Recent Developments in the Hungarian Housing Market; A Model with Quality Differential

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Abstract

In this paper we study the developments of the Hungarian home market. We show that the global house price boom was present in Hungary and the price increase can be explained by the increase of income, the softening credit constraints and the installastion of the governmental subsidy system. We complemented the observation of the recent halt of the house price rise with the further rise of the better quality homes. We present a two sector model with better and worse quality homes to describe the latter phenomena.

1 Introduction

Housing is important not only on its own right, but also as an important fraction of aggregate demand. As real estate wealth constitute an important part of households' assets, housing prices and rents have an effect on aggregate demand. Housing has become a particularly interesting sector and the topic of many reasearch recently, as since the 1990s prices increased spectacularly in many countries. In particular, this phenomenon was observed in Hungary as well. The explanation is not obvious, however.

Macromodels frequently contain a special housing block, where housing demand is treated in the traditional manner: the demand for housing services is determined by the relative price of housing services (rents). Rents and housing prices are related through an asset pricing relationship. The housing stock evolves like the stock of capital, and new houses are produced like any other output in a possibly imperfectly competitive market. Thus there are four equations: a supply function (or cost function) and an accumulation identity (a technology condition) characterize the supply side, while the demand side is given by a (conditional) demand function, as well as a an asset pricing equation. These equations determine the four variables of interest: investment in housing, stock of houses, rents and house prices. An important question both theoretically and empirically whether this framework is capable of accounting for the development of the housing market in the last 10 to 15 years. Or, do we need to replace or supplement this framework by adding features like capital market imperfections (e.g credit constraints), market frictions (e.g. costly search), or possibly some bounded rationality behavior as behavioral economists have suggested?

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In the following we will study the Hungarian housing market though we hope that the analysis may shed light on the more general question of how to integrate the housing market in a more general macro model. In fact the original purpose of this research was to account for some curious facts pertaining to the Hungarian housing market. In order to accomplish this task, first we describe these facts in some detail, identify some salient large shocks that must have affected the housing market, and address the question whether the economy's actual response to these shocks can be explained by the traditional model. We find that one can go a long way to find explanations in this manner, but there were some abrupt changes that cannot be squared with the traditional model. One key novel feature of our theoretical framework is vertical differentiation in the housing market, an important feature we deduced from the evolution price data. Though we cannot prove, we have some reason to believe that this may explain house price developments in Hungary.

2 Stylized facts and literature review

2.1 International developments

Table 1 shows the cumulated increase in real house prices in 18 developed OECD economies.

Table 1: cumulated increase of real house prices

	1995-2006			*1995-2006*
Ireland	187%		Norway	70%
Spain	155%		Belgium	60%
Great Britain	139%		Finnland	60%
France	114%		New-Zealand	53%
Denmark	112%		Canada	43%
Sweden	102%		Italy	42%
The Netherlands	99%		Switzerland	0%
Australia	91%		Germany	-12%
USA	86%		Japan	-33%

Source: BIS

The rise is spectacular and almost universal (for details see for example: *Girouard et al. [2006] or Himmelberg et al. [2005]*) Notice the exceptions: Germany and Japan, and Switzerland to some extent. Germany's being an outlier is attributed to the construction boom in East Germany after unification, and the consecutive excess supply (see *Milleker [2006]*). Japan has its own peculiar economic history in the last two decades, where real estate prices loom both high and low.

Terrones [2004] of the IMF remark that the recent developments are atypical, both the size and the persistence of the price increase are quite exceptional by historical standards. They draw attention to the curious fact that house price changes seem to be synchronized internationally, despite houses being usually considered as non-tradables. The price-to-income and the price-to-rent ratios are well above their long run trend in almost all countries (*Helbling [2005]*). It is also remarkable that the price rise was not interrupted by the slowdown of the early 2000s, and the formerly observed procyclicality of house prices may have disappeared.

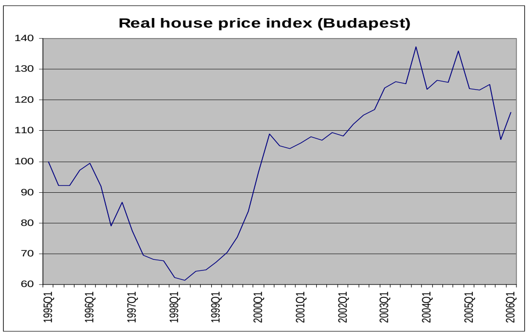
The phenomenon naturally invited explanations, both standard (*Tsatsaronis - Zhu [2004]*) and some non-standard (*Shiller [2005]*) have come along . Standard explanations invoke both demand and supply side factors. With respect to demand there is a claim of higher relative demand for (more and of higher quality housing) due to higher income, and in some cases demographic factors have been enlisted, too. Financial liberalization and the progress of the financial infrastructure may have contributed to an increase in demand via alleviating credit constraints, and by making housing investment less expensive.

