WEALTH PORTFOLIO OF HUNGARIAN HOUSEHOLDS - URBAN LEGENDS AND FACTS

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Abstract

As significant part of national wealth, households' wealth is the central issue in both policy debate and academic literature. Nevertheless, in Hungary little effort has been made so far to conduct thorough evaluation of households' wealth for the last decade. Under the auspices of 'the plural of anecdote is not data' axiom, this study provides a formal estimation for the complete wealth of Hungarian households and connects the development of wealth elements to economic events, such as governmental housing subsidy scheme. According to our results, the recent financial wealth level of Hungarian households is still relatively low, however, the current housing wealth is not evidently below the equilibrium level. We also conclude that the 'saving disaster' experienced in early 2000's, to a certain extent, is the other side of the 'saving miracle' of mid 90's. The governmental housing subsidy scheme increased demand for housing and induced soaring house prices, which, via housing loans, vanished financial savings. Besides, this scheme did not attain significant rise in housing stock.

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I. Introduction

Citation of households' wealth is a recurring subject in several areas of our lives. Politicians, policy makers, analysts and, of course, households themselves are concerned about their wealth positions. While politicians worry about their electors' standard of living, analysts keen on understanding and predicting how certain shocks affect the households' wealth and hence their behavior. Founded on a common conjecture, namely the households' wealth is a substantial part of a nation's wealth, the eager interest is comprehensible. Theoretically oriented research and models are also fond of employing housing or durable consumption stock in utility function. Aoki et al (2002) provide a microeconomic foundation of how housing wealth affect consumption expenditure via risk premium of households' loan. Another interesting examination of households' wealth is the paper of Bruce et al (2004) in which they investigate the relation between economic and subjective well-being. According to their results, consumption, income and wealth all together alter the satisfaction level of households. This result rationalizes the appearance of housing and financial wealth in utility function, for instance money-in-the-utility approach in the literature of monetary theory.

Being the foundation of theoretical works and practical analysis, households' wealth data and related stylized facts are essential. Cardoso and da Cunha (2005) conduct a detailed research about the wealth portfolio of Portuguese households. Similar exercise can be found in Aron and Muellbauer (2006a) for South Africa, Niemeläinen et al (2006) for Finland or O. Berge et al (2006) for Norway.

Contrary to this distinguished attention, little effort has been made to conduct thorough evaluation of Hungarian households' wealth and its structure for the last decade. Zsoldos (1997) provided a systematic examination for the period 1980 to 1996 but since then no study dealt with the entire wealth position. Owing to the lack of studies in Hungary, several legends and conjectures have been stated about the severe decline in financial savings rate, the housing wealth level, the effect of housing subsidy scheme and EU accession on house price level.

Under the auspices of 'the plural of anecdote is not data' axiom, the aim of this study is twofold. First, it provides an exact estimation of the complete wealth of Hungarian households, including financial-, housing wealth and consumer durables, and derives stylized facts. Although financial wealth is broadly accessible at the website of the central bank of Hungary, the housing wealth and durable consumption stock have not been published yet. Second, we assess the development of these wealth elements and connect them to economic events. Due to the fact that housing wealth is expected to be the largest part of households' wealth, we pay special attention to housing subsidy scheme initiated by Hungarian government.

The rest of the study is organized as follows. Section II provides detailed estimation of the total wealth of Hungarian households with special attention to housing and durable consumption wealth. In order to evaluate the current wealth level of households we compare it to other countries' wealth level and estimate the expected steady state wealth levels. Since our aim to examine the portfolio choices and the structural changes in wealth, Section III briefly introduces a formal econometric testing methodology and a small theoretical model. The succeeding parts reveal the details and seek answers how different events influenced Hungarian households' wealth. Finally, Section V concludes and Appendix provides formal proof of how income growth affects steady state wealth ratios and displays the estimation of model parameters.

II. Estimations, stylized facts and international comparison

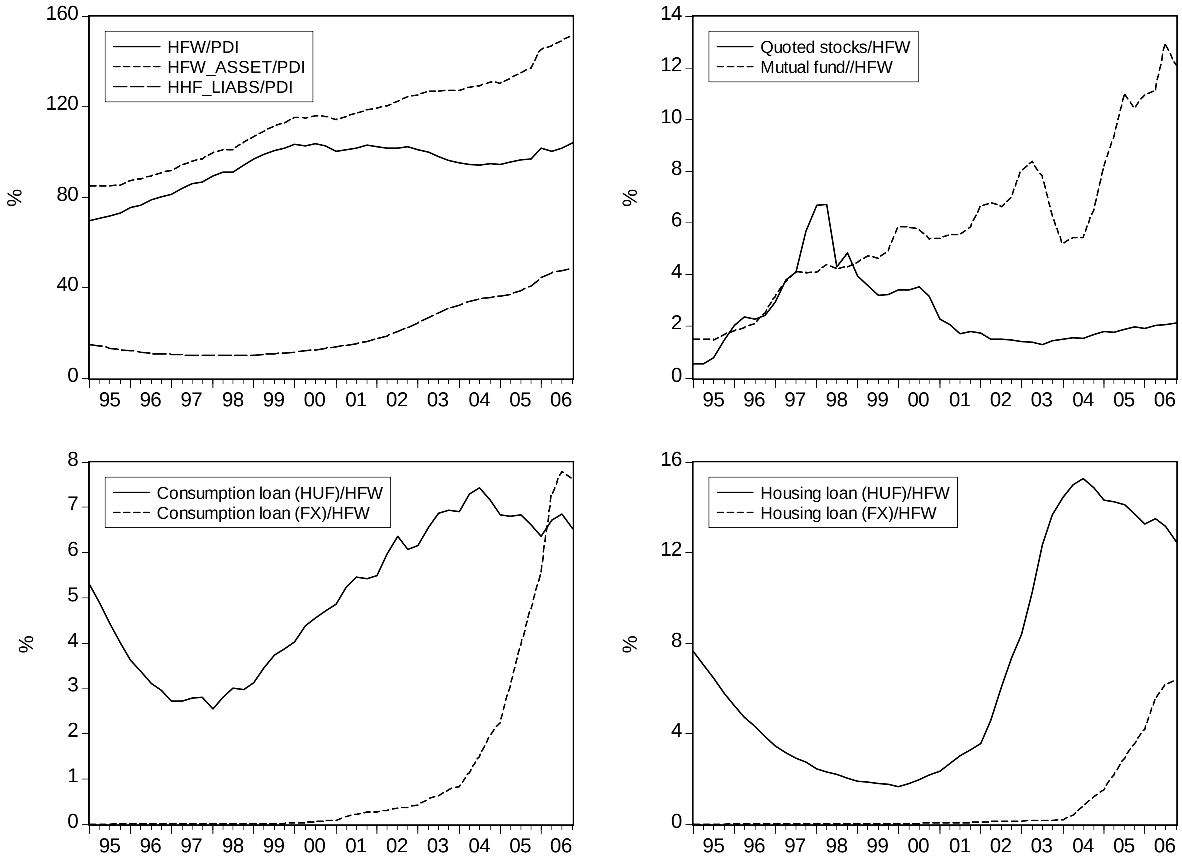
One of the primary goals of this study is to provide estimation for financial wealth, housing wealth and the stock of durable consumption goods of Hungarian households. Fortunately, as we mentioned above the financial wealth of households is accessible. On the contrary neither housing nor durable consumption stock is available. The following part provides estimations for these wealth elements. Obviously, these approximations could be suitable for any theoretical or empirical analysis, however, cannot be considered as official statistics.

II. 1. Financial wealth

Financial position of Hungarian households has undergone some structural changes and been influenced by various shocks. The most noticeable phenomenon is that the ratio of net financial wealth to income is practically constant since 2000 (see the upper-left panel of Figure 1). Even though the financial asset/income ratio continues to increase along the same trend the households' liabilities have expanded at higher pace. In the first phase, around 1998, the increasing income eased the liquidity constraint and made the HUF-denominated consumption loan available. This was followed by foreign exchange-denominated consumption loan since 2000 (see the lower-left panel of Figure 1). At the same time governmental housing subsidy scheme began to stimulate the HUF-denominated housing loan. The tightening of housing subvention (see the details later) shifted the housing loan origination to foreign exchange-denominated mortgage (see the lower-right panel of Figure 1).

