# The Panel VAR Approach to Modelling the Housing Wealth Effect: Evidence from selected European post-transition economies

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**ORIGINAL SCIENTIFIC PAPER**

**RECEIVED:** OCTOBER 2016

**REVISED:** NOVEMBER 2016

**ACCEPTED:** NOVEMBER 2016

**DOI:** 10.1515/ngoe-2016-0021

**UDK:** 332.27:519.2

**JEL:** C33, E21, R30

**Citation:** Čeh Časni, A., Dumičić, K., & Tica, J. (2016). The Panel VAR Approach to Modelling the Housing Wealth Effect: Evidence from selected European post-transition economies. *Naše gospodarstvo/Our Economy, 62*(4), 23–32. DOI: 10.1515/ngoe-2016-0021

## Abstract

Following Friedman's permanent income hypothesis and Ando and Modigliani's lifecycle hypothesis, this paper empirically studies the role of house prices and income in determining the dynamic behaviour of consumption in selected European post-transition economies using the panel vector autoregression (PVAR) approach and quarterly data covering the period from the first quarter of 2002 until the second quarter of 2012. With the shocks being recognized using the customary recursive identification scheme, we found that the response of personal consumption to the housing wealth shock is initially positive, but short lived.

**Key words:** consumption; housing wealth effect; house prices; panel vector autoregression; European emerging markets

## Introduction

The housing wealth effect can be defined as the change in consumer spending caused by an exogenous movement in housing wealth; it has been back on the research schedule ever since the recent[2] boom–bust behaviour of housing markets. Conventional macroeconomic models of private consumption generally include household wealth and income in the analyses, following Friedman's (1957) permanent income hypothesis and Ando and Modigliani's (1963) lifecycle hypothesis. However, quite different views have challenged them (Mishkin,

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[2] The subprime mortgage crisis in the US and the European sovereign debt crisis associated with great fluctuations in housing (and stock) markets in late 2008.

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OUR ECONOMY
Vol. 62 | No. 4 | 2016
pp. 23–32

2007). One such view claims that the housing wealth effect should be larger than the stock wealth effect on personal consumption simply because a household's ownership of housing wealth is larger than an ownership of equity. Furthermore, the housing wealth effect should be more prominent because property prices are less volatile compared to stock prices. As shelter is one of the most basic requirements of human life, housing costs are considered the biggest item in a household budget (Sowell, 2009).

As the theoretical effect of higher house prices on the total consumption seems unclear, the dynamic relationship between consumption and house prices needs to be analysed empirically. In recent decades, a vast number of empirical studies dealing with wealth effect have been published, yet most still refer only to developed countries. Also, the studies of post-transition European economies are sporadic, focusing on the importance of consumer expenditures on the total GDP development. As real house prices in European emerging markets have rapidly changed trends after the financial and real estate crisis in late 2008 (Ciarlone, 2011), it is especially interesting to evaluate the importance of the macroeconomic impact of housing wealth effect on personal consumption in those countries. Hence, the aim of this study is to explore the impact of housing wealth effect on personal consumption in selected European emerging economies, as relevant existing literature tends to treat the impact on housing wealth on consumption as ambiguous.

The contribution of this paper to the existing empirical literature is twofold. First, very few studies employ system estimation of the wealth effects in general, not to mention the studies for European emerging markets. Thus, we make use of the system estimation of housing wealth effect on consumption by employing panel vector autoregressive model that can estimate the housing wealth effect on consumption irrespective to the existence of cointegrating relationship, as the stationary series for all the variables in the equations are used. Our second contribution is a sample period covering the most significant boom–bust housing wealth cycle in the selected European emerging economies along with the global financial crisis period, thereby enabling us to detect housing wealth effect on personal consumption.

