter-intuitive. This is because a very high proportion of the migration to and from the UK has been people working in the building industry. When housing prices rose rapidly in the UK the building industry boomed leading to emigration of Irish building workers.

new entrants to the housing market, is 20 per cent of total expenditure[11]. The modified deflator *PCM* is defined as:

$$PCM_t = 0.8 * PCX_t + 0.2 * PRENT_t \tag{5c}$$

In estimation, we nest the migration equation (5b) within the population equation (5a) as follows[12] [13]:

$$POPH_t = \underset{(-1.3)}{-98.3} + \underset{(3.2)}{244} \log\left(\frac{W_H^*}{PCM} / \frac{W_{UK}^*}{PC_{UK}} \right)_{t-1} + \underset{(3.5)}{0.36}\left(t_t\right)^2 + \underset{(6.5)}{0.72}\, POPH_{t-1} \tag{5d}$$

R2=1.00; Std. Error = 15.6; DW=2.45;

Together with the high-skilled participation equation (see Box 1), this equation determines the supply of high-skilled labour. In a closed labour market, the high-skilled labour market would clear at a much higher wage rate. The inclusion of migration in the determination of the high-skilled population means that participation is very sensitive to changes in wages, with a labour supply elasticity averaging above one between 1980 and 2000, close to the labour supply elasticity calibrated from Doris(2001) for the (closed) low-skilled labour market.

4.4 Consumer prices

Consumer prices are modelled as a function of import prices (*PMGS*), average wages (*W*) and excise taxes (*REX*) as follows:[14]

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[11] Fahey, Nolan and Maitre (2004), using data from the Irish Household Budget Survey, look at how expenditure on housing varies across the life cycle, comparing the years 1994-95 and 1999-2000. They find that for those in the early stages of family formation, likely to include many entrants to the housing market, mortgage or rent expenditure accounts for between 15 and 20 per cent of total household expenditure. In comparison, for these in the later stages of the life cycle, i.e. empty nest or retired, mortgage or rent expenditure accounts for less than 5 per cent.

[12] Estimated 1972-2001; W_H^* is after tax high-skilled wage, W_{UK}^* is after-tax wage in UK.

[13] The equation includes a quadratic time trend term set equal to one in 1968, this captures the non-linearities in the growth of *POPH*. Excluding this term implies explosive estimates with the coefficient on the lagged dependent variable greater than one.

[14] Estimated 1970-2000; R2=1.00; Std. Error = 0.007; DW=2.07;

$$\log(PC)_t = \underset{(-12.2)}{-0.92} + \underset{(16.9)}{0.19}\log(PMGS)_t + \underset{(12.4)}{0.30}\log(W) + \underset{(8.9)}{0.19}\log(REX)_t + \underset{(7.7)}{0.28}\log(PC)_{t-1} \quad (6)$$

The steady-state weight of 0.42 on wages in this equation implies a significant degree of domestically generated inflation.

5 Simulation results: the effect of the housing constraint on labour supply

In this section we use in-sample simulations to illustrate the channels through which rising house prices could create an infrastructural constraint on the economy in this model. Firstly we look at the effect of a 10% house price shock in the model. This simulation traces the mechanisms through which higher house prices can affect employment, wages, labour supply and output.

In the second simulation we provide a numerical estimate of the pure housing constraint effect described in Section 3; we isolate this effect on labour supply by comparing the consequences of an outward shift in the demand for labour when house prices are included and excluded from the migrant's cost of living index, i.e. the difference between E_2 and E_1 in Figure 1.

As mentioned earlier, all parameters in the model are introduced at their steady-state values so that the simulation results estimate the market clearing effect of any shock.

Table 1: Simulation Results[15]

	10% shock to house prices	1% shock to US GDP		
		With house prices	Without house Prices	"Pure" housing effect
% change				
GNP per head	-0.22%	0.87%	1.05%	-0.18%
GNP per worker	-0.13%	0.29%	0.40%	-0.11%
GNP	-0.48%	1.04%	1.43%	-0.39%

[15] There is a threshold switch embedded in the low-skilled labour market in the model to allow for change in market clearing behaviour when the low-skilled wage is above a specified replacement ratio threshold. In these simulations we are concerned with the period of the late 1990s when the unemployment rate among the low-skilled started to fall and the wage to rise, so the results presented here are based on the "market clearing" switch in the model. Results under the alternative switch were not substantively different and are available from the authors on request.