As for the financial assets concern, in the beginning of regime change, i. e. 1990, the typical deposit type was the jar in the cupboard and approximately 40 percent of net financial wealth was held in cash. By the beginning of 2000 this ratio dropped under 10 percent. Due to the fear of hyperinflation in mid 90's the foreign-exchange denominated deposit became a favorite saving form, which, after the consolidation of inflation expectations, gradually decreased to 5 percentage. By the mid 90's Hungarian households began to employ more sophisticated savings forms, such as stocks and mutual funds. As for the quoted stocks, households abandoned stock exchange because of falling stock prices triggered by Russian financial crisis. Even after substantial soaring of stock market in the last few years Hungarian households disregarded quoted shares as a savings variant (see the upper-right panel of Figure 1).

Figure 1 The ratios of assets and liabilities to net financial wealth



where HFW and PDI denote the households' financial wealth and annual personal disposable income in current price. HUF and FX indicate the HUF and foreign exchange-denomination.

II. 2. Housing wealth

Since there is no official data for housing wealth it has to be estimated based on the available data. In theory, this estimation is a sole matter of multiplication:

$$HHW_t = HS_t \cdot \overline{A}_t \cdot \overline{PH}_t$$

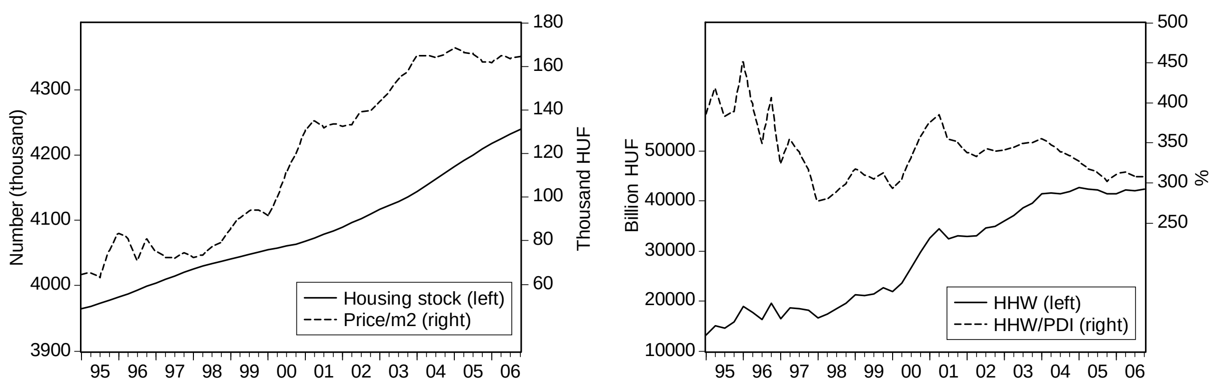
where *HHW*, *HS*, $\bar{A}$ and $\overline{PH}$ denote households' housing wealth, number of apartments, i.e. housing stock, average apartment size and average price per square meter. The challenging issue is to obtain these data.

As for the housing stock, the initial point is the censuses of number of flats and houses in Hungary. Theses surveys were conducted by Hungarian Central Statistical Office (HCSO) in 1990 and 2003. Using the quarterly statistic of finished constructions and demolitions of dwellings the missing stock data between and after these dates can be computed. Fortunately, the average apartment size is also published by HCSO.

As for average price per square meter, it is difficult to obtain applicable price. HCSO publishes a yearbook on house prices starting from 1997; however, this contains square meter prices only for those streets where at least three real estates have been sold. These data are based on the official record of Hungarian Duties Office. Since only the county-level housing stocks are available, average house price time series has to be created. Using the unprocessed HCSO data the necessary aggregation can be done in two steps. First, erroneous records have to be filtered out. We consider a record valid if the size of the flat is between 20 and 600 square meter *and* its price is between 1 and 600 million HUF *and* the square meter price is between 50 thousand and 1 million HUF. Note that all of the three conditions used simultaneously can identify the problematic records. Second, average house prices are calculated by rescaling the county level transactions with the counties' housing stocks.

With the housing stock in square-meter and the calculated averaged price per square meter in hand the households' housing wealth and its ratio to their income can be determined (see Figure 2).

Figure 2 Housing wealth and its ratio to annual personal disposable income



where HHW and PDI denote the housing wealth and personal disposable income in current price.

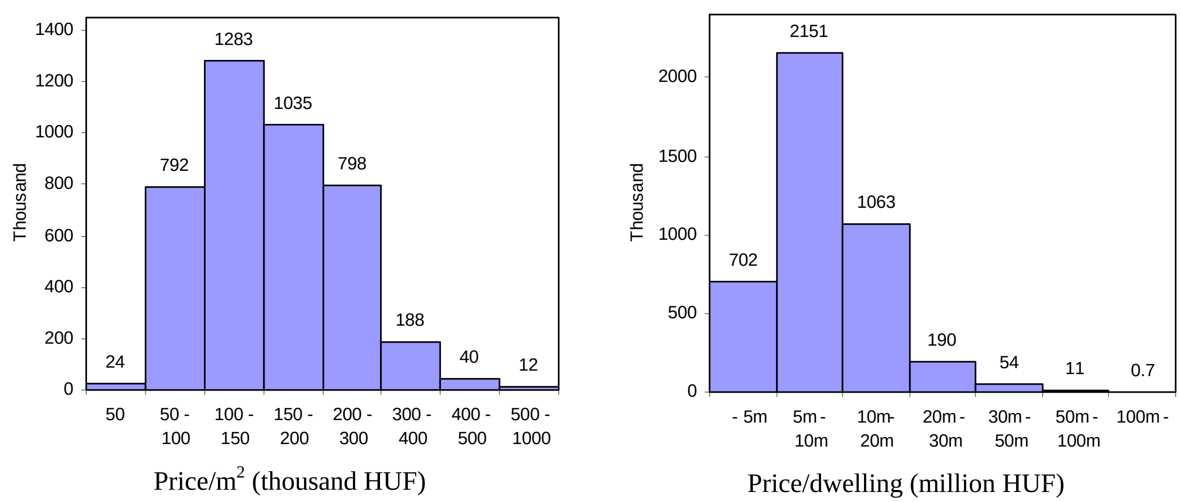
Comparing our results with Zsoldos (1997) estimation for housing wealth in early 90's it is apparent that our estimation is considerably higher. While Zsoldos' approximation is 8000 billion HUF at 1996 price, our figure is nearly 18500 billion HUF in the end of 1996. Unfortunately, his estimation ends at the end of 1996 and our price data are less reliable before 1997. In spite of this, decreasing pattern of real housing wealth in early and mid 90's is presented in both estimations.

Not surprisingly, the housing wealth is significantly higher than financial wealth. Consequently, a relatively moderate shock or adjustment in housing market can dramatically influence the financial saving position. For instance, the saving-miracle in mid

90’s was owing to the portfolio adjustment between financial and housing wealth (see Zsoldos, 1997) and a significant reduction in savings in early 2000’ was induced by governmental housing subsidy scheme (for further discussion see Section IV).

It is also worth elaborating on the distributions of square meter price and housing wealth within a year. According to the left panel of Figure 3 more than one fourth of housing stock is in the relatively low 100-150 thousand forints square meter price range. Skewness is more apparent when one looks at the distribution of housing wealth (see right panel of Figure 3). Less than seven percent of housing stock has higher value than 20 million forints. This dwelling value has a particular interest since in the recent debate of introducing housing tax 20-million-dwelling-value emerged as the possible limit of tax exemption. Note that the average house price did not soar in 2006 (see left panel of Figure 2) hence this distribution is still accurate in 2007. Therefore setting tax exemption limit at 20 million forint is likely to generate minor tax revenue.

Figure 3 Histograms of average house price per square meter and housing wealth (2005)



Another information content of HCSO database, which can reveal interesting aspect of Hungarian housing market, is the number of transactions within regions. In 2005, there were 46.9 thousand sales in Hungary, 38 percent of which took place in Budapest. Comparing the transactions to the housing stocks, the most vivid housing markets were Fejer county, Budapest and Bekes county where 2.2, 2.1 and 1.7 percent of housing stocks have been sold respectively. Nograd, Borsod-Abauj-Zemplen and surprisingly Pest county (obviously excluding Budapest) are at the other end of the line where nearly zero, 0.3 and 0.4 percent of housing stocks have been sold respectively. The large difference between transaction data in Budapest and Pest county implies that the common assumption, namely there is a significant flow from the capital to its agglomeration, at least in 2005[2], is not supported by housing market transaction data.