Using the panel vector autoregression (PVAR) approach in the manner of Abrigo and Love (2015), we estimated housing wealth effect on consumption for a panel of seven selected emerging European economies. As suggested by Larson, Lyhagen, and Løthgren (2001) and Larsson and Lyhagen (1999), a panel VAR approach allows insights into the role that housing wealth and income play in restoring the long-term equilibrium. Furthermore, the VAR approach has the advantage of explicitly allowing for response effects from consumption to wealth and income, for which a single-equation approach cannot account. It also illustrates how the responses of consumption and wealth differ according to the nature of shocks on them. To the best of our knowledge, this is the first study to address exclusively housing wealth effect on personal consumption in European emerging markets using panel VAR methodology for the period that covers the recent global financial crisis.

The remainder of this paper proceeds as follows. After the introduction, a brief literature review on important empirical papers that exclusively study housing wealth effect is provided. The next section describes data and applied methodology, followed by a section giving the results of the estimated PVAR model. The final section concludes the paper and gives some policy recommendations.

## Brief Literature Review of the Housing Wealth Effect

Concerning the modelling of the wealth effect on personal consumption, relevant scientific literature can be classified into two broad groups: papers that model the wealth effect based on aggregated macroeconomic data and papers that examine the wealth effect based on micro data. Paiella (2009) provided detailed insights into both categories and distinguished three sub-groups among them: papers dealing with merely the financial wealth effect on personal consumption, those modelling only the housing wealth effect on personal consumption, and those dealing with both the housing and the financial wealth effect on personal consumption. In their recent study, Ahec Šonje, Čeh Časni, and Vizek (2014) provided an overview of macro-econometric studies concerning the wealth effect. Yet, in this research only the housing wealth effect on personal consumption is modelled, as many studies, including Čeh Časni and Vizek (2014), Ahec Šonje, Čeh Časni, and Vizek (2012), Bertaut (2002), Carroll, Otsuka, and Slacalek (2006), Case, Quigley, and Shiller (2005), Ciarlone (2011), and Bayoumi and Edison (2003), have reported a larger housing wealth effect than the stock market wealth effect. According to Belsky and Prakken (2004), housing accounts for a considerable share of the total household net worth, which makes house prices a crucial component in formulating decisions about consumption.

Furthermore, empirical studies on the impact of housing wealth on personal consumption are mainly focused on advanced economies (e.g., Case et al., 2005; Dvornak & Kohler, 2003; Labhard, Sterne, & Young, 2005). However, still no consensus exists on the concrete quantity of the housing wealth effect, probably due to dissimilarities in data collection methodology,[3] economic settings, or sampling periods.

Current empirical research also provides very limited insights into asymmetric responses to housing wealth shock, as the real estate market had not gone through such a dramatic decline prior to 2008. Nevertheless, the previously mentioned drop in housing prices due to the global financial crisis allows for an analysis of the asymmetric housing wealth effect on consumption.

In general, in the post-transition European countries, mostly due to data unavailability that prevents complete and effective empirical analysis, the impact of housing wealth on consumption has not been sufficiently explored. A limited number of existing studies provide evidence of significant housing wealth effect in European post-transition countries (e.g., Aben, Kukk, & Staehr, 2012; Ahec Šonje et al., 2012; Čeh Časni, 2014; Seč & Zemčík 2007). Even so, most previously mentioned studies apply a single-equation method relying on the cointegrating[4] relationship among consumption, income, and housing wealth when determining the housing wealth effect on personal consumption. However, in order to identify the response of consumption to a shock, it is important to take into account all the variables in the system. This is where the VAR model comes into play, as it has the advantage of explicitly allowing for responses from consumption to housing wealth and income. By employing PVAR methodology, our study addresses the issue of unobserved heterogeneity by correcting for fixed effects.

## Data and Methodology

We used the data from an unbalanced panel of seven selected European post-transition economies—Bulgaria, Croatia, the Czech Republic, Estonia, Lithuania, Hungary, and Slovenia—selected on the basis of the availability of data for variables of interest. Our dataset consisted of quarterly indices for personal consumption, disposable income, wages, and real estate prices. We used total consumption[5] as a proxy variable for personal consumption. Furthermore, disposable income and wages were the two proxy variables used for income, with the aim of checking the robustness of the estimated baseline model. Real estate prices[6] were used as a proxy variable for housing wealth.

