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Abstract

Constructing a financial stress index, we examine the relationship between financial stability and real estate price fluctuation in Greece, whose experience during the last two decades makes it an ideal laboratory. Employing a VAR and a Bayesian VAR model, we demonstrate the ability of this measure to explain the phases of the housing market (in terms of both residential prices and investment). We find that an adverse shock in financial stability has prolonged adverse effects in the Greek real estate market. Our findings also suggest that residential prices are more sensitive to changes in financial stress conditions than residential investment.

Keywords: House prices; residential investment; financial stability; uncertainty

JEL Classification: E6, E44, C10, C22

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1. Introduction

It is widely accepted that real estate price and investment fluctuations affect consumption, savings, portfolio choice, and asset prices, as well as business cycle and monetary policy (Piazzesi and Schneider, 2016). Surging housing prices can also trigger social dissatisfaction and financial risks, as is usually the case during boom-bust episodes. All the above signify the vital role of the real estate sector on the economy.

The bursting of the housing price bubble in the USA, which led to the global financial crisis in 2008, has brought the interaction between the housing market and financial stability into the epicenter of the economic policy debate[1]. A better understanding of the interaction between them may improve the monitoring of financial risks related to real estate price volatility.

The investigation of the dynamic linkages between house prices, investment, and financial instability presupposes the construction of an aggregate index of financial stability. Despite the existence of extended past literature on the construction of financial stability indices (see, among others, Park and Mercado, 2014; Liu *et al.,* 2020; Cardarelli *et al.,* 2011; Moscone *et al.,* 2014), there is no commonly accepted framework for its measurement. In addition, although there is some past evidence on the association between the real estate market and financial stability, the literature is still sparse (Liu *et al.,* 2020 and Zhang *et al.,* 2018a).

In this study, we set out to (i) extend the already existing literature on financial stress indicators (Illing and Liu, 2006; Park and Mercado, 2014; Liu *et al.,* 2020) by proposing a new financial stress index for Greece proxying for the economy's financial stability, (ii)

[1] On top of the fact that malfunctioning residential markets were among the leading causes of the 2008 global crisis, there is strong evidence that their response to the unconventional policy measures - undertaken to restore financial stability and economic activity – was strongly positive both in residential investment and pricing (Rahal, 2016; Ahmed *et al.,* 2020).

examine for the first time the dynamic linkages between real estate market and financial stress (stability) in Greece and (iii) explore whether the proposed financial stress index exerts a symmetric impact on residential investment and prices.

Employing a VAR and a Bayesian VAR model, our findings suggest that a shock in the proposed Greek financial stress index reflects a kind of financial instability, leading to an abrupt and persistent decrease in residential investment and prices. We also find that residential prices are more sensitive to changes in financial stress conditions than residential investment. These findings are an essential contribution to the literature, as to the best of our knowledge, no other papers are investigating the impact of financial stability on the Greek real estate market in such a context.

The rest of the paper is structured as follows. Section 2 presents the previous literature, the theoretical background, and the hypothesis development. Section 3 describes the data and the econometric methodology, while Section 4 discusses the empirical findings. Finally, Section 5 concludes.

2. Determinants of House prices in Greece

2.1 The Received Evidence

The empirical literature identifies several macroeconomic drivers of house price volatility in Greece. Firstly, several studies have underlined the causal relationship of the house price cycle with the credit cycles as mortgage loan expansion increases house prices while the higher collateral value strengthens borrowing capacity. Simigiannis and Hondroyiannis (2009) provide evidence of a bidirectional causal relationship between house prices and mortgage loans. Brissimis and Vlassopoulos (2009) examine the interaction between house prices and housing loans in Greece and find that, although in the short run, there is a bidirectional relationship between the two variables, a long-run causal relationship running from housing loans to housing prices is not confirmed. Kapopoulos *et al.,* (2020) found that a Granger causality runs one-way from mortgage loans to RRE prices and not in the opposite direction.

Secondly, empirical literature for Greece has identified a long list of macroeconomic drivers of house price fluctuations such as interest rates, inflation, and employment (Apergis and Rezitis, 2003), construction and labor costs (Gounopoulos *et al.,* 2012), consumer inflation and the industrial production (Katrakilidis and Trachanas, 2012), retail trade in the long run (Panagiotidis and Printzis, 2016) and property taxation and Airbnb listings (Kapopoulos *et al.,* 2020).

Thirdly, the investigation of the dynamic linkages between real estate pricing and stock market pricing in Greece realizes the existence of (i) a 'wealth effect', which claims that households with unanticipated gains in share prices tend to increase the amount of housing by rebalancing their portfolios in the short term (Kapopoulos and Siokis, 2005) and (ii) a credit price effect in the long run (Gounopoulos *et al.,* 2019), which claims that a rise in real estate prices can stimulate economic activity, future profitability and stock market prices.