A number of supply side factors were uncovered, too. It has been pointed out that the construction sector might have had a slower TFP growth than the rest of industry, thereby the real marginal cost of building has gone up. Others have noticed that land prices have constituted an increasing share of housing costs, and this may have been caused by the effective scarcity of land (*Glaeser et al. [2005]*). ("Effective", because regulation played a role alongaside geography.) This explanation may be circular, however, since land prices should not be independent of house prices. Still it points to the possibilty that construction must have faced increasing marginal costs for technological reasons. Alternatively this may be at variance with an explanation based on higher costs of construction.

2.2 Hungarian developments

Developments in the Hungarian housing market are quite similar to those discovered above. The notable exception is that the period 1995-2006 divides into two subperiods: with a dramatic fall in prices in the first and shorter (1995-98) subperiod and an even more spectacular rise in the second (1998-2006). The overall in-sample real price rise amounts to 30%, but is as large as 78% for the period 1998-2004 (see *Figure 1*).

Figure 1: Real house price index (Budapest)

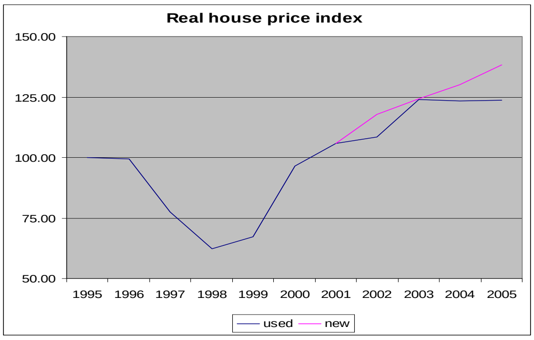


Source: National Bank of Hungary and own calculation

Even though the general pattern is quite similar and quantitatively comparable to the international developments (documented in *Table 1*), the possible driving forces behind are not. We will identify factors influencing real estate prices later in Secion 5, and discuss in detail the mechanisms they could have worked through. For a short listing, the country-specific effects include the shortage of high quality flats in the beginning of the 1990s (as a heritage of the state-controlled construction sector of the communist system), the large-scale portfolio reallocation after the Russian crises, the initial backwardness and the consequent substantial progress in financial intermediation, the steady growth in households' income starting from 1997, and the high frequency of exogenous shocks to the state subsidies system.

Moreover, a closer look at the Hungarian (Budapest) housing market revealed a new and interesting phenomenon: a widening gap between 'good' and 'bad' quality prices for the last couple of years (see *Figure 2*).[1]

Figure 2: Real house price index (used and new)



Source: National Bank of Hungary, Otthon Centrum and own calculation

Part of the gap is attributable to asymmetric subsidies on new and old houses (new constructions were more encouraged by regulation), but change in prerefences could also have played a role. This paper is designed to integrate the specific features of the Hungarian housing market into a general model, and provide a coherent and consistent story about the past ten years of the Hungarian housing market.

3 The model

Aggregate house price modelling was launched by *Poterba [1984].* This model is a slight generalization of *Topel – Rosen-[1988]* as a partial equilibrium model of the housing market with representative agents and a quadratic-linear structure. It contains the traditional features. On the demand side conditional housing demand is derived from a quadratic utility framework. Dynamic utility maximization also implies the asset pricing equation, linking house prices and rents.On the supply side there are cost functions for building new flats, and an accumulation equation. Then profit maximization provides the implicit supply functions.

3.1 Households

Representative households (think in terms of extended families living in a modern society) have preferences over houses of higher (HG_t), and lower quality (HB_t), as well as a numeraire good (C_t). Instantaneous utility is generated according to:

$$u_t = -aHG_t^2 - bHB_t^2 - cHG_t \cdot HB_t + \left(\overline{d} + d_t\right) HG_t + \left(\overline{e} + e_t\right) HB_t + f + \frac{1}{\alpha} C_t$$

[1] We will use 'newly constructed' and 'old/used' houses for proxies of 'good' and 'bad' quality. The reason being that houses constructed in the late communist system by all standards inferior to newly built dwellings of the last couple of years.

All the parameters are non-negative. It is implicitly assumed that housing services are proportional to the stocks of each variety of houses. The relationship $a > b$ is imposed as an expression of vertical (quality) differentiation, positive c represent complemetarity, d_t and e_t are relative preference shocks.

Stocks of the two types of houses develop according to the following processes:

$$\begin{aligned} HG_t &= (1-\delta_G)HG_{t-1} + PG_t DG_t \\ HB_t &= (1-\delta_B)HB_{t-1} + sHG_{t-1} + PB_t DB_t \end{aligned}$$

Here DG_t and DB_t denote the purchase of new houses, and PG_t and PB_t their respective prices. The parameter $s > 0$ means that in each period s percent of high quality houses becomes low quality (obsolescence). The δ parameters represent traditional depreciation.