Our data—namely, housing wealth, wages, disposable income, and personal consumption—were first recalculated into base indices (2005 = 100), then deflated and deseasonalized using the X-12-ARIMA method (Hood, 2002) and finally expressed in logs. We used the first-differences[7] of the log variables (which were time demeaned before being differenced). When available, the data cover the period from the first quarter of 2002 to the second quarter of 2012.

Data sources used in the empirical analysis include the Vienna Institute for International Economics (WIIW), the International Financial Statistics and Eurostat databases for personal consumption, disposable income, and wages as well as the Bank for International Settlements databases for real estate price indices.[8] Data sources and time periods for each of the seven countries under analysis, forming an unbalanced panel, are given in Table 1.

This study benefits from the PVAR methodology evolved by Abrigo and Love (2015) in exploring the housing wealth effect on personal consumption by modelling the endogenous behaviour between consumption, income, and housing wealth. The PVAR approach combines the traditional VAR approach, treating all the variables in the system as endogenous, and the panel-data approach, allowing for unobserved individual heterogeneity by introducing fixed effects, resulting in an improved consistency of the estimation (Love & Zicchino, 2006). According to Lettau and Ludvigson (2004), who showed that consumption and wealth are both endogenous, conventional econometrics methods that treat wealth as an exogenous variable may cause biasness, as wealth also responds to exogenous shocks.

The first step of the empirical analysis was to choose optimal lag order in PVAR and in the moment condition (Abrigo & Love, 2015). According to Andrews and Lu (2001), consistent moment and model selection criteria

3 The deficient data on housing prices might be the main reason for inconclusive results in the existing empirical literature on whether the stock market wealth effect or the housing wealth effect has a stronger impact on personal consumption.

4 The crucial assumption of the panel cointegration literature is the independence assumption of the error term. Keeping in mind that national markets are highly integrated, this assumption is very likely violated. In that sense, a more appropriate econometric alternative would be a panel VAR modelling approach.

5 For a discussion, see, for instance, Mehra (2001).

6 In a number of other studies, such as Ludwig and Sløk (2004), Labhard et al. (2005), Case et al. (2005), Carroll et al. (2006), real estate price indices were also used as a proxy variable for housing wealth.

7 According to the performed panel unit root tests (which are not presented here, but are available from the authors upon request), all analysed variables have a unit root, so they are difference-stationary.

8 The comparability of real estate price indices from BIS across countries is discussed in Girourard and Blöndal (2001, p. 36).

**Table 1.** Data Description and Sources

| Country | Time span | Variable | | | |
|---|---|---|---|---|---|
| | | Real estate price (HW) | Personal consumption (C) | Wage (w) | Disposable income (Y) |
| Bulgaria | 2002q1 – 2012q2 | Flats, existing, big cities, BIS | Constant prices, IFS | WIIW database | IFS database |
| Croatia | 2002q1 – 2011q4 | All types of dwellings, new and existing, Croatian National Bank | Constant prices, IFS | WIIW database | IFS database |
| Czech Republic | 2002q1 – 2012q1 | Single family houses and flats, BIS | Constant prices, IFS | WIIW database | IFS database |
| Estonia | 2002q1 – 2012q1 | All types of dwellings, new and existing, BIS | Constant prices, IFS | WIIW database | IFS database |
| Lithuania | 2002q1 – 2012q2 | All types of dwellings, new and existing, BIS | Constant prices, IFS | WIIW database | IFS Database |
| Hungary | 2002q1 – 2012q2 | All types of dwellings, new and existing, BIS | Constant prices, IFS | WIIW database | IFS Database |
| Slovenia | 2003q1 – 2011q4 | All types of dwellings, new and existing, BIS | Constant prices, IFS | WIIW database | IFS Database |