2.2 What makes Greece an ideal laboratory?

The paper in hands examines the relationship between financial stability and real estate price fluctuation in Greece, whose experience makes it an ideal laboratory.

The housing sector has always also played a significant role in the Greek economy's overall growth. Dividing the house price index timespan of the last two decades into three main phases, i.e., boom (2000-2008), bust (2009-2017), and recent gradual recovery (2018-2020), we can easily see that the price fluctuations undoubtedly have produced substantial sometimes positive and sometimes negative wealth effect for homeowners (Kapopoulos *et al.,* 2020).

In addition, the real estate market boom in the early '00s led to an overabundance of housing, with Greece reaching a very high homeownership ratio. During the "bust" phase of the real estate price cycle, the house price index in Greece dropped cumulatively by 42.4% from its peak in Q3 2008 until the trough in Q3 2017. Disinvestment in residential property hiked up, and physical capital depreciation remained higher than fixed capital formation for a prolonged period.

3 Financial Stress vs. House Prices and Investment

Although the plethora of past literature on the determinants of house prices and residential investment for the particular case of Greece, there is no prior study in the literature examining the impact of financial instability (stress) on housing in Greece. Hence, we aim at filling this gap in the literature. The following section provides the theoretical background to establish the interconnection between the financial stress indicator and the real estate market.

3.1 Theoretical Framework and Hypothesis Development

The interconnection between financial stress and the real estate market (both in terms of prices and investment) can be formulated in a fourfold manner. Firstly, *the tightening of credit criteria.* Financial instability makes banks adopt more rigid lending policies, thus reducing credit supply and hampering residential prices and investment.

Second, *the increase in liquidity risk*. During a heightened financial stress period driven by – either a stock market collapse or/and a surge in sovereign bond yields – residential prices and investment are compressed. Under extreme circumstances – like those experienced in Greece in 2011 and 2015 – an increase in the spreads of the government bond yields could be transmitted to an extreme FX risk (Grexit), which lead to a collapse of deposits, jeopardizing the ability of banks to support business liquidity, housing lending and consequently, residential prices and investment.

Third, *the wealth effect on housing consumption.* Given that households' total wealth consists of the sum of housing (non-financial) and financial wealth (Kapopoulos and Siokis, 2005), households are expected to stall their decision to buy a house during a financial stress period characterized by declining stock and bond prices. This is expected to hamper housing prices and investment as well.

Fourth, *a fall in collateral values can increase banks' losses*. Borrowers with low income and low house prices are more likely to behave as strategic defaulters (Campbell and Cocco, 2015; Schelkle, 2018; Pavan and Barreda-Tarrazona, 2020) in the sense that they default on loan payments even though they afford to continue to repay their loans. This magnifies further the financial stress contaminating the banking balance sheets. Besides, there is strong evidence for a negative relationship between collateral value and strategic defaulting in Greece (Assimakopoulos *et al*., 2017; Kapopoulos *et al*., 2017).

Based on the previously discussed theoretical framework and the above discussion, we formulate the following testable hypotheses:

H1a: Increase in financial stress will cause a decrease in real estate prices.

H1b: Increase in financial stress will cause a decrease in residential investment.

H2: Increased financial stress leads residential prices to react more vigorously than residential investment.

3.2 On the construction of the financial stress index: Some Stylized Facts

The financial stress index has been proposed to gauge financial stability in recent studies (Illing and Liu, 2006; Louzis and Vouldis, 2012; Park and Mercado, 2014; Zhang *et al.,* 2018a; Zhang *et al.,* 2018b; Liu *et al.,* 2020). Following this prior work, we construct a novel financial stress indicator for Greece. For its construction, the first step is to employ a GARCH (1,1) model on the following variables aiming at obtaining their volatility:

(i) Non-performing Loans[2] (outstanding amounts)

(ii) Bank deposits (outstanding amounts)

(iii) Athens stock exchange general index

(iv) Spread between the Greek and the German 10-Year Government bond yield

These variables capture all facets of the Greek financial system: banking stability, stock market stability, and sovereign risk. Then, we perform a Principal Component Analysis (PCA) on the volatilities of these variables as mentioned above to obtain the common factor. Then the first principal component is now our financial stress indicator (*fsi*)[3] proxying for the financial stability in Greece. A higher *fsi* suggests a more volatile financial system, indicating a less stable financial system in Greece.

Figures 1 and 2 present the evolution of the *fsi* and *hp*, and *fsi* and *hi* over the examined period. We observe a clear inverse association between *fsi* and each real estate component in both figures, thus providing preliminary evidence suggesting that the residential house prices and investment contract during more intense financial stress periods. Moreover, we observe an apparent abrupt upward inclination of the *fsi* at the beginning of the financial crisis in 2008 and a downward trajectory after 2015Q3 coinciding with the recovery of the Greek economy.

