View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by Clute Institute: Journals

An Extended Measure Of The User Costs Of Housing - New Evidence From The U.S.

Tobias Duemmler, Darmstadt University of Technology, Germany

ABSTRACT

This paper is based on a traditional neoclassical approach to housing investment and our previous work carried out for Germany. In this study we check the relevance if the definition for the user costs of housing should be extended by an additional term which mirrors the credit constraints a household would be faced with for the U.S. economy. This extension term consists of the inflation gap between consumer and house price inflation multiplied with an average loan-to-value ratio and the real house prices. The empirical relevance of our finding is confirmed by a VECM using U.S. data. A time series for the user costs of housing in the U.S. is calculated.

Keywords: Housing Investments; User Costs of housing in the U.S.; Cointegration

1 INTRODUCTION

The housing market plays an important role in all economies. The ECB (2003) for example mentioned three key reasons. First, housing is one of the main parts of the private sector's net wealth. Households' behavior may have serious impacts on aggregate demand. Second, house price bubbles, as have occurred in some countries, play a major role in financial stability and monetary transmission. Third, the housing market with its high transaction costs and non-portable housing-related benefits has an implication for labor mobility, and thus for the supply side of an economy.

The concept of the user costs is important for modeling investment behavior. A classical derivation can be found in Jorgenson (1963). Dougherty and Van Order (1982) applied the concept to housing investment decisions and derived a measure of user costs of housing in a neoclassical environment. This approach was enlarged by Duemmler and Kienle (2010) by lifting the perfect capital market assumption. In their approach the household can only partly finance housing investment by a mortgage; the remainder has to be financed by other liquid funds which imply higher expenditures. Duemmler and Kienle found that the definition of the user costs of housing then should be extended by an additional term consisting of the real house prices, an average loan-to-value-ratio, and an inflation gap defined as the difference between the changes in consumer prices and house prices respectively. The authors checked their results for Germany. Using a Vector Error Correction Model (VECM), they show that the expression term is present in the user costs expression.

This paper focuses on the user costs of housing in the United States. We check if Duemmler and Kienle's enlargement of the user costs expression can be also confirmed using U.S. data. This is done by estimating a VECM. Our sample starts in the first quarter of 1975 and ends in the fourth quarter of 2011. A likelihood-ratio (LR) test suggests that the extension is present in the user costs expression. Based on this LR test we conclude that Duemmler and Kienle's results are supported by the U.S. data. Finally, we calculate and show time series for the user costs of housing.

The remainder of the paper is organized as follows. In Section 2 we briefly show the theoretical model used. In Section 3 econometric analyses are carried out in order to evaluate the relevance of the theoretical derivation for the case of the United States. Section 4 gives a summary and some final conclusions.

2 THEORETICAL MODEL

Duemmler and Kienle (2010) extend the neoclassical approach of Dougherty and Van Order (1982). They derive a theoretical framework containing a credit constraint relevant to the representative household's decision between non-durable consumption and residential investment. This results in an extended version of the user costs of housing (5) which includes - in addition to the basic expression of user costs of housing (6) - a term depending on the inflation gap between consumer prices and house prices, real house prices, and an average loan-to-value ratio. Their argumentation is as follows.

The representative household maximizes life-time utility (1) subject to the real housing accumulation (2), real debt expansion (3), and the real budget constraint (4).

(1) $$\max_{c_t, h_{t+1}} \sum_{t=0}^{T} \rho_t^t u(c_t, h_t)$$

(2) $$h_{t+1} = (1-\delta_t)h_t + x_t$$

(3) $$-s_t = h_{t+1}(1+\pi_{h,t}) - h_t$$

(4) $$y_t - q_t s_t = c_t + q_t x_t + [i_t - \eta(\pi_t - \pi_{h,t})] q_t h_t$$

Thereby $u(c_t,h_t)$ is an instantaneous utility function with u'>0 and u''<0. The consumption of non-durable goods is reflected by c_t. h_t is the use of housing services in period t. ρ_t is a discount rate with $\rho_t=(1+i_t+\pi_t)^{-1}$. i_t is a nominal interest rate, π_t is the consumer price inflation, $\pi_{h,t}$ the house price inflation. The household receives a real income flow y_t and can raise real liquid funds through debt expansion $-s_t$. Both can be spent on consumption goods c_t, gross housing investment x_t affecting housing stock h_t, or interest payments on debt. δ_t is the economic depreciation rate of the housing stock. It consists of technical decay δ_t^{tech} as well as capital gains or losses: $\delta_t= \delta_t^{tech}-(\pi_{h,t}-\pi_t)$. q_t is the price ratio $p_{h,t}/p_t$, i.e. the real house prices. The new element introduced by Duemmler and Kienle (2010) is the introduction of the credit constraint. The nominal housing stock H_t can be financed either by a mortgage loan M_t or by an unsecured credit B_t. The household pays a nominal interest rate $i_{h,t}$ or i_t respectively. A mortgage is covered by housing stock. Only the share of the nominal housing stock η (with $0 \leq \eta \leq 1$) can be financed by this kind of credit. Since the mortgage is cheaper, the household always takes the maximum available share. We have $M_t= \eta H_t$ and $B_t=(1- \eta)H_t$. η also can be interpreted as a loan-to-value ratio for real estate mortgages. Iacoviello and Minetti (2008) expect the ratio to be in a range between 60 and 100 percent.