(MMSC) for general method of moments (GMM) models are based on Hansen's (1982) J statistic of over-identifying restrictions.[9] Hence, based on three model selection criteria by Andrews and Lu (2001), the preferred model in our case was first-order PVAR.[10] Thus, we specify the following first-order three-variable PVAR model:

$$Z_{i,t} = \mu_i + \Theta(L)\, Z_{i,t} + f_i + d_{c,t} + \varepsilon_{i,t} \qquad (1)$$

where $\mu_i$ is the vector of constant terms for each variable, $\Theta(L)$ is the lag operator, and $Z_{i,t}$ represents a vector of three endogenous variables (C, Y, HW), where C and Y are the changes of household total consumption and disposable income[11] and HW denotes changes in housing wealth. Subscripts $i$ and $t$ refer to country and time, respectively. Furthermore, $f_i$ denotes the fixed effect, $d_{c,t}$ represents the country-specific time dummy, and $\varepsilon_{i,t}$ denotes the vector of residuals.

In the PVAR framework, in order to make sure that the underlying structure is equal for all the countries in the panel, some constraints[12] on parameters need to be imposed. Yet in practice, such constraints are likely to be violated; one way to overcome this problem is to allow for individual heterogeneity in all the variables by introducing fixed effects, denoted by $f_i$ in equation (1). However, the fixed effects are correlated with the regressors due to the lags of the dependent variable; therefore, we use forward mean-differencing, also known as the Helmert procedure (Arellano & Bover, 1995).[13] The Helmert procedure removes the mean of all future observations available for each country and time in order to preserve the orthogonality between transformed variables and lagged independent variables (Love & Zicchino, 2006). Even so, the differencing might result in a simultaneity problem due to the correlation between regressors and the differenced error term. Moreover, heteroscedasticity may also exist due to maintenance of heterogeneous errors with different countries in the panel. Accordingly, after eliminating fixed effects by differencing, we applied the panel GMM, where lagged regressors were used as instruments in order to estimate coefficients more consistently.[14]

In our model, we assumed that the vector of residuals ($\varepsilon_{i,t}$) is independent and identically distributed. However, this assumption normally fails in practice, as the concrete variance-covariance matrix of the errors is unlikely to be diagonal. Thus, in order to isolate shocks to one of the VAR errors, it is necessary to decompose the residuals in such a way that they become orthogonal. According to Sims (1980), variables in VAR should have a recursive causal ordering based on their degree of exogeneity. This procedure is also known as the Cholesky decomposition of the variance-covariance matrix of residuals and ensures the orthogonalization of shocks. Simply stated, the variables that come earlier in ordering affect the subsequent variables at the same time and with a lag, while the variables that

9 For more details, please refer to the original paper: Andrews and Lu (2001).

10 To save space, we do not present the results of the model selection, but they are available from the authors, upon request.

11 In our baseline model, as a proxy variable for disposable income we use wage; disposable income is used as a baseline model robustness check.

12 The PVAR approach requires the underlying structure to be the same across all countries in the panel by imposing pooling restrictions across countries.

13 In our case, we use the option *fod* in a package of programs for Stata developed by Abrigo and Love (2015).

14 Namely, we used the first three lags of consumption, wage, and housing wealth as instruments.

come later only affect previous variables with a lag (Love & Zicchino, 2006). In our paper, the housing wealth effect is ordered after personal consumption and income, which is based on previous research concerning this matter.[15] Within the chosen empirical framework, the dynamic responses delivered via the Cholesky decomposition are not structurally interpretable. The reason for this is the lack of theoretical foundation about the behaviour of the variables in the analysis—namely, a shock in housing wealth should be interpreted as an orthogonalized reduced-form shock, but it is impossible to determine if the underlying structural moving force is a housing-demand or housing-supply shock. Structural shocks may be identified by using a more sophisticated identification scheme, which is beyond the scope of this paper.[16]

In our analysis, we also focused on the impulse-response functions (IRFs), which describe the reaction of one variable in the system to the innovations in another variable in the system, holding all other shocks at zero. IRFs are constructed from the estimated VAR coefficients and their standard errors. We also present the variance decomposition expressing the magnitude of the overall effect of a shock, providing the proportion of the movement in one variable explained by the shock to another variable over time.