*****Insert Figures 1 and 2 here*****

4 Data and Econometric Methodology

Our analysis is based on a quarterly dataset spanning from 2003Q1 to 2020Q3. The period under-scrutiny coincides with a period of substantial economic growth realized by the Greek

[2] Although data before 2003 are available for most of the variables under-scrutiny, data for NPLs are available since 2003Q1 from the Bank of Greece.
[3] It must be noted that this new financial stress index was found to have a high positive correlation (around 0.77) between the Greek Composite Indicator of Systemic Stress (*ciss* of Hollo *et al.,* 2012) and the Country-Level Index of Financial Stress (*clifs* of Duprey *et al.,* 2017). We believe that such a finding enhances our understanding of the ability of our index to capture financial stress in Greece.

economy (2003Q1-2008Q2) and a deep recession (2008Q3-2015Q2) caused by a deep financial and debt crisis. Therefore, the Greek case is a perfect candidate to explore the association between financial stability and the real estate market. To fully capture the Greek housing market, we collected data for residential real estate prices (*hp*) and residential investment (*hi*) from reliable sources, namely the Bank of Greece and ELSTAT, respectively. In our analysis, both series are expressed in annual growth rates.

Apart from the three main under-examination variables (i.e., *fsi, hp,* and *hi*) we also consider in our model the construction cost (*construct*), the real GDP (*rgdp*), the spread between the Greek and the German 10-Year Government bond yield (*spread*), the credit for mortgages (*credit*), and the Harmozined Consumer Price Index-HCPI (*inflat*). All these series are expressed in annual percentage changes (apart from the variable *spread)*, and their choice is based on the past housing literature (see among others, Tsatsaronis and Zhu, 2004; Adams and Füss 2010; Beltratti and Morana, 2010; Katrakilidis and Trachanas, 2012; Gounopoulos *et al.,* 2012; Rahal, 2016). Table 1 below offers some valuable information regarding our dataset and the Greek economy as well.

*****Insert Table 1 here*****

For our analysis, we operationalize a reduced-form VAR model of order one[4]. Our specification contains eight variables revolving around a core housing market-orientated VAR model. Before we proceed to the estimation of our VAR model, as a first step, we examine all the variables for stationarity by employing the unit root tests of Dickey and Fuller (1979) (ADF) and Phillips and Perron (1988) (PP). Table 2 contains the empirical results from the unit root tests, from which we conclude that almost all the variables described above are

[4] The conventional lag length information criteria indicate a preference for one lag.

stationary. The initial variable *spread* (in levels) was only found to be non-stationary. For this reason, we include it in first differences in the VAR system.

*****Insert Table 2 here*****

A reduced-form finite-order VAR representation reads as follows:

$$\boldsymbol{Y}_t = \boldsymbol{A_o} + \sum_{j=1}^{q} \boldsymbol{A}_j \boldsymbol{Y}_{t-j} + \varepsilon_t \, , \varepsilon_t \sim N(0, \boldsymbol{\Omega}) \quad (1)$$

where $\boldsymbol{Y}_t$ equals a (n×1) vector of variables under-scrutiny, $\mathbf{A_0}$ equals an (n×1) vector of constant terms, $\mathbf{A}_j$ denotes matrices of coefficients, and ε_t denotes the vector of residuals whose variance-covariance is $\boldsymbol{\Omega}$. The estimation method of the reduced-form VAR is OLS. Identification is achieved by Cholesky-decomposing the variance-covariance matrix of the VAR residuals, $\Omega = \mathbf{PP}'$, where $\mathbf{P}$ is the unique lower-triangular Cholesky factor with non-negative diagonal elements.

Figure 3 shows that the VAR model meets the stability conditions since the inverse roots of AR characteristic polynomial lie inside the unit circle, and thus, it is stationary.

*****Insert Figure 3 here*****

5 Results

Figure 4 depicts the 10-quarter impulse response functions (IRFs) of the under-examination variables after estimating the VAR model. Plotting IRFs allow us to trace the dynamic impact of shocks in the Greek real estate market. Specifically, we are interested in examining how the system's variables respond to one positive standard deviation shock to *fsi*. We observe that positive shock to *fsi* by one standard deviation (s.d.) leads to a strong immediate negative response of *hp,* which holds for the whole 10-quarter period. Furthermore, a positive shock to *fsi* induces a strong negative effect on the *hi* for three quarters until it stabilizes. These permanent shocks on both housing market components indicate the large and extensive financial stability impact on the Greek housing market. Another interesting finding is that a shock to the *fsi* lowers real GDP and credit while it increases inflation rate and bond spread. The latter might indicate that higher financial instability negatively affects housing prices and residential investment directly through the weakening of mortgage debt affordability (lower incomes) and less credit expansion. Additionally, increasing financial stress may lead to house price compression and postponement of investment decisions because of the uncertainty fueled by increasing inflation or/and higher spreads on bond yields.