Optimization of the problem (for details see Duemmler and Kienle 2010) leads to the expression of real user costs of housing (UC_t):

(5) $$UC_t = (1-\eta)q_t(\pi_t-\pi_{h,t})+q_t(i_t- \pi_t+ \delta_t)$$

Depending on the share of mortgage loans (η), user costs of housing ranges between $q_t(i_t- \pi_t+ \delta_t)_{\eta=1}$ and $q_t(i_t- \pi_{h,t}+ \delta_t)_{\eta=0}$. If the full stock of housing can be financed by a mortgage, i.e. η=1, the user costs of housing collapse to the version presented by Dougherty and Van Order (1982). These (basic) user costs without a binding credit constraint are defined as

(6) $$UC_t^B = q_t(i_t- \pi_t+ \delta_t).$$

3 EMPIRICAL ANALYSIS

The theoretical consideration delivers arguments for the presence of an extension term in the expression of the user costs of housing that mirrors the credit constraint a household may be faced with. This paper checks the relevance of the extended version for the U.S. economy. The sample starts in the first quarter of 1975 and terminates in the fourth quarter of 2011.

First, we take a closer look at the extension term. As shown, it depends on the inflation gap between consumer prices and house prices (π_t-$\pi_{h,t}$), real house prices q_t, and the average loan-to-value ratio η which we take as a constant parameter. η is expected to be strictly positive since η=0 implies that no loan is available (irrespective of housing stock pledged as collateral). In Figure 1 we plot the series for the inflation gap and the real house prices.

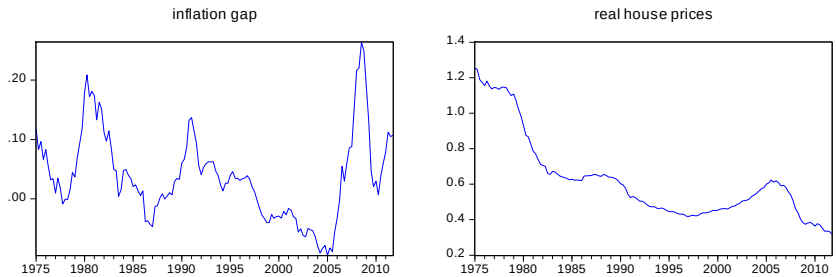

Figure 1: Inflation gap (π-π_h) and real house prices q. Source: Own calculation.

If the inflation gap has a zero mean, i.e. E(π-π_h)=0, the extension term is irrelevant in the long run even if a credit constraint is binding. The mean is 3.6% and the median 3.3% in the sample at hand. The null hypothesis of zero mean can be rejected at the 1% level (t-statistic 2.96, probability 0.004, using Newey-West HAC standard errors and covariance). The real house prices have a negative trend in the sample at hand.

As the second step we set up an econometric model to estimate a long-run equilibrium relationship for housing demand. The econometric analysis is carried out for the U.S. economy. As done for the German case, we include six variables in our model: private residential investment (hi), disposable income (di), financial assets (fa) and liabilities (fl). These variables are divided by the number of households and transformed into logs. Of course, we also include the extension term [q(π-π_h)] and the basic user costs UC^B. A vector z_t'=[hi_t di_t fa_t fl_t q_t(π_t-$\pi_{h,t}$) UC_t^B] is defined. Standard unit root tests indicate that series for hi, di, fa and fl can be regarded as I(1) processes and series for q(π-π_h) and UC^B as stationary I(0) processes.

All variables under consideration are modeled jointly, taking them as endogenous in general. Since most of the time series are nonstationary, we apply the concept of cointegration and use a vector error correction model (VECM) to reveal the relationship between the variables. The model can be written as

$$\Delta z_t = \Pi z_{t-1} + \sum_{\omega=1}^{\mu-1} \Gamma_\omega \Delta z_{t-\omega} + \varepsilon_t \tag{7}$$

where z_t is a set of k given time series variables, μ is the lag order of the underlying vector autoregression (VAR) and Γ_ω are short-run parameter matrices. Under cointegration, the matrix Π has reduced rank r , 0<r< k , and can be written as Π =αβ', where α and ß are (k x r) matrices. The residual ε is a zero mean white noise process with time-invariant positive definite covariance matrix. The matrix ß collects the cointegrating vectors of the system. Thus ß'z_t ~ I(0) can be interpreted as an equilibrium relationship.