## Results of Empirical Analysis

The main results of the baseline PVAR model are given in Table 2. We report estimates of the coefficients given in equation (1), where the fixed effects and country-time dummies have been removed.

In Table 2, we report the 1-lag baseline model with wage as a proxy variable for income. We also performed some post-estimation tests: Granger causality Wald test and stability condition of estimated PVAR. The results of Granger causality tests[17] show the consumption Granger-causes wage and housing wealth at the 1% significance level. Wage Granger-causes consumption and housing wealth at the 1% significance level, while housing wealth Granger-causes wage at the 1% significance level, but it does not Granger-cause consumption. We checked for the stability condition of our PVAR model by calculating the modulus of each eigenvalue of the estimated model. According to Lutkepohl (2005) and Hamilton (1994), the VAR model is stable if all moduli of the companion matrix are strictly less than one. In our case, the estimated PVAR model satisfies the stability condition, as all eigenvalues lie inside the unit circle.[18]

**Table 2.** Main Results of a Baseline (1-lag) PVAR Model (with wage)

| Response of: | Response to (GMM estimates): | | |
|---|---|---|---|
| | C(t-1) | w(t-1) | HW(t-1) |
| C(t) | -0.4437*** [0.0305] | -0.4066*** [0.0574] | 0.0808*** [0.0256] |
| w(t) | -0.2841*** [0.0341] | -0.1692*** [0.0467] | 0.0957*** [0.0172] |
| HW(t) | 0.0429 [0.0477] | -0.2451*** [0.0595] | -0.1136** [0.0533] |

Source: Authors' calculations.

Note: The three-variable VAR model is estimated by GMM; country-specific and fixed effects are removed prior to estimation. Heteroscedasticity and serial correlation robust standard errors are in brackets. *** and ** denote significance at the 1% and 5% significance level, respectively.

As already mentioned, the impulse response functions capture the time profile of the effect of shocks at a given point in time on the expected future values of variables in a dynamic system (Simo-Kengne, 2012). We present them in Figure 1. The sign of estimated coefficients given in Table 2 are in line with our expectations, thereby producing theoretically consistent impulse response functions. According to the estimated PVAR model with wage (as a proxy variable for disposable income), it can be concluded that responses of personal consumption to disposable income, consumption, and housing wealth in a 1-lag model are statistically significant at the 1% significance level. Furthermore, wage responds negatively to the changes in consumption and wage, with statistically significant coefficients at the 1% significance level, with the coefficients being -0.284 and -0.169, respectively. Furthermore, according to the estimated baseline 1-lag PVAR model, housing wealth responds positively to changes in consumption, but negatively to changes in housing wealth and wage, with statistically significant coefficients at the 1% and 5% significance levels, respectively.

Figure 1 plots the responses of consumption, wage, and housing wealth to a shock in the 1-lag PVAR model. We observe that a wage shock of one standard deviation results in a personal consumption decrease and then an increase of about 0.04% after two quarters. That influence diminishes