*****Insert Figure 4 here*****

To investigate whether *fsi* has a predictive causal impact on the Greek housing market, we employ a pairwise Granger causality test. The results in Table 3 suggest rejection of the null hypothesis that *fsi* does not Granger-cause neither the *hp* nor the *hi* but not the other way around. Hence, there is a unidirectional causal relationship from *fsi* to the Greek housing market, implying that our financial stability measure has predictive causality for both *hp* and *hi*. In other words, a sudden drop in housing prices or residential investment will not destabilize the Greek financial system, while a sudden surge in the financial stress index will destabilize the Greek real estate market.

This finding supports three out of four ways formulating the interconnection between financial stress and the real estate market; namely, the tightening credit criteria, the increase in liquidity risk and the wealth effect on housing consumption. On the contrary, the third possible interconnecting manner, which documents the impact of the declining collateral value on the formation of the non-performing loans, would imply a bidirectional causal relationship between financial stability and house prices investment.

*****Insert Table 3 here*****

We proceed to examine whether *fsi* exerts the same impact on *hp* and *hi*. To do so, we employ a Seemingly Unrelated Regressions model (SUR) of Zellner (1962) to test for cross-equation constraints, and the results are reported in Table 4. We find that the hypothesis of symmetry of absolute effects is rejected, concluding that *fsi* exerts an asymmetric impact on house prices and residential investment. We also find that *fsi* exerts a more significant impact on *hp* than *hi,* suggesting that prices are more sensitive to changes in the system's financial stability than investment. In other words, we find evidence that prices react more vigorously in the event of higher financial stress. The finding that house prices are more sensitive to financial stress periods indicates that policymakers might need to pay more attention to the house prices than the residential investment when designing the appropriate policy measures.

*****Insert Table 4 here*****

VAR models usually employ the same lag lengths for all variables in the system, indicating that one must estimate several parameters, including a number of them being statistically insignificant. This creates an over-parameterization problem, which could lead to multicollinearity concerns and a loss of degrees of freedom, leading to inefficient estimates. Some researchers apply near VAR models, specifying an unequal lag structure for the variables in the system (Doan, 2007), while some others employ unrestricted VARs excluding lags that provide statistically insignificant coefficients (see Dua and Ray, 1995; Dua and Miller, 1996; Dua *et al.,* 1999).

To overcome the over-parameterization problem, Litterman (1981), Doan *et al.,* (1984), Todd (1984), Litterman (1986), and Spencer (1993) use a Bayesian VAR (BVAR) model. As also stated by Gupta and Miller (2012), *"rather than eliminating lags, the Bayesian method imposes restrictions on the coefficients across different lag lengths, assuming that the* *coefficients of longer lags may approach more closely to zero than the coefficients on shorter lags."* If, however, stronger effects come from longer lags, the data can override this initial restriction.

For the estimation of the BVAR model, a prior distribution must be set. Litterman (1981) imposes a diffuse prior for the constant. Following Gupta and Miller (2012) and Cuestas (2017), we also utilize this "Minnesota prior" in our analysis, where we implement a Bayesian variant of the previously discussed classical unrestricted VAR model. Mathematically, the means and variances of the Minnesota prior read as follows:

$$\beta_i \sim N\left(1, \sigma^2_{\beta_i}\right) \, and \;\; \beta_j \sim N\left(0, \sigma^2_{\beta_j}\right) \qquad (2)$$

where β_i equals the coefficients associated with the lagged dependent variables in each equation of the VAR model (i.e., the first own-lag coefficient), while β_j equals any other coefficient. In sum, the prior specification reduces to a random-walk with drift model for each variable if we set all variances to zero. The prior variances, $\sigma^2_{\beta_i}$ and $\sigma^2_{\beta_j}$, specify uncertainty about the prior means $\overline{\beta_i} = 1$, and $\overline{\beta_j} = 1$, respectively. In addition, the hyper-parameters employed in our analysis are in line with Gupta and Miller (2012).

In Figure 5, we display the IRFs based on the BVAR model. As we can observe, a positive shock by one s.d. on *fsi* leads once again to an abrupt and persistent negative response of both *hi* and *hp*. Hence, our results remain nearly unchanged, confirming the previously discussed findings obtained by the unrestricted VAR model, and therefore they are robust.

*****Insert Figure 5 here*****

6 Conclusions

Following the prior literature, we construct a new measure able to gauge financial stability in Greece for the period 2003Q1-2020Q3. We also formulate several aspects of the interconnection between financial stress and the real estate market. Our findings can be summarized as follows: (i) an adverse financial stability shock has prolonged negative effects in the real estate market, both in terms of house prices and residential investment; (ii) during periods of increased financial stability, residential prices react more vigorously than residential investment.

Additionally, our findings offer a rigorous interpretation of how the “perfect financial storm” hit the real estate market in Greece during the previous decade. This storm has comprised by housing credit contraction, increasing spreads on government bond yields skyrocketing the so-called “Grexit from euro” risk, which caused mass deposit outflows and lower household incomes and thus less affordability of mortgage debt. The latter has been further fueled the financial sector stress as non-performing loans were increasing. A lower supply of housing loans has accompanied the subsequent less demand for housing loans because of the tightening of credit criteria and the exposure of banks to liquidity risk.