Household labour and other income (Y_t) is exogenous and the intertemporal wealth constraint can be written as:

$$Y_t + (1+r)\, B_t = B_{t+1} + C_t + PG_t DG_t + PB_t DB_t,$$

where r is the constant yield on non-housing investment, $\beta = \frac{1}{1+r}$. Households are unrestricted on capital markets, thus B_t may take on either negative or positive values.

Households maximize an intertemporal utility index

$$U = \sum_{t=0}^{\infty} \beta^t E_t\left[u_t\right]$$

subject to the above conditions, where $\beta < 1$.

Imposing the transversality condition, and solving the problem of utility maximization yields the following first order conditions:

$$\frac{1}{\alpha} = \lambda$$

(where λ is the marginal utility of income),

$$\begin{aligned} \alpha(-2aHG_t - cHB_t + \left(\overline{d} + d_t\right)) &= PG_t - \frac{(1-\delta_G)\, E_t\left[PG_{t+1}\right] + sE_t\left[PB_{t+1}\right]}{1+r} \\ \alpha(-2bHB_t - cHG_t + \left(\overline{e} + e_t\right)) &= PB_t - \frac{(1-\delta_B)\, E_t\left[PB_{t+1}\right]}{1+r}. \end{aligned}$$

Rents can be defined as:

$$\begin{aligned} RG_t &= PG_t - \frac{(1-\delta_G)\, E_t\left[PG_{t+1}\right] + sE_t\left[PB_{t+1}\right]}{1+r} \\ RB_t &= PB_t - \frac{(1-\delta_B)\, E_t\left[PB_{t+1}\right]}{1+r}. \end{aligned}$$

Then one can obtain the following static demand functions:

$$HG_t = \frac{2b\left(\overline{d} + d_t\right) - c\left(\overline{e} + e_t\right) - \frac{2b}{\alpha} RG_t + \frac{c}{\alpha} RB_t}{4ab - c^2}$$

$$HB_t = \frac{2a\left(\overline{e}+e_t\right) - c\left(\overline{d}+d_t\right) - \frac{2a}{\alpha}RB_t + \frac{c}{\alpha}RG_t}{4ab-c^2}$$

3.2 Construction industry

The representaive building company maximize expected discounted profits. .

$$\Pi = \sum_{t=0}^{\infty}\frac{1}{(1+r)^t}E_t\left\{[PG_{t+1}, PB_{t+1}]\begin{bmatrix} CG_t \\ CB_t \end{bmatrix} - K(CG_t, CG_t - CG_{t-1}, CB_t, CB_t - CB_{t-1})\right\}$$

We assume that period t production involves costs $K(CG_t, CG_t - CG_{t-1}, CB_t, CB_t - CB_{t-1})$ depending on current production, and also on the adjustment of production with respect to the previous period. (There are convex adjustment costs.) Moreover, there is one period delay between production and selling. Hence firms must advance funds, whose remuneration is uncertain at the time of expensing. The cost function is quadratic.

$$\begin{aligned} & K(CG_t, CG_t - CG_{t-1}, CB_t, CB_t - CB_{t-1}) \\ = \;& g_1 CG_t + \frac{g_2}{2}\left(CG_t - CG_{t-1}\right)^2 + b_1 CB_t + \frac{b_2}{2}\left(CB_t - CB_{t-1}\right)^2 \end{aligned}$$

where all parameters are non-negative. The only restriction about the cost function - apart from all parameters being positive - is that high quality houses are more expensive to build than low quality houses, thus $g_1 > b_1$.

The implicit supply functions are easily derived from the first-order conditions:

$$\begin{aligned} g_1 + g_2\left(CG_t - CG_{t-1}\right) &= \frac{1}{1+r}E_t\left[PG_{t+1}\right] \\ b_1 + b_2\left(CB_t - CB_{t-1}\right) &= \frac{1}{1+r}E_t\left[PB_{t+1}\right] \end{aligned}$$

3.3 Equilibrium

There are two simple equilibrium conditions, according to which houses built in period $t-1$ are sold to households in period t.