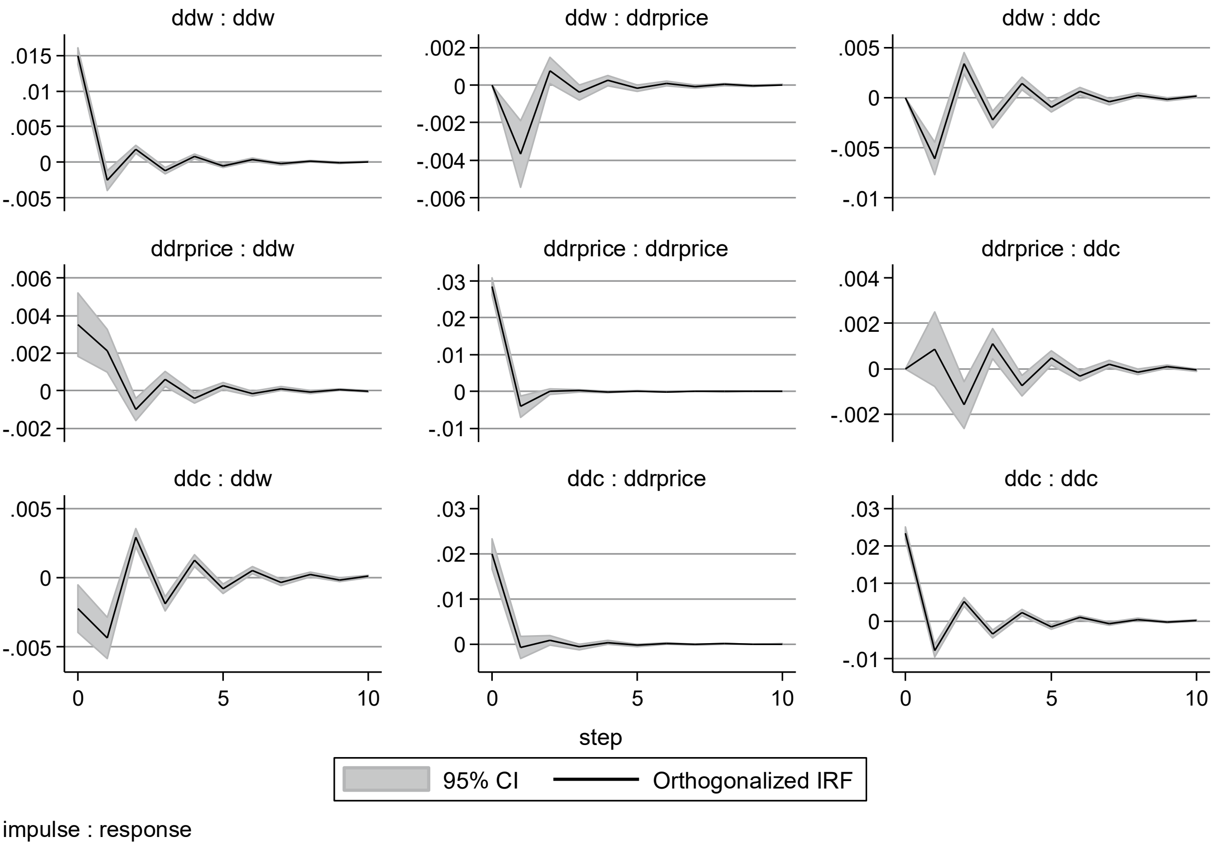
[15] For a discussion, please see Lettau and Ludvigson (2004), Patelis (1997), Thorbecke (1997), Neri (2004), Cochrane (1994), and Fisher and Voss (2001).

[16] For details please read Andre, Gupta, and Kanda (2011).

[17] The results of Granger causality tests are not presented, but they are available from the authors, upon request.

[18] Results are available from the authors, upon request.

**Figure 1.** IRF for baseline (1-lag PVAR) model with wage (Stata 13)




Note: ddc = C, ddi = w, ddpp = HW

after six quarters. The result of particular interest is the response of personal consumption to a one standard deviation shock in housing wealth. It initially increases personal consumption, following a decrease after three quarters and another increase after three quarters. Finally, after six quarters the influence of housing wealth on personal consumption diminishes.

Variance decomposition of the baseline 1-lag PVAR model presents an alternative way of summarizing the information described by IRFs in Figure 1. Accordingly, the contribution of the housing wealth shock to the variance of consumption is 0.76% at the 10-quarter horizon. Furthermore, the housing wealth shock accounts for 6.3% of the variation in wage, which accounts for 7.9% of the variation in personal consumption.

**Table 3.** Variance Decomposition (for 1-lag PVAR baseline model)

| Variables | Shocks | | |
|---|---|---|---|
| | C(t-1) | w(t-1) | HW(t-1) |
| C(t) | 0.9130 | 0.0794 | 0.0076 |
| w(t) | 0.1320 | 0.8046 | 0.0633 |
| HW(t) | 0.3218 | 0.0115 | 0.6667 |

Source: Authors' calculations.