Finally, our results advance (i) the understanding of the interconnection between financial stability, the house price movements, and the residential investment decisions and (ii) the debate on monitoring financial stability in the Greek financial system. Therefore, for all these reasons, the proposed financial stress indicator can effectively support supervisory authorities and researchers in assessing financial stability in Greece. Furthermore, the nature and the direction of the causal relationship between the housing market (both in terms of prices and investment) and financial stability are important to be determined given that they are of great importance to analysts, practitioners, and policymakers.

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Tables

Table 1: Descriptive Statistics								
	hp	**hi**	**rgdp**	**credit**	**inflat**	**construct**	**spread**	**fsi**
Mean	-0.01	-8.13	-0.89	6.65	1.64	1.03	5.30	0.00
Median	-0.34	-10.00	0.43	-2.28	1.54	0.61	3.46	-0.53
Maximum	13.71	47.61	6.77	33.49	5.60	6.61	29.03	3.96
Minimum	-12.84	-59.40	-14.21	-10.07	-2.20	-3.30	0.12	-2.28
Std. Dev.	7.08	25.31	5.20	14.62	2.01	2.47	6.37	1.49

Notes: (a) This tables reports the main descriptive statistics of our variables, which are all expressed in annual percentage changes, with fsi and spread being in levels, (b) the sample is quarterly, covering the period between 2003Q1-2020Q3.

Table 2: Unit root tests		
	ADF	**PP**
hp	-1.958** (0.048)	-2.019** (0.042)
hi	-1.911* (0.054)	-3.293** (0.019)
rgdp	-4.861*** (0.000)	-1.630* (0.097)
credit	-1.735* (0.078)	-2.252 (0.024)
inflat	-1.678* (0.088)	-3.337* (0.068)
construct	-1.714* (0.082)	-1.676* (0.088)
spread	-2.423 (0.139)	-1.976 (0.296)
fsi	-1.946** (0.049)	-2.201** (0.027)

Notes: (a) This table presents the results from the unit root test we conducted, where all variables are expressed in annual percentage changes, with fsi and spread being in levels, (b) ADF: Augmented Dickey-Fuller test; PP: Phillips and Perron test, (c) the sample is quarterly, covering the period between 2003Q1-2020Q3, (d) ***, ** and * denote significance at the 1, 5 and 10%, levels, respectively.

Table 3: Short-run Granger causality tests			
	hp **(probability value)**	***hi*** **(probability value)**	***fsi***
fsi **does not Granger cause the** ***hp***	0.082	-	-
fsi **does not Granger cause the** ***hi***	-	0.018	-
hp **does not Granger cause the** ***fsi***	-	-	0.697
hi **does not Granger cause the** ***fsi***	-	-	0.847

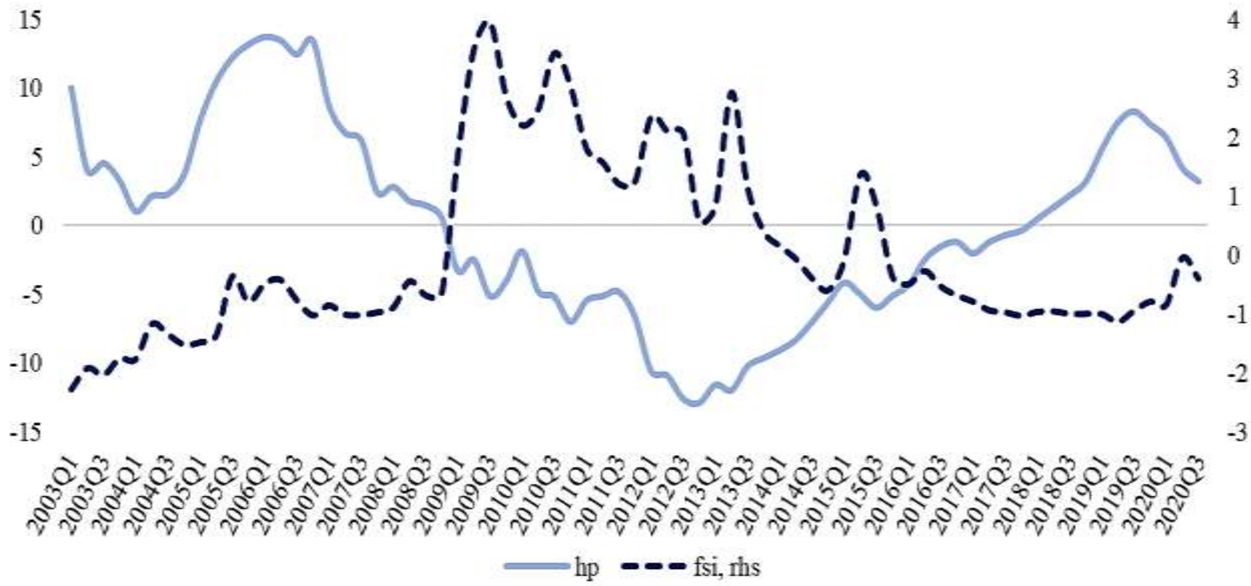
Notes: This table presents the results from the Granger causality test after the estimation of the unrestricted VAR model. As it shows, the financial stress indicator has predictive causality on house prices and residential investment but not the other way around. This implies that we find a unidirectional short-run relationship between fsi and the housing market.