$$\begin{aligned} DG_t &= CG_{t-1} \\ DB_t &= CB_{t-1}. \end{aligned}$$

4 The dynamic system

The equations of the linear dynamic system can be summarized as follows:

$$\begin{aligned}
\frac{E_t\left[PG_{t+1}\right]}{1+r} &= g_1 + g_2\left(CG_t - CG_{t-1}\right) \\
\frac{E_t\left[PB_{t+1}\right]}{1+r} &= b_1 + b_2\left(CB_t - CB_{t-1}\right) \\
HG_t &= (1-\delta_G)HG_{t-1} + CG_{t-1} \\
HB_t &= (1-\delta_B)HB_{t-1} + sHG_{t-1} + CB_{t-1} \\
\alpha(-2aHG_t - cHB_t + \left(\overline{d} + d_t\right)) &= PG_t - \frac{\left(1-\delta_G\right)E_t\left[PG_{t+1}\right] + sE_t\left[PB_{t+1}\right]}{1+r} \\
\alpha(-2bHB_t - cHG_t + \left(\overline{e} + e_t\right)) &= PB_t - \frac{\left(1-\delta_B\right)E_t\left[PB_{t+1}\right]}{1+r}
\end{aligned}$$

The endogenous variables include: $HG_t, CG_t, PG_t, HB_t, CB_t, PB_t$.

Our model differs from the Rosen-Topel framework in the following features:

- the housing market exhibits vertical differentiation,

- the quality of houses may deteriorate,

- there is a one-period lag between production and selling new houses.

4.1 The deterministic steady state

In the steady state house prices are determined by marginal costs and the rate of interest, thus are independent of demand. High quality houses are more expensive since they are more costly to build.

$$\begin{aligned}
\frac{PG}{1+r} &= g_1 \Rightarrow PG = g_1\left(1+r\right) \\
\frac{PB}{1+r} &= b_1 \Rightarrow PB = b_1\left(1+r\right)
\end{aligned}$$

From this, it follows immediately that rents, too, depend on technological parameters and the interest rate.

$$\begin{aligned}
RG &= PG - \frac{\left(1-\delta_G\right)PG + sPB}{1+r} = \frac{\left(r+\delta_G\right)PG}{1+r} - \frac{sPB}{1+r} \\
RB &= PB - \frac{\left(1-\delta_B\right)PB}{1+r} = \frac{\left(r+\delta_B\right)PG}{1+r}
\end{aligned}$$

The steady state stocks and new construction can be easily calculated from the demand functions:

$$\begin{aligned}
HG &= \frac{2bd - \frac{2b}{\alpha}RG}{4ab - c^2} \\
HB &= \frac{2ae - \frac{2a}{\alpha}RB}{4ab - c^2}
\end{aligned}$$

$$
\begin{aligned}
HG &= (1-\delta_G)HG + CG \Rightarrow CG = \delta_G HG \\
HB &= (1-\delta_B)HB + sHG + CB \Rightarrow CB = \delta_B HB - sHG
\end{aligned}
$$

4.2 Dynamics

While the steady state can be recursively calculated, the solution and analysis of the full dynamic system requires a numerical algorithm. We employed the *Blanchard – Kahn [1980]* method. To transform our model into this framework we need auxiliary variables $(E_t\left[PG_{t+1}\right], E_t\left[PG_{t+1}\right], \epsilon_t)$:

$$
\begin{aligned}
PG_t &= E_{t-1}\left[PG_t\right] + \eta_t^{PG} \\
PB_t &= E_{t-1}\left[PB_t\right] + \eta_t^{PB} \\
d_t &= \rho_d d_{t-1} + \varepsilon_t^d \\
e_t &= \rho_e e_{t-1} + \varepsilon_t^d
\end{aligned}
$$

The endogenous y_t vector in our case:

$$
y_t = \begin{bmatrix} E_t\left[PG_{t+1}\right] \\ E_t\left[PB_{t+1}\right] \\ PG_t \\ PB_t \\ CG_t \\ CB_t \\ HG_t \\ HB_t \\ d_t \\ e_t \end{bmatrix}
$$

The coefficient matrices:

$$
\Gamma_0 = \begin{bmatrix}
\frac{1}{1+r} & 0 & 0 & 0 & -g_2 & 0 & 0 & 0 & 0 & 0 \\
0 & \frac{1}{1+r} & 0 & 0 & 0 & -b_2 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\
\frac{1-\delta_G}{1+r} & \frac{s}{1+r} & -1 & 0 & 0 & 0 & -2a\alpha & -c\alpha & & 0 \\
0 & \frac{1-\delta_B}{1+r} & 0 & -1 & 0 & 0 & -\alpha c & -2b\alpha & & 0 \\
0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1
\end{bmatrix}
$$

$$\Gamma_1 = \begin{bmatrix} 0 & 0 & 0 & 0 & -g_2 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -b_2 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 1-\delta_G & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & s & 1-\delta_B & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \rho_d & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \rho_e \end{bmatrix}$$

$$C = \begin{bmatrix} g_1 \\ b_1 \\ 0 \\ 0 \\ -\alpha d \\ -\alpha e \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \qquad \Psi = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 1 \\ 1 \end{bmatrix} \qquad \Pi = \begin{bmatrix} 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 1 & 0 \\ 0 & 1 \\ 0 & 0 \\ 0 & 0 \end{bmatrix}$$