It is the conventional practice of choosing the lag order μ by fitting unrestricted VAR(μ) models in levels for the set of lag orders μ=1,2,…, μ_{max}, where μ_{max}=8 in this application. The estimated selected is of the order μ, which minimizes standard information criteria AIC (Akaike 1969, 1971). Table 1 presents the results.

Table 1: VAR lag order selection

Lag	0	1	2	3	4	5	6	7	8
AIC	-11.469	-33.456	-33.979*	-33.807	-33.773	-33.920	-33.889	-33.710	-33.642

AIC suggests to choose lag order μ=2. Therefore we consider a VECM with one lag of the variables in first differences in the analysis that follows (see also Lütkepohl 2007 for details).

Conditional on μ=2, we test for the cointegration rank using the procedures proposed by Johansen (1995). At this stage of the analysis, the vector of endogenous variables does not contain the extension term and the UC^B because they turn out to be I(0). According to the results of the Johansen tests, we conclude that there is exactly one cointegrating relation between the I(1) variables.

Table 2: Test for the cointegration rank: Johansen Trace Test indicates one cointegrating equation at the 0.01 level

Cointegration rank r	Trace Statistic	0.01 Critical Value
r=0**	128.775	60.16
$r \leq 1$	39.279	41.07
$r \leq 2$	11.550	24.60
$r \leq 3$	4.242	12.97

Critical values for the Johansen trace test are drawn from Osterwald-Lenum (1992).
** denotes rejection of the hypothesis at the 0.01 level.

The resulting reduced rank regression of the VECM(2), without imposing restrictions on the cointegrating space, yields the cointegrating relation (standard errors are given in parentheses):

$$\hat{\beta}'z_t = hi_t - \underset{(0.504)}{1.802}\, di_t - \underset{(0.319)}{0.011}\, fa_t + \underset{(1.395)}{0.525}\, fl_t + \underset{(0.930)}{5.078}\, q_t(\pi - \pi_h)_t + \underset{(1.291)}{1.344}\, UC_t^B \tag{8}$$

Regarding possible restrictions imposed on the cointegrating space, we first check the net wealth condition. Because net financial wealth is defined as the difference between financial assets and liabilities, the estimated coefficient should be equal in absolute value. An LR test of this hypothesis is not rejected by the data: $\chi^2(1)$ statistic is 1.159 and thus the probability under the null hypothesis is 0.282. Second, we assume that the extended user costs are weakly exogenous. The LR test statistic $\chi^2(2)$ is 4.094 with a probability of 0.129. The hypothesis of weak exogenity is not rejected by the data. Third, we check for the joint restriction, i.e. weak exogenity together with the net wealth condition. The LR test for binding restrictions delivers a $\chi^2(3)$ value of 4.646 which come together with a probability of 0.200. Thus, the joint restriction on ß and α is not rejected by the LR test either.

As the extension term $q(\pi-\pi_h)$ in the definition for the user costs of housing is the new element, we test for the relevance of this term within the estimated VECM. Therefore we use a LR test with the hypothesis of no impact. $\chi^2(1)$ statistic is 19.890 with a probability of 0.000. We can reject the hypothesis of no impact at the 1% level. According to these results, the impact of the extension term on household investment cannot be denied.

In sum, i.e. with imposing both restrictions (net wealth condition and weak exogenity of user costs) on the cointegrating space, the cointegrating relation is given by:

$$\hat{\beta}'z_t = hi_t - \underset{(0.047)}{1.193}\, di_t - \underset{(0.245)}{0.238}\, fa_t + \underset{(0.245)}{0.238}\, fl_t + \underset{(0.821)}{3.703}\, q_t(\pi - \pi_h)_t + \underset{(1.136)}{1.147}\, UC_t^B \tag{9}$$

Using that net financial wealth is defined as $nw_t=fa_t-fl_t$ and rearranging terms yields the long-run equilibrium relationship:

	household investments hi_t
- 1.193	disposable income di_t
- 0.238	net wealth nw_t
+ 1.147*	$3.23*q_t(\pi_t-\pi_{h,t})+UC_t^B$
	~ I(0)

Looking at the partial effects of income, wealth and extended user costs, it can be seen that they are in line with intuition. A higher income or a higher net wealth leads to more investments in housing. Higher user costs lead to less investment. Unfortunately, the value for η which can be derived from the equilibrium relationship does not fit into our considerations. We think, our estimation is not precise enough at this point, e.g. the standard error for the variable UC^B is quite high. Generally, the estimation results have to be interpreted cautiously. This is due to

measurement issues - in particular, concerning financial assets and financial liabilities as well as inflation expectations. In the derivation that follows we set η=0.80, which we think is an appropriate value.