Note: The table reports the percentage of variation in the row variable explained by the column variables in the three-variable VAR model. The variance decomposition is at a horizon of 10 quarters after the shock.

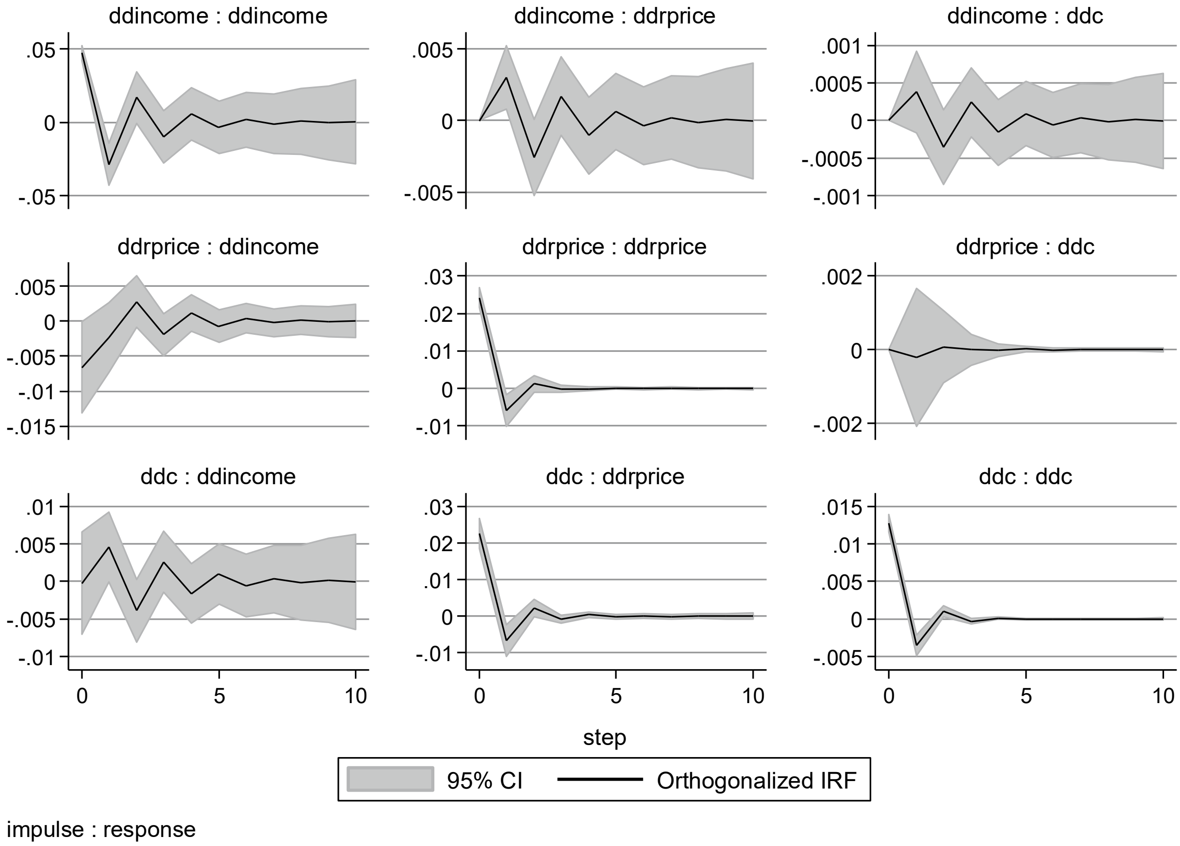
**Table 4.** Robustness Check: Results of a (1-lag) PVAR Model with Income

| Response of: | Response to (GMM estimates): | | |
|---|---|---|---|
| | C(t-1) | Y (t-1) | HW(t-1) |
| C (t) | -0.2646*** [0.0929] | 0.0081 [0.0059] | -0.0065 [0.0363] |
| Y (t) | 0.8137*** [0.1639] | -0.6058*** [0.1527] | -0.2613*** [0.0675] |
| HW(t) | -0.1177 [0.2272] | 0.0643** [0.0249] | -0.2264** [0.0880] |

Source: Authors' calculations.