We set the baseline parameters to the following values. The interest (discount) rate $r = 0.05$. Depreciation rates are $\delta_G = 0,1$, $\delta_B = 0,1$, and $s = \delta_G$ means that good quality homes become bad quality homes after deterioration. By definition, good quality homes must be more expensive to construct: $g_1 = 200 > b_1 = 150$. We set the adjustment costs to the same in the two sectors: $g_2, b_2 = 15$. The other parameters have mostly scaling role: $\overline{d} = 50$, $\overline{e} = 75$, $a = 0.5$, $b = 0.5$, $c = 0$ (we omit the possibility of complementarity), $\alpha = 2$. Finally the setting of the exogenous shock process parameters: $z_1, z_2 = 0.5$, $\rho_d = 0.9$, $\rho_e = 0.95$.

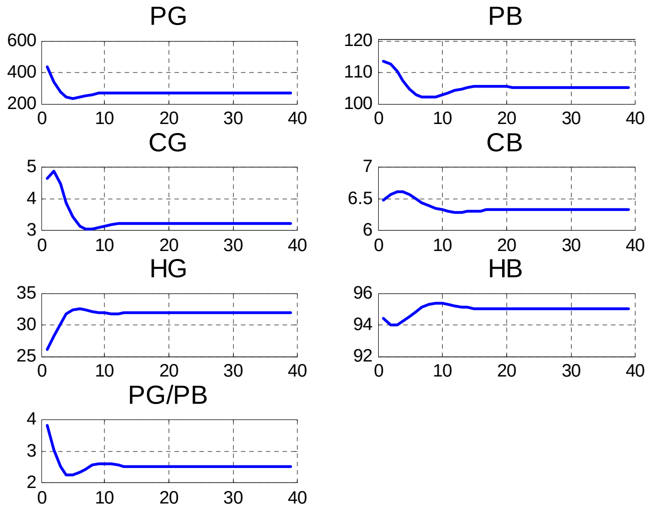
5 Shock identification in the Hungarian market

In this section we anecdotically identify shocks in the Hungarian housing market and replicate the effect of these in the model. Our identification process is very rough at this stage of the research: we call an exogenous change a shock in Hungarian housing market, if we think it must have had a significant effect on the housing market. For this "identification process" we go on step by step through the relevant explanatory variables of the Hungarian housing market.

5.1 Quality shortage in the early 1990s

Housing construction was coordinated by central planning during the socialist regime in Hungary. Equality was (is) one of the socialist principles, so houses were mainly built in equal quality. The main memento of this are the numerous blocks of flats all over the country. Therefore, after the regime change a slight shortage of good quality homes was a massive phenomenon in the Hungarian house market (*Hegedűs – Tosics [1990]*). This quality shortage could be easily identified in our model. *Figure* 3 shows the consequences of 20% less stock of good quality homes compared to its long run steady state quantity.

Figure 3: Impulse responses to quality deficit

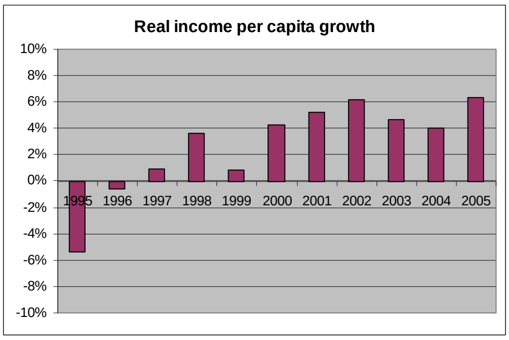


If there are less good quality homes, then the relative demand increases their price, so the relative price of good quality homes increases, then slowly moves toward the long run equilibrium. The construction of better quality homes jumps to a relatively high level and then gradually decreases.

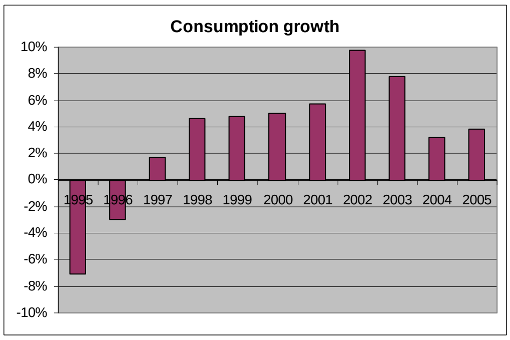
5.2 Income growth

Figure 4a shows the massive income growth Hungary experienced since the end of ninetees. The growth rate of consumption is on *Figure 4b*. The two patterns look more or less the same, decreasing in 1995 and 1996 and growing permanently afterwards. (There is small difference between the path of income and consumption in the past years, consumption growth was extremely high in 2002 and 2003, and then it slowed to lower pace compared to the income growth.) We identify the robust and steady growth in the real income and consumption since 1997-98 a permanent income shock with our simple identification method.