To sum up, the econometric analysis has provided evidence that variables which are related to the presence of a credit constraint have to be considered in the modelling of housing demand. This includes an extension term in the formula of user costs which is dependent on the inflation and an average loan-to-value ratio.

Finally, we compute the extended measure of user costs which is given by $UC_t = (1\text{-}0.80)q_t(\pi_t\text{-}\pi_{h,t})+UC_t^B$. In Figure 2, a comparison of both series (basic user costs and extended user costs of housing) is shown. Both measures of user costs behave rather similarly with regard to trend properties, which come as no surprise against the backdrop that the inflation gap is stationary. However, it substantively affects the cyclical properties of user costs. In particular, the extension term lifts the volatility.

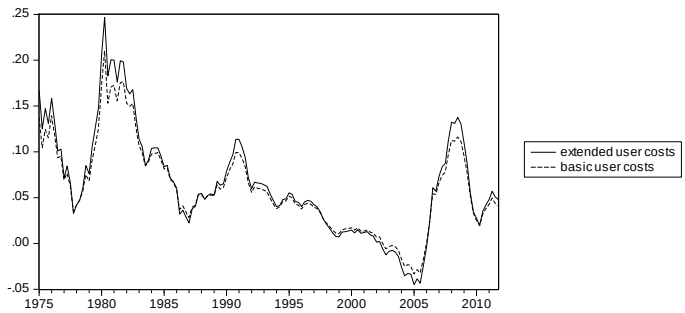

Figure 2: Extended and basic user costs of housing. Source: Own calculation

4 CONCLUSIONS

The goal of this paper was to check if Duemmler and Kienle's enlargement of the user costs expression based on the Dougherty and Van Order model can be also confirmed for the United States. Additionally, due to the overall importance of the housing market, this paper presents some theoretical and empirical considerations in order to obtain further insights in the investment decision of private households in the U.S.

The relevance of the theoretical findings are checked in the empirical part of the paper by specifying and estimating a time-series model for housing demand incorporating elements related to the presence of a binding credit constraint. We find that an impact of Duemmler and Kienle's extension term on household investments in the U.S. between 1975 and 2001 cannot be denied.

AUTHOR INFORMATION

Tobias Duemmler studied Business Administration at the University of Applied Sciences of the Deutsche Bundesbank and Economics at the Goethe University, Frankfurt/Main. Currently, he is a doctoral student at the Darmstadt University of Technology, Germany. His main field of interest is monetary economics. Tobias Duemmler, Darmstadt University of Technology, Frankfurt, Germany. E-mail: tobias.duemmler@stud.tu-darmstadt.de

DISCLAIMER

The views expressed in this paper are those of the author alone. Any remaining shortcomings are entirely the responsibility of the author.

REFERENCES

1. Akaike, H. (1969). Autoregressive model fitting for control, *Annals of the Institute of Statistical Mathematics*, 21, 1, 243-247.

2. Akaike, H. (1971). Fitting autoregressive models for prediction, *Annals of the Institute of Statistical Mathematics*, 23, 1, 163-180.
3. ECB (2003), *Structural factors in the EU housing markets*, Frankfurt.
4. Dougherty, A. and Van Order, R. (1982). Inflation, Housing Costs, and the Consumer Price Index, *American Economic Review*, 72(1), 154-164.
5. Duemmler, Tobias and Stephan Kienle (2010). User costs of housing when household's face a credit constraint – evidence for Germany. In: De Bandt et al. (Eds.): "*Housing Markets in Europe: A Macroeconomic Perspective*", Springer, 213-240.
6. Iacoviello, M. and Minetti, R. (2008). The credit channel of monetary policy: Evidence from the housing market, *Journal of Macroeconomics*, 30, 1, 69-96.
7. Johansen, S. (1995). *Likelihood-based Inference in Cointegrated Vector Autoregressive Models*, Oxford.
8. Jorgenson, D. (1963), Capital theory and investment behaviour, *American Economic Review*, 53(2), 247-259.
9. Lütkepohl, H. (2007). *New introduction to multiple time series analysis*, Berlin.
10. Osterwald-Lenum, M. (1992). A Note with Quantiles of the Asymptotic Distribution of the Maximum Likelihood Cointegration Rank Test Statistics, *Oxford Bulletin of Economics and Statistics*, 54, 3, 461-471.

DATA

We use standard data for the U.S. hi (private residential investments) and di (disposable personal income) are drawn from Bureau of Economic Analysis, fa/fl (total liabilities/assets of households) from the Federal Reserve Board, δ_t^{tech} was computed using consumption of fixed capital and real estate assets of households, p_h/π_h are based on the home price index from Shiller. p/π are CPI values from Bureau of Labor Statistics and the total number of households are drawn from the Census Bureau.

 © 2012 The Clute Institute