Total Employment	-0.35%	0.74%	1.03%	-0.28%
High-skilled	-0.36%	0.78%	1.07%	-0.29%
Low-skilled	-0.33%	0.66%	0.94%	-0.27%
Labour Supply	-0.35%	0.74%	1.02%	-0.28%
High-skilled	-0.36%	0.78%	1.07%	-0.29%
Low-skilled	-0.33%	0.66%	0.94%	-0.27%
Consumer prices	0.27%	1.01%	0.79%	0.22%
House Prices	8.85%	11.55%	11.84%	-0.29%
Average wage	0.65%	2.43%	1.90%	0.53%
High-skilled	0.81%	2.66%	1.99%	0.66%
Low-skilled	0.02%	1.52%	1.51%	0.01%
Real average wage	0.38%	1.41%	1.10%	0.31%
High-skilled	0.54%	1.63%	1.19%	0.44%
Low-skilled	-0.25%	0.51%	0.71%	-0.21%
Real average wage for high-skilled immigrants	-0.82%	0.52%	1.19%	-0.67%
in thousands:				
Net Immigration	-9.6	6.1	13.9	-7.8
Housing Completions	5.6	6.9	7.3	-0.4

I House price shock

In this shock we simulate the impact of a 10% rise in nominal house prices in the year 2000. Because the model is expressed using steady-state coefficients only, the simulation results in 2000 give an estimate of the full pass-through effect of such a shock in the model.[16] The rise in house prices increases rents and leads to a fall in the real wage facing migrants. The consequent emigration (reduced immigration) leads to a reduction in high-skilled labour supply, putting upward pressure on the nominal wage. This in turn increases unit labour costs, reducing profitability and competitiveness and causes a reduction of almost 0.5% in GNP. Both total employment and labour productivity fall as a result.

Such a house price shock alters the relative living standards available in Ireland and abroad, and has important differential effects on real wages for those high-skilled workers who have not yet bought a house. Despite a fall in the population due to net emigration (reduced immigration) of 9,600[17], GNP per head is lower (-0.22%). The real wage increases by 0.38%, while productivity falls by 0.13%, together this ensures that the labour share of value added increases and the balance of growth in the labour market moves from employment to wages.

[16] So for example the final equilibrium increase in house prices in the model simulation is just under 9% given a 10% initial shock.

[17] Or a reduction in net immigration.

However while the real consumption wage for high-skilled workers who have already entered the housing market increases (0.38%), the real wage facing migrants or first time house buyers falls (-0.82%). For the low-skilled or non-migrant worker, the real consumption wage falls by -0.25% due to higher consumer prices.

II Outward shift in the demand for labour

We use the model to simulate an outward shift in the demand for labour under two scenarios[18]. The first "base" scenario uses the aggregate consumption deflator (*PC*) as the cost of living index for migrants in determining the supply of high-skilled labour, while the second "housing constraint" scenario endogenises rents, which are in turn driven by house prices, in the migrant's cost of living index (equation 5c). The simulation is a 1% positive shock to world demand, measured as US GDP in the model, increasing the demand for Irish GNP. Given that the demand for labour in the model is a derived demand, this shock will in turn lead to a positive shock to the demand for labour. We combine this shock with the previous 10% shock to house prices, this ensures that the differential effects of house prices on migration for the "with housing constraint" and "without housing constraint" scenarios can be separately identified. By calculating the difference between the "housing constraint" and the "base" results we then get an estimate of the effect of the housing constraint on the economy.

Given a housing constraint operating in the high-skilled labour market, a positive world output shock would be expected to lead to higher output, productivity, employment and wages. This attracts in immigrants putting upward pressure on house prices. Contrasting this to a model where rents are not endogenised in the migrants cost of living index, we find higher output, higher immigration and higher house prices. By comparing the two results we can readily see that house prices act as a brake on the growth in output and employment, by lowering the rate of immigration, which in turn leads to higher wages and unit labour costs.