Figure 4a: Real income per capita growth **Figure 4b**: Real consumption growth



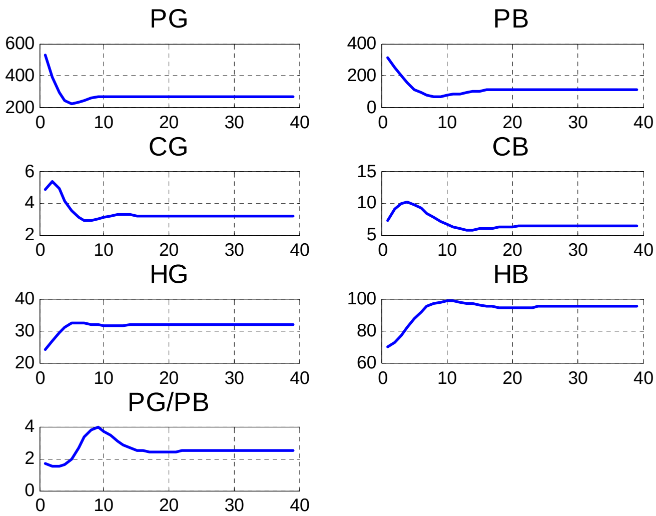
Source: Central Statistical Office (Hungary)



Source: Central Statistical Office (Hungary)

In the model income shocks can be identified as the change in parameter α, which shows the reciprocal of other goods consumption's marginal utility. Since our model is calibrated with a constant steady state in the long run, permanent growth is omitted at this stage of the analysis. Therefore we formulate the increase of income growth rate with a one time permanent decrease in the marginal utility of consumption, i.e. an increase of α. The impulse responses to income's increase (a one time α increase from 0.5 to 3) are shown in *Figure 5*.

Figure 5: Impulse responses to consumption growth

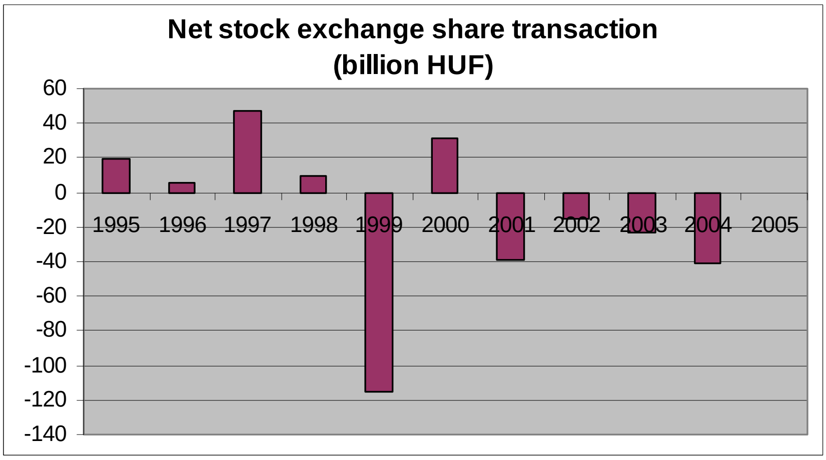


The effect of the income growth on prices in the model is an immediate growth of both type of houses' price, because the relative shortage prevailing at the time of the massive positive demand effect. The construction rapidly increases and then slows to the steady state level, when the quantity of both type of houses are higher. The relative price of the different type of houses follows an overshooting path. The relative price of the better houses reaches a higher level than in the steady state.

5.3 The effect of the Russian crisis

Figure 6 shows a circumstancial evidence of the change in Hungarian investors decision in portfolio investments. There was a significant one time reallocation of portfolios at the expense of shares. There is no evidence that this private portfolio wealth was transposed to real estate wealth only, but together with anecdotical evidence from our experience in the late ninetees, it can be identified as a one time permanent demand shock at the housing market.

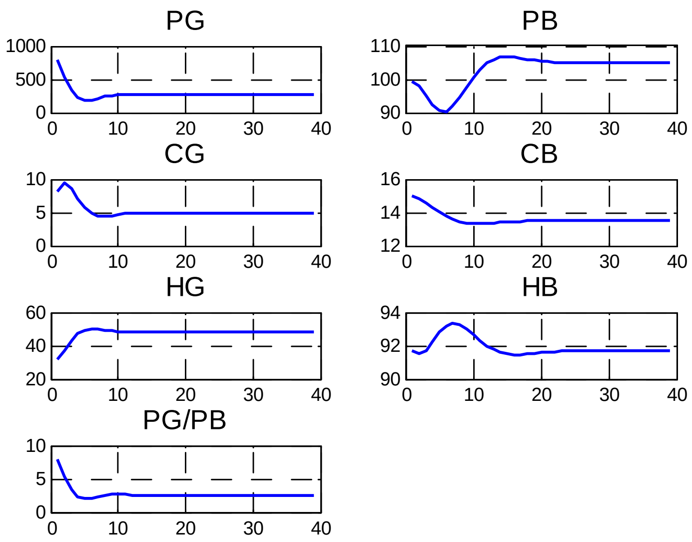
Figure 6: Portfolio reallocation after the Russian crises