Table 4: SUREG estimation results		
Variables	***hp***	***hi***
fsi	**-1.506*** [0.507]**	**-0.602** [0.261]**
Control variables	Included	
Constant	0.880 [0.851]	-0.643 [0.437]
Observations	71	
Hypothesis testing		
Joint zero effect of *fsi* on the housing market (χ^2 statistic)	10.465***	
Symmetry of absolute effects *fsi* on the housing market (χ^2 statistic)	3.356*	

Notes: (a) This table presents the results from the SUREG estimation methodology, (b) *, **, *** denote statistical significance at the 10, 5, and 1 percent level, respectively, (c) numbers in brackets denote robust standard errors.

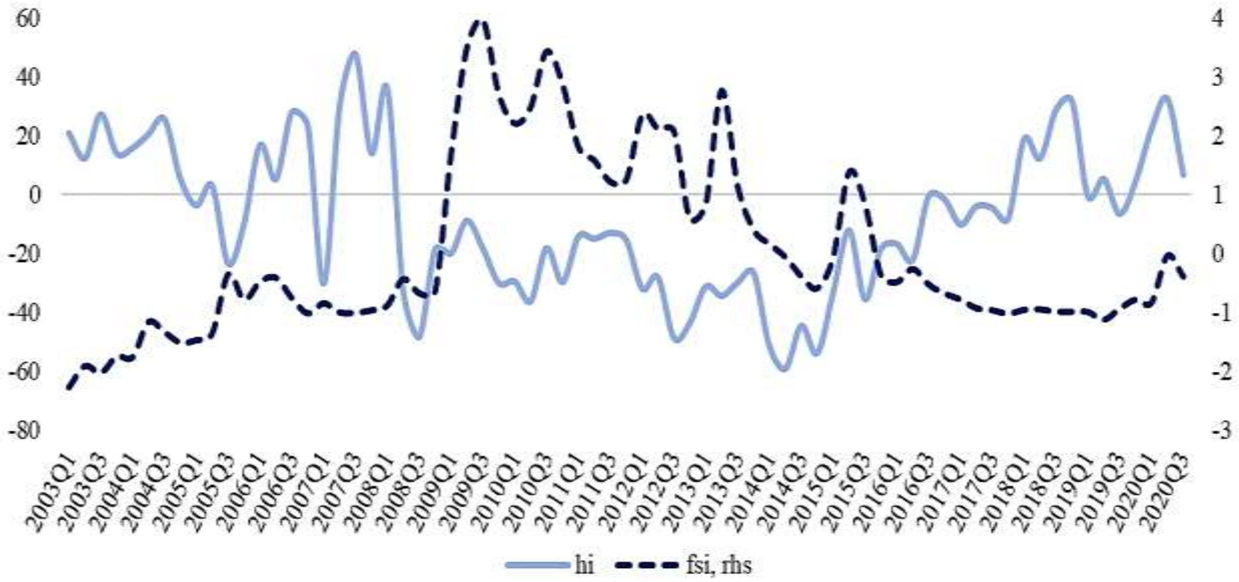
Figures

Figure 1: Trajectory between financial stress indicator-fsi (levels) and house prices-hp (annual growth rates)