[2] Nevertheless the same large discrepancy remains true in the whole sample period.

II. 3. The stock of consumer durables

There are two statistics at our disposal that can be exploited to estimate the stock of consumer durables: the current expenditure on durable consumption goods and the number of durable goods per 100-household. Although the latter one could seem promising, data such as there are 50 cars in 100 households is rather insufficient because we have to find average price to every durable branch for all periods. Consequently, we apply a perpetual investment method as in the Hungarian capital stock estimation of Pula (2003), however, we assume that the duration of consumer durables follows a Weibull distribution. Therefore, the stock of these goods is determined by the expenditure on durables multiplied by the survivor function:

$$HDW_t = \sum_{s=0}^{S} C_{D,t-s} \exp\left[-\left(s/\lambda\right)^k\right]$$

where C_D, k, λ and S denote the spending on durable consumption, the shape and scale parameters of Weibull distribution and the scrapping age respectively. Spending on durable consumption is available from 1995 to 2004. Fortunately, the ratio of durable goods expenditure to the entire consumption is reasonably stable. It stays between 14 and 15 percent until 2001 and increases up to 17 percent by 2004. Consequently, we assume 14-percentage share before 1995 and 17-percentage share after 2004. Although PIM requires long time series, due to the poorer quality and comparability problem of statistics before the regime change, we start our sample from 1991.

The average service life and the first-year depreciation assumptions pin down the shape and scale parameters. As vehicles represent the major part of consumer durables the assumption on their average age is essential. Fortunately, HCSO data are available showing that the average age of vehicles was 10.31 in 2006. With assumptions on the other parts[3], the estimated average age of durables is 9.15 year. Knowing that the mean value of Weibull distribution is $\lambda\Gamma(1+1/k)$, where Γ is the gamma function, the scale parameter can be defined by $\lambda=9.15/\Gamma(1+1/k)$. To define the shape we calibrate the first year depreciation to 20 percent based on expertise information. At first glance, it may seem to high, however, the first year depreciation of vehicles, depending on their types, can be even 30-50 percent. As a result $k=0.739$ and $\lambda=7.584$.

As for scraping age, there is no standard statistic to be applied. The only technical data that can be used is again related to cars. Based on general technical specifications the scrapping age of cars, in average, is around 15 years[4]. Assigning scrapping ages to every other

[3] Refrigerator: 5 years, microwave oven: 5 years, washing machine: 8 years, TV: 5 years, CD-DVD player: 2 years, camcorder: 4 years, PC: 2 years and mobile phone: 2 years.

[4] Car engines are generally running at 250-300 thousand kilometers. The average use of cars is 15 thousand kilometers per year, which implies 15 service lifetime.

Table 1 Estimated wealth of Hungarian households

Year	House price/m^2 (thousand HUF)	Wealth (billion HUF)			Wealth (% of personal income)		
		Financial	Housing	Durables	Financial	Housing	Durables
1991	54.1	853	12775		47	701	
1992	57.3	1300	13622		60	634	
1993	57.8	1672	13799		68	559	
1994	62.3	2070	14926		70	505	
1995[a]	67.0	2652	14644		71	394	
1996	79.0	3519	18114		78	400	
1997	73.5	4536	17887		84	333	
1998	75.5	5744	17989		91	286	
1999	90.9	6898	21554		100	311	
2000	105.3	8126	25457		103	323	
2001	132.6	9175	33102		102	366	
2002	136.1	10205	33862		102	338	
2003	150.9	10757	37793		98	346	
2004	164.6	11451	41545		95	344	
2005	165.5	12854	42148	8617	96	314	64
2006	163.6	13821	41983	9363	102	309	69

a) The dynamics of house price and housing wealth estimation before 1995 is based on Zsoldos (1997) in which the house prices were proxied by the market value of apartments sold by local governments. Data are in current price.

durable branch the average scrapping age becomes 13.8 year. In the time of scrapping, the value of durable goods is less than 20 percent of the original value.

Using the above-defined parameters the estimated stock of consumer durables is 8617 and 9363 billion HUF in 2005 and 2006 respectively, which is between 64 and 69 percentage of annual disposable income. In order to obtain an approximate cross-check estimation the number of durable goods per 100-household can be applied by assigning average price to every durable branch. Using expertise price estimations the stock is in line with the PIM method.

II. 4. International comparison and steady state wealth ratios

Previous section revealed the wealth level of Hungarian households, however, it is unexplored so far whether a country wealth level is at its equilibrium or is expected to soar or decline. There are two frequent approaches to conduct empirical evaluation on this issue: cross-country comparison and econometric methods.

The use of cross-country data reveals the relative wealth position of different counties, which might identify whether a country or its wealth element is far from the international experience. Table 2 displays the related values of G7 countries and Hungary. In addition, we also display Portugal as it is generally considered as the most similar country to Hungary.

Table 2 International comparison of households' wealth (2003)

as a percentage of disposable income							
Net financial wealth		Housing wealth		Durable goods		Total wealth	
Country	Ratio	Country	Ratio	Country	Ratio	Country	Ratio
Japan	369	Italy	477	Japan	158.7	Italy	903
USA	294	UK	381	Italy	142.6	Japan	744
Italy	283	**Hungary**	**346**	UK	72.4	UK	703
UK	249	France	318	Canada	71.0	France	585
France	233	Germany	268	Germany	70.0	USA	540
Canada	226	Portugal	226	USA	61.2	Canada	519
Germany	169	Canada	222	**Hungary**[a]	**60**	Germany	507
Portugal	155	Japan	216	France	33.7	**Hungary**	**504**
Hungary	**98**	USA	184.0				

financial wealth elements as a percentage of net financial wealth							
Shares & Equitiy [b)]		Mutual funds		Loans		Mortgage	
Country	Ratio	Country	Ratio	Country	Ratio	Country	Ratio
USA	38.0	Italy	17.0	Portugal	73.1	Germany	43.3
France	25.9	Germany	12.0	Germany	66.4	UK	41.0
Portugal	21.0	France	10.0	UK	55.6	Canada	32.2
Italy	18.0	USA	10.0	USA	39.9	USA	28.4
UK	11.0	Portugal	9.0	Japan	36.4	Portugal	28.2
Germany	10.0	**Hungary**	**7.6**	Canada	36.1	France	24.9
Japan	9.0	Canada	6.3	France	32.7	Japan	16.8
Hungary	**7.3**	UK	5.0	**Hungary**	**28.0**	Italy	11.5
Canada	6.9	Japan	2.0	Italy	18.0	**Hungary**	**11.3**

Sources: Annex to OECD's Economic Outlook (December 2005), Cardoso and Cunha (2005), Eurostat, Magyar Nemzeti Bank, Statistic Canada and own calculations.
a) Based on expertise judgment.
b) Excluding mutual funds.

As for net financial wealth concern, since Hungarian institutional environment is likely to be closer to German system than Anglo-Saxon system we can conclude that the ratio of financial wealth is expected to increase in the future, however, it is not possible to increase rapidly and reach the UK or US level. As for the elements of financial wealth concerns, it is worthy to outline that the share of mutual funds, liabilities and mortgage loans have increased significantly since 2003. These ratios soared to 12, 46 and 19 percent respectively by the end of 2006, consequently, attained at internationally standard share relative to net financial wealth. However, since the ratio of net financial wealth to income has not increased, the proportions of these wealth elements relative to income are still low.

Contrary to net financial wealth, housing wealth seems to be high relative to other countries. The level of housing wealth became more extraordinary if we consider the ratio of housing wealth to financial wealth, which is 3.5 in Hungary, meanwhile the next closest value is 1.6 in Italy. Assuming that the financial wealth ratio converges to the German level and housing wealth stays still, Hungarian housing per financial wealth ratio still remains to be the highest. This relative wealthiness could have a serious implication on how housing wealth react to the government subsidy scheme.

The other and more formal empirical approach to examine the equilibrium wealth level is the application of econometric methods. Generally, to detect significant deviation from steady state wealth ratio, this methodology applies error-correction model (ECM) between financial wealth and households' income. The equilibrium is attained when the error correction part is zero. Consequently, this method seeks the wealth level that makes the long-run part equal zero at a certain income level.