Source: National Bank of Hungary

We identify this demand shock in the model with a permanent, additive growth of the demand for housing. However it is less plausible to identify which demand parameter should be changed. We can't prove our hypothesis, but to the best of our recollection investors portfolio reallocation towards the real estate investments was mainly for better quality houses. So – more or less arbitrarily – we chose to identify the Russian crisis with a one time permament increase in the demand for *better quality* homes. The impulse responses of this shock (a one time d_t increase) are shown in *Figure 7.* The result of the demand growth for better quality houses in the model is an immediate price increase of the better quality homes, and the increase of relative price too. These price variables slowly move back to their long run level, which is determined by the supply side of the model.

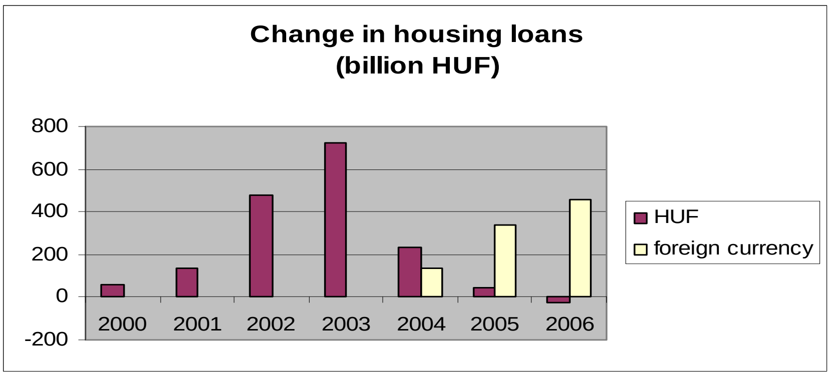
Figure 7: Impulse responses to a permanent demand shock



5.4 Financial infrastructure development

The Hungarian financial infrastructure started to develop in the mid ninetees. Bank lending was one of the main field of the development, and together with the evolution of the legal background mortgage credits became available (*Hegedűs - Várhegyi [2000]*). *Figure 8* shows the change of housing loans from the almost zero level. There was a significant second phase of this process too, when foreign currency loans became available.

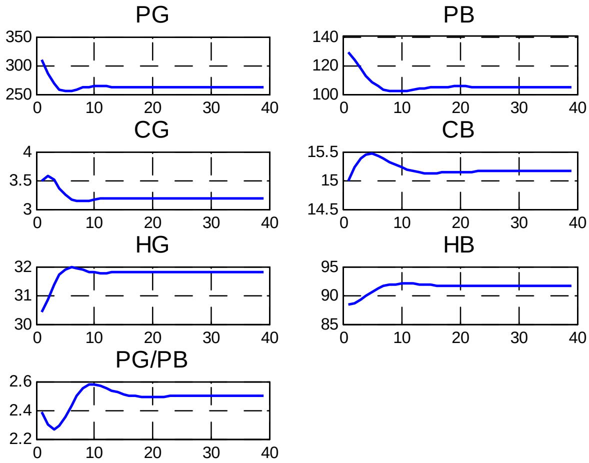
Figure 8: Increase of housing loans



Source: National Bank of Hungary

We don't integrate credit constraints to our simple model, so we identify this development with the decrease of the interest rate. The impulse responses are shown on *Figure 9*.

Figure 9: Impulse responses to a decrease of the interest rate



A one time decrease in the interest rate results in an increasing demand for both type of flats. Because of this, prices of both type of flats increase.

5.5 Governmental subsidy system

There was a major governmental influence on the Hungarian house market in the last ten years. The government stated a system of subsidies from 2000, which grew in size more and more until it became unsustainable, and was cut to a lower level. The subsidy system contains about 7 policy elements (building allowance, tax refund, mortgage interest subsidy, complementary interest subsidy, redemption subsidy, home saving subsidy, duty subsidy), so it is hard to compress it into few numbers and it is hard to fit into our model. Our rough computation to transform this nontransparent system into our model is made in the following way. We summarized all the possible subsidies to various flats and tried to reconstruct the changes during the last few years. We used past yield curves to calculate the past values of interest rate subsidies. Then we summed up the total amount of different subsidies to a given flat. We turned the absolute values into percentage measure. It shows that how much less is paid by the buyer than the selling price is (see *Table 2*).