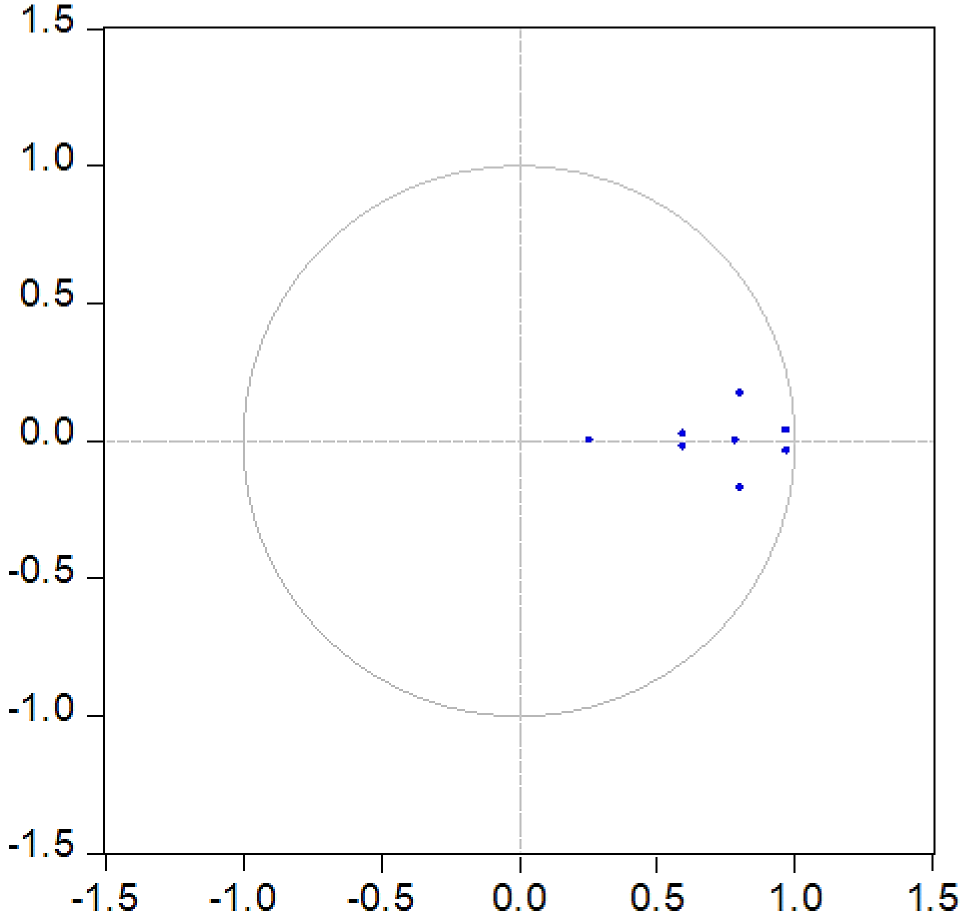
Notes: This figure depicts the trajectory between financial stress indicator-fsi (in levels) and house prices-hp (in annual growth rates) for the period under-scrutiny.

Figure 2: Trajectory between financial stress indicator-fsi (levels) and residential investment-hi (annual growth rates).



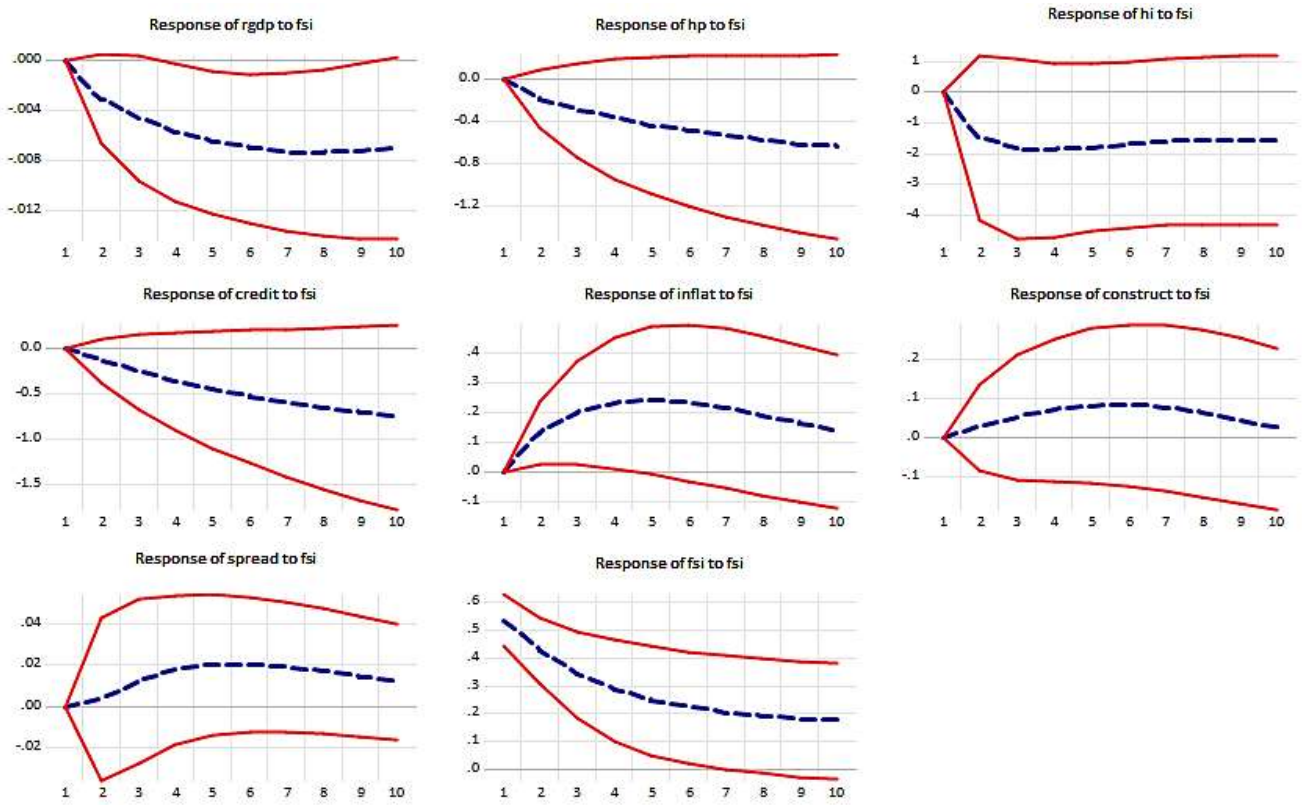
Notes: This figure depicts the trajectory between financial stress indicator-fsi (in levels) and residential investment-hi (in annual growth rates) for the period under-scrutiny.