Note: The three-variable VAR model is estimated by GMM; country-specific and fixed effects are removed prior to estimation. Heteroscedasticity and serial correlation robust standard errors are in brackets. *** and ** denote significance at the 1% and 5% significance level, respectively.

**Figure 2.** Robustness check: IRF for 1-lag PVAR model with income (Stata 13)




Note: ddc = C, ddw = Y, ddpp = HW

In order to check the robustness of our baseline model with wage (as a proxy variable for income), we used disposable income. The results of the estimated PVAR model with one lag with disposable income are given in Table 4.

According to the estimation results, we can conclude that our baseline model is robust to the changes in the proxy variable for income.

Figure 2 shows the impulse response functions for the 1-lag model with disposable income, which is estimated from the respective PVAR model. Accordingly, we can conclude that it is compatible with theoretical expectations.

## Implications and Concluding Remarks

The aim of this study was to explore the impact of the housing wealth effect on personal consumption in selected post-transition European countries. Using the PVAR approach in the manner of Abrigo and Love (2015), we estimated the housing wealth effect on consumption for a panel of seven selected post-transition European economies. In our analysis, we also focused on the IRFs, which describe the reaction of one variable in the system to the innovations in another variable in the system, holding all other shocks at zero. Following Friedman's permanent income hypothesis and Ando and Modigliani's lifecycle hypothesis, we included household housing wealth and income in the analyses. We estimated the baseline consumption PVAR 1-lag model with wage as a proxy variable for disposable income. Our model has the advantage of explicitly allowing for responses from consumption to housing wealth and income and addresses the issue of unobserved heterogeneity by correcting for fixed effects. In order to check the robustness of the baseline model, we estimated another model with disposable income. The results of the estimated models show that the response of personal consumption to a housing wealth shock is initially positive, but transitory, which is in line with previous research in this field.

Our results also have strong policy implications. Policymakers need to identify a housing bubble in its early stage to avoid a much larger bubble burst in the future. Furthermore, it is necessary to preclude over-consumption as a response to a positive housing price shock that may result in the volatility of the future GDP growth. In addition, the real estate market should receive priority from policymakers as the housing price effect has significantly increased in recent years. Therefore, monetary stabilization policies need to be implemented.

Although these conclusions are based on particular statistical methodology, they shed some light on the response of consumption to the housing wealth shock in selected European emerging markets and can serve as a solid foundation for further research in this area.

## Acknowledgment

This work has been fully supported by the Croatian Science Foundation under the project

ST*atistical Modelling for* REspoN*se to Crisis and Economic* G*row*TH *in We*S*tern Balkan Countries* -STRENGTHS (No. IP 2013-9402)

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# Panelni VAR-pristop k modeliranju učinka stanovanjskega premoženja: dokazi iz izbranih evropskih posttranzicijskih gospodarstev


## Izvleček

Upoštevaje Friedmanovo hipotezo o permanentnem dohodku in Ando-Modiglianijevo hipotezo o življenjskem ciklu, v članku empirično proučujemo vlogo cen stanovanj in dohodkov pri določanju dinamičnega obnašanja pri potrošnji v izbranih evropskih posttranzicijskih gospodarstvih. Uporabljen je bil vektorski avtoregresijski pristop na podlagi panelnih podatkov od prve četrtine leta 2002 do druge četrtine leta 2012. S spremembami, ki so bile pripoznane z uporabo običajne rekurzivne identifikacijske sheme, smo ugotovili, da je odziv pri osebni potrošnji na spremembo v začetku pozitiven, vendar kratkotrajen.


**Ključne besede:** potrošnja, učinek stanovanjskega premoženja, cene stanovanj, panelna vektorska avtoregresija, evropski rastoči trgi