Justification of such an approach could come from ECM-type consumption functions. Incorporating financial wealth in consumption function is widespread, for instance see Muellbauer and Lattimore (1995), Fagan *et al* (2001) among others. After housing market booms in some countries it became inevitable that financial wealth is not sufficient to explain the wealth effect on consumption. As a result, many macro models and analysis, such as Girouard and Blöndal (2001), Case et al (2005) and Paiella (2007), incorporate housing wealth into consumption function. Under the assumption of long-run homogeneity the ECM-type consumption ensures stable consumption/income and wealth/income ratios. Therefore, the above-described direct estimation between wealth and income seems to provide appropriate results.

Nevertheless, this direct methodology leaves out an important factor, namely, the ECMs are dynamic models, hence, extracting the long-run part as static equation rules out additional information. It can be shown that not only the level of income but also its growth rate determines the steady state consumption/income and wealth/income ratios (for details see Appendix). More precisely, the steady-state wealth/income ratio is negative function of the income growth rate.

In order to be able to calculate steady state wealth ratios we apply the Quarterly Projection Model of MNB (Benk et al, 2006) parameters for consumption function defined in equation (A-1). Table 3 displays the solution to the steady state wealth rate based on equation (A-10).

In line with the international comparison, Table 3 also indicates that the recent financial wealth level of Hungarian households is still relatively low. Based on the range of estimations the ration of financial wealth to income is likely to converge to the Portugal or German values, which is around 1.5.

Another important implication is in connection with the financial savings rate (NFS/PDI). This estimation underpins the suggestion of Zsoldos (1997), namely the so-called saving miracle in the mid '90s was merely induced by the reallocation between housing and financial wealth. Consequently, unless another significant shock occurs, it is unlikely to experience financial savings rate higher than 10% again.

Table 3 Steady state wealth ratios and financial savings rates at 1% annual depreciation[5]

g	Financial wealth only in cons. equation				Financial and housing wealth in cons. equation			
	HFW/PDI	NFS/PDI	HHW/PDI	HI/PDI	HFW/PDI	NFS/PDI	HHW/PDI	HI/PDI
1	136	1.4	108	1.1	205	2.0	162	1.6
2	126	2.5	197	2.0	148	2.9	231	2.3
3	117	3.5	271	2.7	121	3.6	280	2.8
4	110	4.3	335	3.4	104	4.1	318	3.2

Results are in percentage points. *g*, *NFS* and *HI* denote the annualized growth rate of income, net financial savings and housing investment respectively.

Contrary to the financial wealth, where every equilibrium wealth ratio is higher than the actual one, the current share of housing wealth is not evidently below the equilibrium level. Again, the importance of this result is essential when we evaluating whether the governmental subsidy scheme can enhance housing supply.

III. Methodology of the analysis

Before we turn to the detailed examination of households' wealth, it is straightforward to outline both the empirical and theoretical methodologies to be invoked.

III. 1. Detection of structural breaks

Two main questions occur when one tends to examine portfolio decisions. First, how the levels of wealth elements are evolving. Second, whether the relative shares of wealth elements to each other are stable or not. To address this issue we rephrase the question and seek the answer whether the time series of wealth elements contain structural breaks, if so, how many there are and where they are.

Several tests have been proposed to test structural breaks, for instance, Wu (2004), Juhl and Xiao (2005), and Wu and Zhao (2006) among others. Bai and Perron (1996, 2003) suggest a set of tests that provides appropriate methodology to examine the presence, the number and the locations of structural break. In order to obtain answers to the above-described question we will apply the following tests among the Bai-Perron tests.

Double maximum test can be applied when the main interest is the existence of structural breaks regardless of their number and the locations. More formally, double maximum method tests the null hypotheses of no structural break against an unknown number of breaks. The basic intuition behind the test is to find the maximum of F-type statistic given the maximum number of breaks while the estimation of break points comes from the global minimization of sum of squared residual. There exist unweighted and weighted double maximum test in which the individual F tests are weighted to obtain equal marginal p-values across of the number of break points. In the succeeding empirical analysis, we are

[5] Gauss program for computing steady state ratios is downloadable from www.vadasg.extra.hu/codes.html

going to use the weighted version of double maximum test denoted by *WD*max. The other test we invoke is the no structural break versus ℓ break points test, which helps to identify the number of breaks and their location.

An important aspect of testing procedure is to assess the possible number of break points. General concern about structural break test is that the numerous break points may result too short time interval span. The design of Bai-Perron test ensures that the two break points cannot be too close to each other by terminating the increase of the number of breaks.

Another relevant note is that special care should be given when these test statistics are used to evaluate whether the wealth allocation of households is stable or not. If the share of a wealth element is continuously changing along a linear trend then the above-described tests indicate no structural change. To put it differently, the rejection of no structural breaks in favor of structural breaks is a clear indication of altered wealth allocation. Contrary, the acceptance of null hypothesis of no structural break could imply both stable wealth share and linearly increasing or decreasing proportion. Consequently, 'visual inspection' remains a crucial part of our analysis.

III. 2. A simple model of housing market

The above outlined empirical tests help to identify whether data reveal any significant changes or patterns that we expect based on intuitions. If so, it is worth checking whether there is any theoretical explanation for these results. If not, it is essential to find theoretical underpinnings why our expectations are not detectable in the data. Consequently, the following part establishes a modeling framework in which the empirical findings can be put into economics perspective.

The most substantial effect on Hungarian housing market was the governmental subsidy scheme so Poterba (1984) model that is designed to analyze such subsidies is an appropriate baseline framework. Two basic equations are the no-arbitrage condition, i.e. the return on real and financial assets are equal, and the transition equation of housing stock (*HS*):

$$\Delta PH_{r,t+1} = (r_t + \delta)PH_{r,t} + \tau_t - R(HS_t) \quad (1)$$

$$HS_{t+1} = (1-\delta)HS_t + \Psi(PH_{r,t}) \quad (2)$$

where PH_r, τ and δ denote the real or relative house price, the tax on housing and the depreciation of housing stock. Since Hungarian housing subsidy scheme supports households by the use of interest rate subsidy, I denote this subsidy by *rs*.

In addition, two points are worthy of note. First, this setup pays no attention to the effects of housing market on the other aspects of households' decision problems. House prices also affect consumption expenditure, see for instance Shiller (2004), Carroll et al (2006), and hence financial savings. Second, the assumption of the model is that $\Psi(.)$ is increasing in its only argument, i.e. house price.

Note that these omitted factors can be taken into account by the extension of $\Psi(.)$ function. There are two channels through which house price influences the start of new construction. The one is the above-mentioned substitution effect between housing and consumption.

Apparently, higher house price induces shift toward consumption, therefore, reduces the gross savings, which is the sum of financial saving and dwelling investment. The other channel is how the return on housing, which is influenced by house price, affects the households' portfolio allocation between financial saving and dwelling investment. The higher the change in house price the more excess return can be realized on real assets, therefore, dwelling investment becomes more attractive. Based on this line of reasoning the model can be reformulated the following way:

$$\Delta PH_{r,t+1} = (r_t + \delta)PH_{r,t} - rs_t - R(HS_t) \qquad (1')$$

$$HS_{t+1} = (1-\delta)HS_t + \eta(g_{PH,t}, r)(PDI_{r,t} - C_t)/PH_{r,t} \qquad (2')$$

where g_{PH} denotes the growth rate of house prices. Evidently, the transition equation of financial wealth (HFW_r) is:

$$HFW_{r,t+1} = (1+r)HFW_{r,t} + \left[1-\eta(g_{PH,t}, r)\right]\ (PDI_{r,t} - C_t) \qquad (3)$$

In order to close the model, one should note that the housing wealth, as it has consumption value through housing service, enters in utility function. The use of wealth elements in utility function is also underpinned by Bruce et al (2004) estimation. Assuming CES utility function we obtain $U(C,HS) = \left(C^{(\sigma-1)/\sigma} + H^{(\sigma-1)/\sigma}\right)^{\sigma/(\sigma-1)}$, where C and σ denote the consumption expenditure and the elasticity of substitution, consequently:

$$\ln\left(\frac{C_t}{HS_t}\right) = \sigma \ln\left(PH_{r,t}\right) \qquad (4)$$

Note that $\partial\eta/\partial PH_r > 0$, as in Vadas (2004), implies $\Psi' > 0$ and $\sigma=0$ reduces the extended model to the original Poterba model.