Figure 3: VAR Stability Conditions (Inverse Roots of AR Characteristic Polynomial)



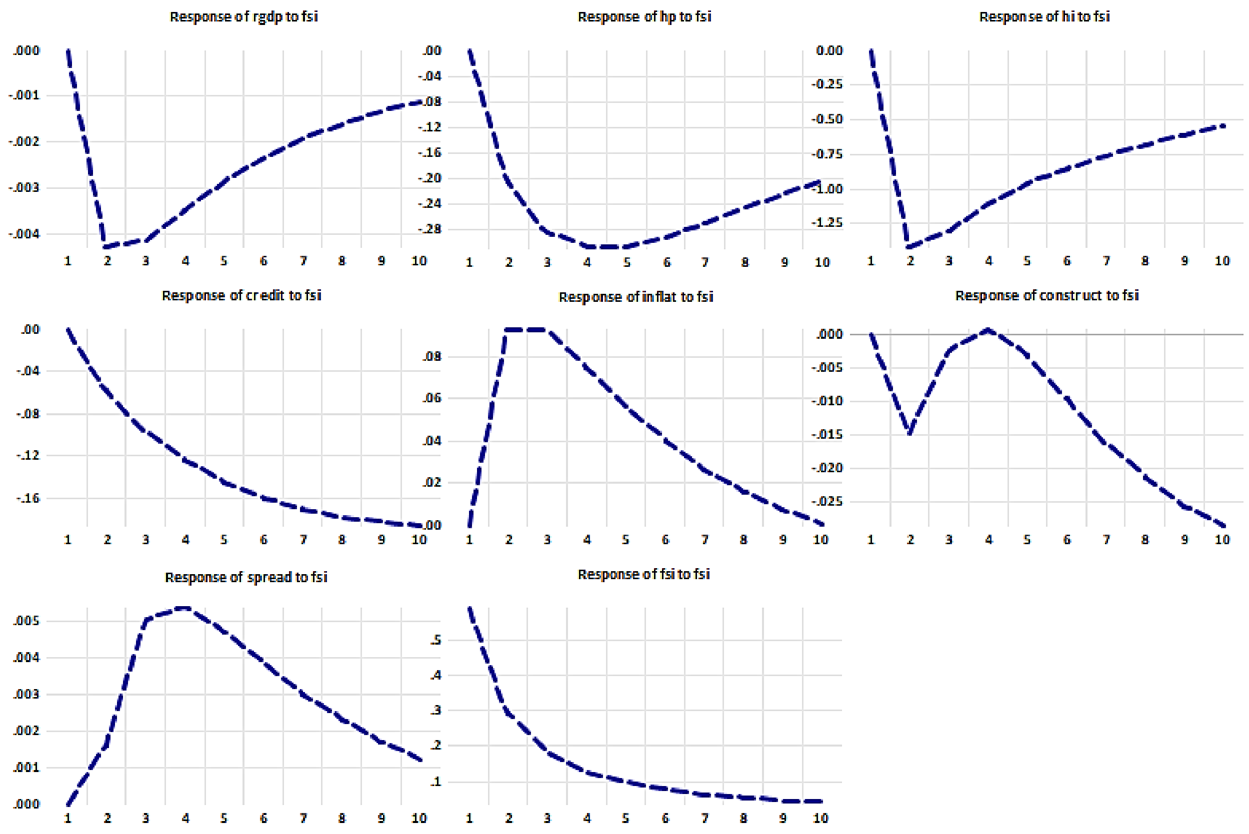
Notes: This figure depicts the Inverse Roots of AR Characteristic Polynomial of the VAR model. It confirms that the Stability Conditions hold and thus our VAR model is stable and stationary.

Figure 4: Impulse response functions of a 1 s.d. shock on FSI with 95% confidence bands (VAR model)



Notes: This figure depicts the Impulse Response Functions of a 1 s.d. shock on FSI after the estimation of the unrestricted VAR model.

Figure 5: Impulse response functions of a 1 s.d. shock on FSI (BVAR model)



Notes: This figure depicts the Impulse Response Functions of a 1 s.d. shock on FSI after the estimation of the BVAR model.