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[18] The simulation is a 1% positive shock to world demand for Irish GNP, measured as US GDP in the model. Given that the demand for labour in the model is a derived demand, this shock will in turn lead to a positive shock to the demand for labour. We combine this shock with the previous 10% shock to house prices, this ensures that the differential effects of house prices on migration for the "with housing constraint" and "without housing constraint" scenarios can be separately identified.

[19] The simulation is a 1% positive shock to world demand, measured as US GDP in the model. Given that the demand for labour in the model is a derived demand, this shock will in turn lead to a positive shock to the demand for labour. We combine this shock with the previous 10% shock to house prices, this ensures that the differential effects of house prices on migration for the "with housing constraint" and "without housing constraint" scenarios can be separately identified.

Table 2 presents the simulation results. Under the "base" scenario GNP is 1.4% higher while under the "housing constraint" scenario it is 1.0% higher; the housing constraint knocks almost 0.4 percentage points off the growth rate. Under the "base" scenario the average wage is 1.9% higher, under the "housing constraint" scenario it is over 2.4% higher while net immigration is 7,800 lower than in the base scenario. The effect of the housing constraint in the labour market is to shift the balance between wages and employment in the total wage bill.

Output per worker is lower as a result of the housing constraint (by 0.11 percentage points). This is driven by two interrelated mechanisms in the model. Firstly the immigrants who are discouraged from coming to Ireland because of the cost of housing are skilled and their absence from the work force reduces the rate of human capital accumulation, with a consequent reduction in domestic productivity. Secondly the housing constraint holds back the *scale* of the economy; in an economy characterised by increasing returns to scale in production this also reduces productivity growth.

The bulk of migration is in the working age group (75%) so that the dependency ratio is higher in the face of the housing constraint. Because of this, the reduction in output per head of 0.18 percentage points is greater than the reduction in output per worker.

For the resident skilled population who already own dwellings there is a real increase in wage rates which is not offset by the rise in housing costs (Daschler, 2001). For unskilled labour, the reduction in immigration constrains output. Given an unchanged supply of unskilled labour and a very low elasticity of substitution between skilled and unskilled labour, the reduction in demand sees a reduction in real wage rates sufficient to clear the unskilled labour market. For the skilled migrant who is seeking to enter the housing market the rise in house prices means that the real wage falls.

5 Conclusions

Ireland is unusual because it has such an open labour market.[20] High rates of migration mean that labour market behaviour is more like that of a regional economy – a state of the US or a region of the UK. Because of this the very rapid rise in house prices in recent years has introduced a new infrastructure constraint into the labour market, since immigrants are typically in the household formation age group. There is a growing literature on the role of public infrastructure as a potential constraint on growth[21]. In this paper we explore an example where privately provided infrastructure – housing – can place a significant constraint on growth.

These links between the housing market and the labour market via migration are developed within a small structural model of the determination of output, employment and wages. Within this model a house price shock reduces immigration and high-skilled labour supply, this leads to a rise in the average wage and a deterioration in competitiveness.

Using this model we isolate the "pure" effect of the housing constraint on the labour market. Our results indicate that the presence of this housing constraint results in a slower rate of growth in the face of rising world demand. This occurs because the housing constraint, through the labour market, translates into a loss of competitiveness for the tradable sector of the economy.

Although the presence of the housing constraint implies a lower level of GNP per capita, the welfare implications of the housing constraint differ for different groups in the economy. For skilled domestic labour already in possession of a house there is an unambiguous gain, with higher real consumption wages. By contrast, immigrants and first time buyers are net losers, facing a lower real wage rate under a housing constraint. The heaviest burden falls on the low-skilled labour market since lower immigration does not alter the supply of low-skilled labour. This segment of the labour market faces the burden of wage adjustment, so that these workers face a lower real wage, even if they are already home owners.

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[20] Krugman (1997) argued that the Irish economy is best characterised as a regional economy because of the openness of its labour market.

[21] For example (Barro, 1990, Futagami et. al., 1993) treat public infrastructure directly as an additional input in the production function.

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