IV. Development of Hungarian households' wealth portfolio

Second main objective of our study, based on the wealth estimations of households and the above outlined methodologies, is to analyze the changes in portfolio shares, and if any, put these results into economics context. There are two main common beliefs in connection with households' wealth. One is linked to the governmental subsidy scheme and the other to EU accession. In the next parts these two events will be examined in greater detail.

Even without any formal test, it is apparent that the trend of financial wealth per income ratio broke around 2000. As it was outlined in the stylized facts, this phenomenon is owing to the expansion of households' liabilities. Structural break tests strengthen this notion (see Table 4). The major breaks of financial wealth/income correspond to the extension of HUF denominated consumption loan, started around the first quarter of 1998, the significant increase in HUF-denominated mortgage loan started around 2000 and the expansion of FX-denominated consumption loan and housing credit since the first quarter of 2003. Whether this extensive spending on housing market induced higher housing supply, i.e. housing stock, will be examined in the following part.

IV. 1. Housing subsidy scheme

Hungarian housing market has been affected by several shocks. The most relevant ones were initiated by government subsidy scheme that has undergone several changes for the last decade. Due to the permanent adjustment of governmental support system it is not feasible to list all the modification, hence, we outline only the major changes:

In 1994, households were eligible to apply for interest-subsidy up to 2.8 million HUF loan value in the case of new house construction and 0.6 million HUF in other cases. In addition, the social subsidy based on the number of children increased, namely, households entitled for 0.2, 1.2 and 2.2 million HUF per one, two and three children respectively. Any additional child increased the financial support by 0.2 million HUF. In January 1999, the ceiling of loan value increased from 0.6 million to 1.2 million HUF. In February 2000, subsidy scheme was extended to reconstruction and second-hand housing market. Loan-ceiling increased to 30 million HUF. In the same year, government introduced an additional interest subsidy up to 10 million HUF in August. The maximum duration of subvention was 10 years. In 2001, the so-called ‘half social subsidy’ was established, which was the half of the financial support of the ‘normal’ social subsidy. In March 2002, government increased the maximum duration of subvention to 20 years.

By 2003, due to the enormous raise in new housing loan, it became evident the subsidy scheme was not sustainable. Tightening measures primarily attempted to cut the budget expenditures on interest rate subsidies. Given the lower subsidies for the new loans, banks’ profit margins declined, parallel with the significant increase in the interest burden of households. Furthermore, the changes to the subsidy scheme gave rise to two new features: mortgage rates became partly linked to market rates, and the difference between subsidies for new and existing housing widened from 1 to around 3 percentage points.

The latest major revision of housing subsidy scheme took place in February 2005. The loan-ceiling in the case of new house construction has been reduced to 15 million if the property is situated in Budapest or other capital of counties and 12 million in the case of any other location. Meanwhile the loan-ceiling in second-hand housing market became 15 million if the property is situated in Budapest or other capital of counties and 12 million in the case of any other location.

Supporters of governmental housing subsidy scheme argue for this program based on the claim that it increases the housing supply. Turning to the empirical tests this argument is not supported since there is no significant structural break in housing stock since 1993. Without any particular theoretical elaboration, two points should be noted. First, as we described above, it is uncertain whether the relative housing wealth is below its equilibrium level or not. If it is not then promoting housing market does not increase housing stock. Second, housing stock, hence housing supply, is entirely inelastic in short-run. Introduction of housing subsidy scheme increases the demand which, given fix housing stock, raises the house prices only in short-run. This effect is well recognizable from the test results of house prices.

Table 4 Structural breaks of wealth elements

	WDmax	Number of breaks F(ℓ | ℓ =0) at			Locations of breakpoints
		10%	5%	1%	
income	break(s)	5	5	5	1996:q3, 1998:q1, 2000:q2, 2002:q2, 2004:q1
financial wealth/income	break(s)	3-5	3-5	3-5	1996:q2,1997:q3, 1999:q2 2000:q4, 2003:q2
stocks	break(s)	3-5	3-4	3	1994:q3, 1997:q1, 2000:q4
consumption loan (HUF)	break(s)	4-5	4-5	4-5	1992:q1, 1995:q3, 1998:q1, 2000:q3, 2003:q1
mortgage loan (HUF)	break(s)	2,4-5	2,4-5	2,4-5	1993:q1, 1995:q2, 1997:q3, 2000:q4, 2003:q1
housing stock	no break	0	0	0	-
house prices	break(s)	2-5	2-5	2-5	1996:q3, 1999:q1, 2000:q3, 2002:q2, 2003:q4
housing wealth	break(s)	1-5	1-5	1-5	1996:q3, 1999:q1, 2000:q3, 2002:q2, 2003:q4
income	break(s)*	5	5	5	1996:q3, 1998:q1, 2000:q2, 2002:q2, 2004:q1
house prices /income	break(s)	1-5	1-5	1-5	1996:q2, 1997:q4, 2000:q2, 2001:q4, 2004:q2
housing wealth /total wealth	break(s)	1-5	1-5	1-5	1996:q2, 1997:q4, 2000:q3, 2002:q4, 2004:q2

The main house price increase between 1998 and 2003 is underpinned by the estimated location of structural breaks. Besides, we found a structural break around the third quarter of 2000, which can refer to the extension of subsidy scheme to second-hand housing market. Since in that market the supply is definitely fix the only effect is the increase in housing price. Although increasing income could also induce soaring house prices, however, in our case the ratio of housing wealth and prices to income also shows a significant break in 2000 implying that the governmental subsidy scheme considerably increased house prices. Given that housing wealth is the multiplication of housing stock and house prices it is apparent to observe the same structural breaks in housing wealth as in house price.

To verify these empirical results and to obtain more structural analysis of households we estimate the parameters of the above described theoretical framework on Hungarian data (see the estimation details in the Appendix). Nevertheless, two modeling details have to be established. First, the governmental subsidy scheme, as it was outlined, has altered continuously. Setting that number of shocks would render the evaluation of impulse responses cumbersome. Since the most significant effect on housing market was the extension of subsidy scheme to the second-hand housing market in 2000, besides this was the year when the mortgage loan began to soar, the model is shock by a permanent decrease in mortgage rate started at 2000:q1. Second, in order to gain practical use of the model, the impulse response functions and the data have to be comparable. As there is only one observation for real data, it is challenging to generate 'real' data without shocks, i.e. baseline data of house prices, housing stock, consumption and financial wealth.

As for house prices, the main factor in inverse demand function is the housing stock, mortgage rate, disposable income and population. Two out of four demand shifters, namely personal disposable income and population, are assumed to be unaffected by housing subsidy scheme.[6] Since house price can react to any shocks immediately, the effect of housing stock and mortgage rate can be filled out by keeping the ratio of house price to disposable income times population constant at its 2000:q1 level. To put it differently we assume that if the subsidy scheme had not been introduced every fluctuation in house prices would have been caused by the variations of disposable income and population. Consequently, any change in house price/income×population relative to its value in 2000:q1 is resulted by the subsidy scheme that alters the housing stock and mortgage rate.

Since the housing stock adjusts sluggishly the above trick cannot be applied. A possible way to generate baseline 'fact' would be to set up an empirical equation in which the right hand side variables contains income, population etc. and generate forecast with unaltered mortgage rate. Unfortunately, in this approach we implicitly reformulate the model; therefore, instead of baseline 'fact' we obtain the baseline of the model. Consequently, only univariate methods are applicable so the most common approach, HP filter, is invoked. The apparent caveat of HP filter is that it overestimates trend values when the sample ends in positive cyclical phase. To control this phenomenon we estimate a simple linear time trend up to 1999:q4 and generate out-of-sample forecast. Obviously, the forecasted trend values are seriously underestimated as the substantial increase in income growth since 2000 is completely omitted. Nevertheless, the two cyclical components depict reasonably same pattern hence we use the HP filtered values.

Although the consumption expenditure, due to habit formation, may not adjust as fast as house prices do, however, similar approach is justifiable. The main demand shifters of aggregate consumption are real income, financial and housing wealth. Among these factors only income is unaltered by housing subsidy scheme, therefore, any change in the ratio of consumption to income relative to its value in 2000:q1 is considered as the effect of subsidy scheme on consumption.