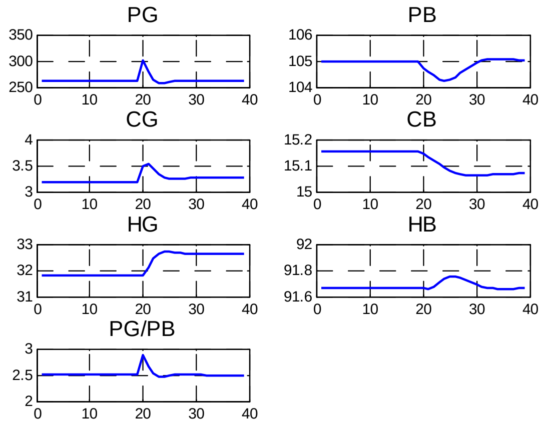
Table 2: Changes in the governmental subsidy system

	discount to a flat worth		
	20 MHuF	15 MHuF	15 MHuF, used
-2000	3.2%	4.8%	4.8%
2000	11.6%	11.9%	5.8%
2001. feb.	23.3%	25.7%	17.3%
2001. aug.	26.7%	21.8%	20.7%
2001. nov.	33.3%	26.8%	23%
2002. marc.	32.7%	32.7%	23.8%
2003. jun.	22.3%	20.9%	14.2%
2003. dec.	13.4%	12%	13.4%

Source: own calculations based on law.

We simulated the effect of a 20% discount in the model.

Figure 10: Impulse responses to permanent governmental subsidy



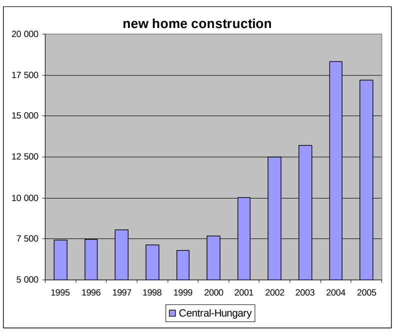
The effect of subsidies can be easily followed on the above Figure (*Figure 11*). Because buyers only pay a discount price, the demand for better quality houses increases, and the relative demand is also increase, because better quality homes are subsidized more. Therefore the absolute price, the relative price and the quantity of the better quality homes constructed increase too.

5.6 Confronting the data with the model

We continue with the comparison of the model simulation and the empirical graphs. Our question is which phenomenon from the past ten years of the Budapest (Hungarian) residential home market can be explained in the context of our model.

Figure ... showed the graph of used home's price in Budapest, which we identify as the price of weaker quality homes. There was a significant price increase in Hungary from 1998, and then in 2004 it stopped. After that the relative price of better quality homes rose as shown in Figure... . Construction of new homes in the region is shown on the next figure (*Figure* .) New homes are built in significantly better quality than the used ones.

Figure 11: New home construction



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We confront the revealed anecdotical empricics with the model in the next table (*Table 3*).

Table 3: Empirics and model simulation results

time and type of the shock	*model*	*empirics*
1995 quality shortage	jumping and decreasing prices jumping and decreasing relative price increasing construction of better homes	decreasing price stagnating construction
1998 permanent income growth	jump of both prices increasing relativ price increasing construction of both type	fast increase of prices stagnating construction
1998 Russian crisis	jumping house prices jumping and decreasing relative price increasing construction of better homes	
2001 governmental subsidy system installed	increasing price of better homes significant relative price increase increasing construction of better homes	slowing price increase relative price increase construction boom
2001 softening credit constraints	jumping house prices slowly increasing relative price increasing construction	slowing price increase relative price increase construction boom
2004 subsidy system cutback	increasing price of better homes decreasing price of worse homes increasing relative price slowing construction	increasing price of better homes decreasing price of worse homes increasing relative price slowing construction

To sum up the Table we say that the model can reproduce the overall massive aggregate price increase in the Hungarian home market. The growing income, the portfolio adjustment of the investors after the Russian crisis, the developping financial infrastructure and the governmental subsidy system all played a significant role in this process. The model also can reproduce the innovative phenomena in our analysis, the difference between the better and the worse quality homes. Great majority of the new home construction is good, and that's a corollary of the inherited quality shortage and the character of the governmental subsidy system. The increasing relative price of better quality homes can be explained by the increasing income. However the time of the consumption boom is unexplained by the model because it started two years later after the demand boom. The empirical observations must be developped in further work.

6 Summary

The objective of this paper was twofold. First, as a theoretical achievement we wanted to present a generic model of the housing sector that could easily be integrated into a more general macroeconomic model. Second, we tried to replicate some important recent empirical developments of the Hungarian housing market. We found that the novel feature of our contribution (introduction of vertical differentiation into the housing market) is important and provides interesting new insights. While we believe to have done reasonably well in both respects, for a more accurate account of the empirical evidence some specific factors and, possibly, some non-standard explanations seem inevitable. Further research could aim at elaborating on these issues.

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