Finally, the baseline 'fact' of financial wealth has to be identified. Fortunately, as the lower-right panel of Figure 1 clearly reveals, the stagnation of financial wealth/income is owing to the extension of housing loan. So we assume that households' saving behavior remain the same as it was before 2000 and the ratio of financial wealth to income converges

[6] High owner-occupancy rate in Hungary implies minuscule income from rental fees hence house price fluctuation alters the disposable income marginally.

to the Portugal value, i.e. 150 percentage. This convergence path implies 126 percent financial wealth per income ratio at the end of 2006.

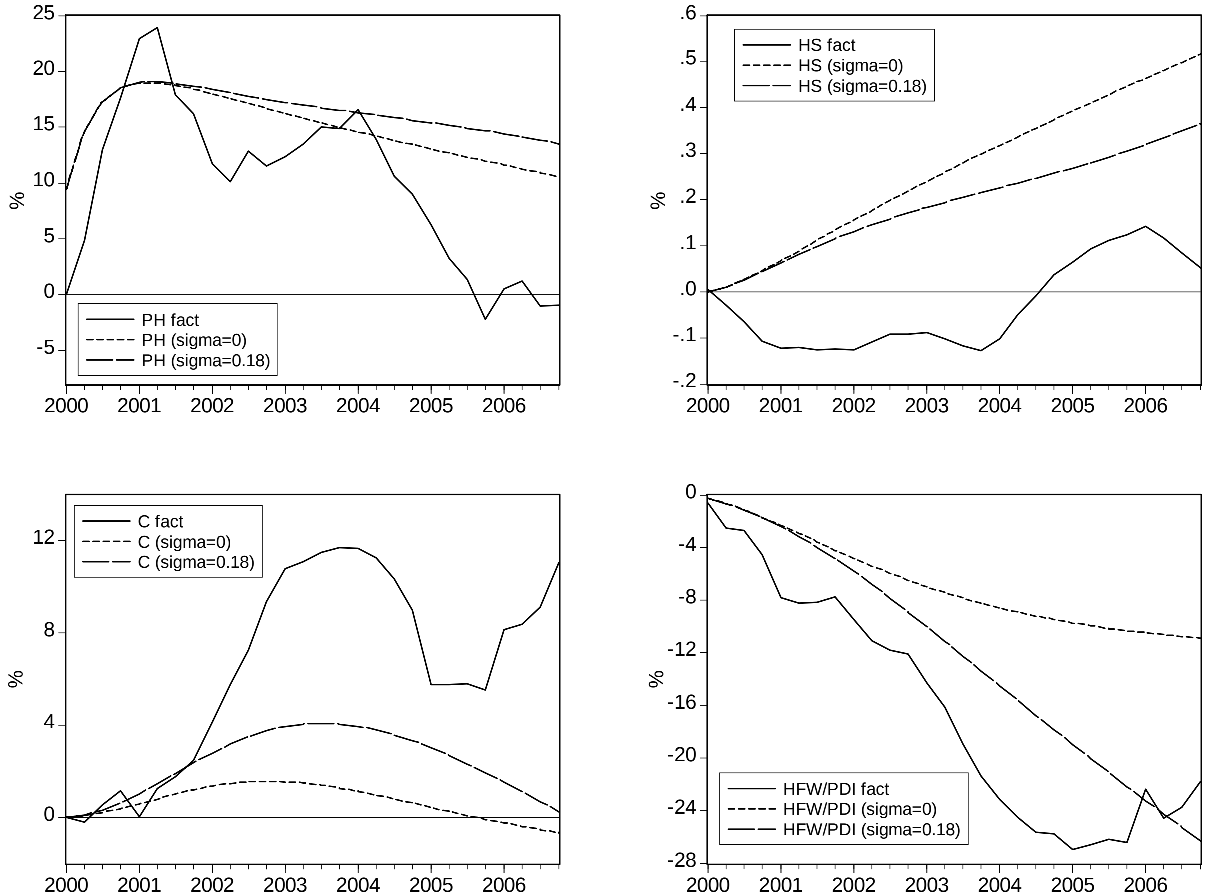
With the ‘fact’ baseline in hand the ‘fact’ impulse response can be computed. The impulse response of the model is based on 5 percentage point permanent decrease in mortgage loan rate, which is a reasonable proxy for the difference between unsupported and supported interest rate of housing loan.

Throughout the simulation exercise, we compare the ‘facts’ and two model results: in which there is no substitution between consumption and housing (σ=0) that is the Poterba (1984) model and in which σ=0.18. Both ‘facts’ and simulated house prices display a clear pattern of overshooting. Obviously, in the case of no substitution effect, all government subsidy remains in housing market inducing more dwelling investment and hence higher housing stock, which in turn, reduces the housing price in faster pace. The moderate response of housing stock is owing to the high level of hosing wealth. Note that even such a considerable price increase induces feeble response in housing stock in short-run. In addition, even though that generous subsidy scheme had been maintained the long-run increase in housing stock would have been 1 percent higher only[7]. Convergence to the new equilibrium level would have taken 41 years while the half-life is 9 years. Accompanying this slow adjustment with the tightening of subsidy scheme at the end of 2003, which is clearly recognizable in ‘fact’ house prices, it is not surprising why empirical test did not reveal any significant increase in housing stock.

Housing subsidy scheme definitely influenced both consumption and financial saving decisions. As for consumption, the original Poterba does not suggest anything about consumption, however, it would be unreasonable to assume complete independence. Therefore, consumption is allowed to response to wealth effect but we exclude substitution effect. Evidently, more considerable consumption response is observed when both effects are presented. Although, housing subsidy scheme had a significant effect on consumption expenditure it is not enough by itself to explain the consumption boom in Hungary. One of the omitted factors is the households’ perception about their current situations. The considerable upsurge of disposable income in early 2000 probably increased households’ willingness to consume more out of their income and wealth. The high propensity to consume out of wealth is underpinned by simulation results. Even in the presence of substitution effect the simulated financial wealth rates are higher than the ‘facts’.

[7] There is marginal difference in simulation runs in long-run. The discrepancy between the new housing stock levels is within 0.1 percent.

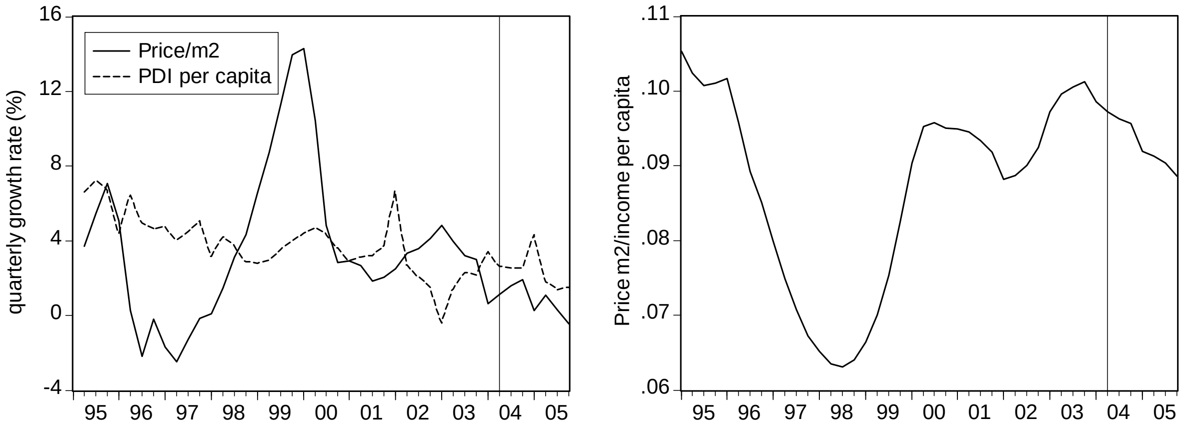
Figure 4 Simulation results



Based on these results we can conclude that the 'saving disaster' experienced in early 2000's, to a certain extend, is the other side of the 'savings miracle' of mid 90's. While in the mid 90's households rearranged their wealth from housing to financial wealth implying decreasing real house prices and housing wealth, from 2000 the increasing demand for housing and soaring house prices, via housing loan, vanished financial savings. Unfortunately, this reallocation did not induce higher housing stock partly because the primary effect, i.e. increasing house prices, absorbed this financial wealth change and partly because it would have required extremely long time to reach the new, otherwise marginally higher, equilibrium level.

Dealing with house prices it is worth examining another urban legend - the EU accession of Hungary boosted/will boost Hungarian house price, which is widespread even among professionals. The effect of EU accession on house prices in a small village somewhere far away from any industrial or touristical sights is clearly ludicrous. Therefore, the finer version of the concept concerns the house prices in the capital of Hungary, Budapest.

Figure 5 Growth rate of house price, income and the ratio of house price to annual income in Budapest



Neither structural break tests nor Figure 5 confirms that EU accession in May 2004 has any effect on house price. House prices and income are decreases by the pace since the beginning of 2003 in Budapest. The same pattern can be observed across Hungary.

V. Summary

The aim of this study was twofold: it estimated the Hungarian households' wealth and challenged the urban legend about households' wealth by evaluating its development in connection with economic events. As far as the first goal concerns, although financial wealth is published by Magyar Nemzeti Bank the housing and durable wealth had to be estimated. According to these approximations, the housing wealth in 2005 is slightly more than three times as high as annual income, meanwhile the durable consumption good wealth is approximately 60 percentage of the annual income. Putting these together with financial wealth the total wealth of Hungarian households is roughly five times as high as annual income. Since the housing wealth is at least three times bigger than the next wealth element, which is the financial wealth, the overall pattern of households' wealth is determined by housing wealth.

Based on the implied equilibrium ratios of ECM form consumption function, it seems the recent wealth level of Hungarian households is still relatively low; as the steady state ratio is around 150 percentage of annual personal income, which is close to German or Portuguese levels. Contrary, the current share of housing wealth is not evidently below the equilibrium level.

Even though the financial asset/income ratio continues to increase along the same trend the households' liabilities have expanded at higher pace since 2000 implying that the ratio of net financial wealth to income remained at the same level since then. It is apparent that the 'saving disaster' experienced in early 2000's, to a certain extent, is the other side of the 'savings miracle' of mid 90's. The governmental housing subsidy scheme increased demand for housing and induced soaring house prices, which, via housing loan, vanished financial savings. The reason for the introduction of governmental housing subsidy scheme was to increase the housing supply. Our results, based on empirical tests and theoretical framework, do not underpin this expectation. First, stimulating a variable that is not below its steady state level is likely to generate moderate effect only. Second, housing stock needs approximately 40 years to attain its new steady state level, however, such a generous subsidy scheme cannot be maintained so long. Dealing with housing market, we examined a frequent anecdote saying the EU accession increases the housing price. In line with economic intuition, this belief is also discarded.

Appendix

A.1 Connection between income growth and equilibrium wealth ratios

There are several approaches how to model households' behavior. Muellbauer and Lattimore (1995) provide a straightforward connection between theoretical and empirical consumption function. Aron and Muellbauer (2006b) argue for the separation of wealth element and several other control variables that are generally omitted from consumption function. However, due to the available sample span, the number of control variables has to be limited hence the applicable consumption function is the following

$$\begin{aligned}\Delta \ln C_t &= -\beta_1(\ln C_{t-1} - \alpha_0 - \alpha_1 \ln PDI_{r,t-1} - \alpha_2 \ln HFW_{r,t-1} - \alpha_3 \ln HHW_{r,t-1}) \\ &\quad + \beta_2 \Delta \ln C_{t-1} + \beta_3 \Delta \ln PDI_{r,t}\end{aligned} \tag{A-1}$$

where C, $PDI_{r,.}$, $HFW_{r,.}$ and $HHW_{r,.}$ denote the consumption, personal disposable income, households' financial and housing wealth in constant price respectively. The two intertemporal budget constraints are the same as in equation (2') and equation (3).[8]

$$HFW_{r,t} = (1+r)HFW_{r,t-1} + (1-\eta_{t-1})(PDI_{r,t-1} - C_{t-1}) \tag{A-2}$$

$$HHW_{r,t} = (1+g_{ph,t})\left[(1-\delta)HHW_{r,t-1} + \eta_{t-1}(PDI_{r,t-1} - C_{t-1})\right] \tag{A-3}$$

where $\eta_t = \eta(g_t, r_t)$ denotes housing investment/gross savings[9], consequently, $1-\eta_t$ denotes the ratio of financial savings to gross savings, therefore $0<\eta<1$. g_{ph} and δ denote the growth rate of house price and the amortization rate respectively. Let g denote the long-run growth rate of potential GDP. As the labor income share is constant in long-run, g also defines the growth rate of personal disposable income, hence $PDI_{r,t} = (1+g)PDI_{r,t-1}$. Expressing C_t from equation (A-1) and dividing by $PDI_{r,t}$ we obtain

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[8] Note that equation (A-3) and equation (2') are equivalent since $HHW_{r,t}=PH_{r,t}HS_t$ and $1+g_{ph,t}=PH_{r,t}/PH_{r,t-1}$.

[9] Gross savings (financial savings plus housing investment) is the difference between income and consumption.

$$\frac{C_t}{PDI_{r,t}} = e^{\beta_1\alpha_0}(1+g)^{\beta_3} \frac{\left(\frac{C_{t-1}}{PDI_{r,t-1}}\right)^{1-\beta_1+\beta_2}\left(\frac{HFW_{r,t-1}}{PDI_{r,t-1}}\right)^{\beta_1\alpha_2}\left(\frac{HHW_{r,t-1}}{PDI_{r,t-1}}\right)^{\beta_1\alpha_3}}{\left(\frac{C_{t-2}}{PDI_{r,t-1}}\right)^{\beta_2}} \frac{PDI_{r,t-1}^{\beta_1\alpha_1+1-\beta_1+\beta_2+\beta_1\alpha_2+\beta_1\alpha_3}}{PDI_{r,t}PDI_{r,t-2}^{\beta_2}} \quad \text{(A-4)}$$

Let $\gamma_t = C_t / PDI_{r,t}$, $\omega_{f,t} = HFW_{r,t} / PDI_{r,t}$ and $\omega_{h,t} = HHW_{r,t} / PDI_{r,t}$ [10], use that, and suppose that $\exists\, \gamma = \lim_{t\to\infty} \gamma_t$, $\exists\, \omega_f = \lim_{t\to\infty} \omega_{f,t}$ and $\exists\, \omega_h = \lim_{t\to\infty} \omega_{h,t}$, then we get from equation (A-4) that

$$\gamma = e^{\beta_1\alpha_0}(1+g)^{\beta_2+\beta_3-1+\beta_1(\alpha_1+\alpha_2+\alpha_3-1)} \gamma^{1-\beta_1} \omega_f^{\beta_1\alpha_2} \omega_h^{\beta_1\alpha_3} \quad \text{(A-5)}$$

Due to the long run homogeneity we may restrict $\alpha_1 + \alpha_2 + \alpha_3 = 1$ and based on Vadas (2004) we impose $\beta_2 + \beta_3 = 1$. In this case equation (A-5) simplifies to the following form:

$$\gamma = e^{\alpha_0} \omega_f^{\alpha_2} \omega_h^{\alpha_3} \quad \text{(A-6)}$$

Now turn to the intertemporal budget constraint of financial wealth, the equation (A-2) can be rearranged:

$$\frac{HFW_t}{Y_t} = \frac{1}{1+g}\left[(1+r)\frac{HFW_{t-1}}{Y_{t-1}} + (1-\eta_{t-1})\left(1-\frac{C_{t-1}}{Y_{t-1}}\right)\right]$$

With γ_t and $\omega_{f,t}$ as above we have:

$$\omega_{f,t} = \frac{1}{1+g}\left[(1+r)\omega_{f,t-1} + (1-\eta_{t-1})(1-\gamma_{t-1})\right]$$

In addition to $\exists\, \gamma = \lim_{t\to\infty} \gamma_t$ and $\exists\, \omega_f = \lim_{t\to\infty} \omega_{f,t}$ suppose that $\exists\, \eta = \lim_{t\to\infty} \eta_t$, thus we get

$$\gamma = 1 - \frac{g-r}{1-\eta}\omega_f \quad \text{(A-7)}$$

Before applying the same procedure to the budget constraint of housing wealth (equation (A-3)), based on Kiss and Vadas (2005), we assume that $g_{ph}=g$. As a result we obtain

[10] One should note the difference between ω and generally displayed HFW_r/PDI_r ratio. ω means the ratio of the stock of financial wealth to income no matter whether they are annual or quarterly data. Meanwhile, the ratio of wealth to income is generally considered as a ratio of wealth to the annualized income.

$$\gamma = 1 - \frac{\delta}{\eta}\omega_h \qquad \text{(A-8)}$$

From equation (A-7) and (A-8) it is apparent that

$$\frac{\omega_f}{\omega_h} = \frac{1-\eta}{\eta}\frac{\delta}{g-r}$$

Consequently, $\omega_h = \omega_f \, \eta(g-r)/((1-\eta)\delta)$ hence equation (A-6) has the following form

$$\gamma = e^{\alpha_0}\left(\frac{\eta}{1-\eta}\right)^{\alpha_3}\left(\frac{g-r}{\delta}\right)^{\alpha_3}\omega_f^{\alpha_2+\alpha_3} \qquad \text{(A-9)}$$

Combining equation (A-7) and (A-9) yields

$$1-\frac{g-r}{1-\eta}\omega_f = e^{\alpha_0}\left(\frac{\eta}{1-\eta}\right)^{\alpha_3}\left(\frac{g-r}{\delta}\right)^{\alpha_3}\omega_f^{\alpha_2+\alpha_3} \qquad \text{(A-10)}$$

Note that if there is no housing wealth in consumption function (α_3=0) the problem is simplified to $1-(g-r)/(1-\eta)\omega_f = e^{\alpha_0}\omega_f^{\alpha_2}$ and all the following results remain true.

To find the relation between ω_f and g rewrite equation (A-10) as

$$F(g,\omega_f) = e^{\alpha_0}\left(\frac{\eta}{1-\eta}\right)^{\alpha_3}\left(\frac{g-r}{\delta}\right)^{\alpha_3}\omega_f^{\alpha_2+\alpha_3} + \frac{g-r}{1-\eta}\omega_f - 1 = 0$$

Let $\omega_f = f(g)$, then we get $F(g,f(g))$=0. Differentiating with respect to g and expressing $f^{'}(g)$ yields

$$f^{'}(g) = -\frac{\partial F/\partial g}{\partial F/\partial \omega}$$

It is apparent that the first derive of $f(g)$ is negative, which means that ω_f is decreasing function of g, if $\partial F/\partial g$ and $\partial F/\partial \omega$ have the same sign.

$$\frac{\partial F}{\partial g} = e^{\alpha_0}\alpha_3\left(\frac{1}{\delta}\right)^{\alpha_3}\left(\frac{(1-g)(g-r)}{1-\eta}\right)^{\alpha_3-1}\left(\frac{\eta(1-\eta)+\eta_g'(g-r)}{(1-\eta)^2}\right)\omega_f^{\alpha_2+\alpha_3} + \frac{(1-\eta)+\eta_g'(g-r)}{(1-\eta)^2}\omega_f$$

To define the sign of this expression we invoke the result of Vadas (2004), namely $\eta(.)$ is increasing in the excess return on dwelling investment, implying $\eta'_g = \partial\eta(g,r)/\partial g > 0$ and $\eta'_r = \partial\eta(g,r)/\partial g < 0$. These results are also reinforced by our estimation presented in the next section. Since $\eta'_g > 0$ it is apparent that $\partial F/\partial g > 0$.

$$\frac{\partial F}{\partial \omega} = (g-r)/(1-\eta) + e^{\alpha_0}\left[\eta/(1-\eta)\right]^{\alpha_3}\left[(g-r)/\delta\right]^{\alpha_3}(\alpha_2+\alpha_3)\omega_f^{\alpha_2+\alpha_3-1} > 0$$

therefore $f^{'}(g) < 0$, hence ω_f is decreasing function of g.

As for the ratio of two wealth elements concerns, the steady state ratio of housing wealth is also increasing relative to financial wealth as g is increasing, since $\partial(\omega_f/\omega_h)/\partial g = (-\eta'_g\delta(g-r)-(1-\eta)\delta\eta)/(\eta(g-r))^2 < 0$.

Worthy of note is how interest rate affect steady state wealth rate. It is intuitively apparent that it has opposite effects. As the interest rate increases, the attractiveness of dwelling investment relative to financial savings decreases implying ω_f is increasing function of g. Formally:

$$\frac{\partial F}{\partial r} = -e^{\alpha_0}\alpha_3\left(\frac{1}{\delta}\right)^{\alpha_3}\left(\frac{(1-g)(g-r)}{1-\eta}\right)^{\alpha_3-1}\left(\frac{\eta(1-\eta)-\eta'_r(g-r)}{(1-\eta)^2}\right)\omega_f^{\alpha_2+\alpha_3} - \frac{1-\eta-\eta'_r(g-r)}{(1-\eta)^2}\omega_f < 0$$

which yields $f^{'}(g) > 0$. As for the ratio of financial wealth to housing wealth, $\partial(\omega_f/\omega_h)/\partial r = ((1-\eta)\delta\eta-\eta'_r\delta(g-r))/(\eta(g-r))^2 > 0$, hence the steady state ratio of financial wealth is increasing relative to housing wealth as r is increasing.

There are two important caveats that should be outlined. First, growth rate has to be higher than the interest rate, otherwise the saving rate would have to be negative in order to obtain stable wealth ratios. Second, growth and interest rate are treated as exogenously given. The effect of interest rate on potential GDP growth and hence personal disposable income, however, is far beyond of the scope of the paper.

A.2 Estimation of model parameters

The following part outlines the estimation procedure of the model parameters described in Section III. 2. As for house price equation, we follow the specification of Cameron at al (2006) in which the housing price is obtained as the inverse demand function where the demand for housing is equated to the housing supply (*HS*, i.e. the number of dwellings). Since the demand function comprises real disposable income (PDI_r), real house price (PH_r), interest rate (r), population (*POP*) and other demand shifters (d) the house price equation has the following form:

$$\ln(PH_r / POP) = \phi_1 \ln(HS / POP) + \phi_2 \ln r + \phi_3 \ln(PDI_r / POP) + \boldsymbol{\varphi}\mathbf{d} \qquad \text{(A-11)}$$

The evolution of housing stock is described by the equation (2') in which the start of new house construction is a highly non-linear function of economic factors. Since our data set comprises roughly ten years the estimation of such a complex non-linear function would not be reasonable. Instead of that, we use the following linear model:

$$\ln(I / POP) = \theta_1 \ln(PH_r / POP) + \theta_2 \ln(C / POP) + \theta_3 \ln(PDI_r / POP)$$

Finally, the elasticity of substitution is estimated by the use of equation (4).

$$\ln\left(\frac{C_t}{HS_t}\right) = \sigma \ln\left(PH_{r,t}\right)$$

Instead of estimating the semi elasticity of house price to interest rate I use the pooled mean group estimation of Kiss and Vadas (2007) as their panel data set comprises broader information content. Nevertheless, equation (A-11) yields $\hat{\phi}_2 = -1.12$ with standard error 0.85 implying that setting ϕ_2 to Kiss and Vadas estimation is an acceptable restriction. Unfortunately, similar panel data cannot be constructed for all our variables, therefore, the rest of the parameter estimation is based on time series only. The results are displayed in Table 5.

Table 5 Estimated parameters

Variable	Description	IV	Estimated value	Standard error
ϕ_1	elasticity of house price to housing stock	yes	-8.6	4.71
ϕ_2	semi elasticity of house price to interest rate	yes	-1.8 [a]	-
θ_1	elasticity of new construction to house price	yes	0.88	0.191
σ	elasticity substitution between cons. and housing	yes	0.18	0.073
δ	depreciation rate (quarterly)	no	0.0023	0.0068

[a] PMG estimation of Kiss and Vadas (2007)

Nevertheless, it is worthy of test whether $\partial\eta/\partial p>0$, which is equivalent to Poterba $\partial\Psi/\partial p>0$ assumption ignoring the substitution between consumption and housing. An appropriate functional form is $\exp(\pi_1+\pi_2(g_{ph}-r))/[1+\exp(\pi_1+\pi_2(g_{ph}-r))]$. Estimation yields $\hat{\pi}_2 = 3.2$ with 2.05 standard error, therefore $\partial\eta/\partial PH>0$ and $\partial\eta/\partial r<0$ assumptions are applicable.

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