.THE IMPACT OF MONETARY POLICY ON REAL ESTATE MARKET DURING COVID-19 CRISIS USING A DSGE MODEL OF A SMALL OPEN ECONOMY

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Abstract

Using a new Keynesian small open economy dynamic stochastic general equilibrium model (NK SOE DSGE) with the housing sector, this paper evaluates the impact of housing collateral and changes in openness of economy on the business cycle in the Czech economy. We devote special attention to the setting of the loan to value (LTV) ratio, which we believe plays an important role as a regulator of the monetary transmission mechanism. Moreover, we try to simulate the effects of a reduction in the openness of the economy in the context of an incoming pandemic crisis. The impacts alternative LTV level and openness level setting are quantified by simulating the responses of monetary shock on key macroeconomic variables. Our simulations are based on an estimated DSGE model. Our approach allows a better understanding of the response of the real economy to monetary tightening mitigated by different levels of LTV, and allows a comparison of how these effects change in an environment of altered economic openness. Our results show that higher loan to value ratios strengthen the effect of the monetary transmission mechanism to consumption and output. In contrast, changes in the openness of the economy showed no significant changes in the dynamics of monetary transmission to real variables.

Keywords

Housing Sector, Loan to Value Ratio, NK SOE DSGE Model, Monetary Transmission Mechanism

I. Introduction

In recent years, the real estate market situation in advanced economies has increasingly come to the forefront of the minds of economists and economic policy makers. This is mainly due to the recent global economic crisis, the origins of which are linked to the US mortgage crisis. This crisis has highlighted that it is the combination of excessive borrowing and rapidly rising house prices that can cause the economy to destabilise. The research therefore focuses on the question of how the monetary transmission mechanism can affect the property market and what policies are able to moderate fluctuations in the property market. In addition, many countries apply so-called macro-prudential instruments to prevent, at least in part, excessive lending and reduce systemic risks.

The paper focuses on the impact of monetary and macroprudential policies on the real estate market in the Czech Republic, with an emphasis on the period of the COVID-19 pandemic. The last few decades have witnessed a significant increase in real estate prices, which institutions such as the Czech National Bank consider as a source of potential risks associated with the financial (in)stability of the economy. A pandemic shock unexpectedly hits the economy in such a set-up and significantly alters the mobility of individual agents in the markets for the duration of the shock. The opportunity to better understand how individual monetary policy actions translate into the domestic housing market during a pandemic was therefore a major motivation for writing this paper.

The aim of this paper is to describe and then quantify the effects of monetary and macroprudential policy on the housing market when the openness of a small economy is reduced. For this purpose, a

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DSGE model of a small open economy (model Funke, Kirkby and Mihaylovsky, 2017) with links to the real estate market and seven time series characterizing the Czech economy are chosen.

A series of simulated scenarios will be run to examine the effects of monetary policy and macroprudential policy itself. The focus will be on the discussion of changes in the behaviour of individual variables in response to a monetary shock. Attention will also be paid to the combination of monetary restriction and alternative settings of loan to value limits under different settings of openness of the Czech economy.

II. Literature review

The cornerstone in modelling the economy with the property market was laid by Iacoviello (2005). Iacoviello (2005) introduced a simple DSGE model of a closed economy with a credit constraint that is linked to the value of real estate through collateral. Although it may seem to be only a minor extension, the inclusion of property value in the model allowed to investigate changes in the behaviour of borrowers in response to changes in property prices. Monacelli (2006) also used a similar model to Iacoviello (2005) in his paper, which focused on the analysis of optimal monetary policy in an economy with credit constraints. According to his conclusions, a floating inflation policy with a redistribution motive appears to be optimal. However, Monacelli (2006) says that price rigidities make the costs of such an applied policy too high. An extension is also provided by Notarpietro (2007), who shows that the effect of traditional price rigidities is less significant in a credit-constrained economy. He further adds that attention should be focused on the nominal debt accumulated by borrowers in the economy.

All the above papers work with a model of a closed economy. However, the Czech economy does not correspond to a closed economy but to a small open economy. Also, the question we want to answer cannot be solved with the closed economy model. Therefore, we will mention a few articles that abandon the assumption of a closed economy. Daracq-Pariés and Notarpietro (2008) builds model on a previous paper by Notarpietro (2007), but the model is newly constructed for two countries -- the US and the Eurozone. The authors show that a shock in the housing sector has a significant effect on the chosen domestic economy, but spillovers to the foreign economy do not appear to be significant. A different two-country model with the addition of a single currency is introduced by Bracons and Rabanal (2010). Using data for Spain and the European Monetary Union after it contributed to housing booms in both economies. Christensen, Corrigan, Mendicina, and Nishiyama (2016) compare two models of an open economy -- with and without financial frictions. The model with borrowers whose lending is constrained by property value appears to be significantly better at explaining the data.

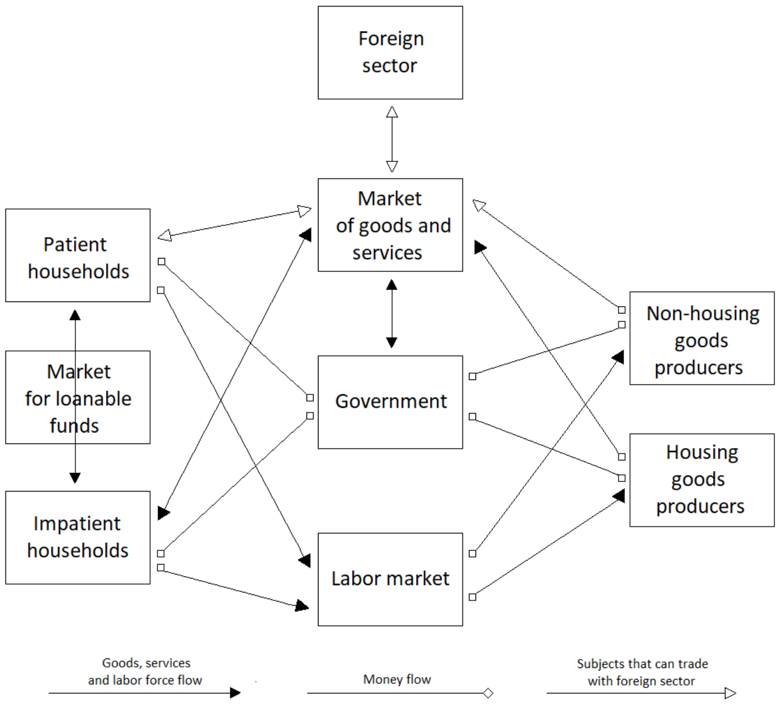
Different variations of the above models are also used to examine the effects of specific economic policies. We focus our attention primarily on the literature that applies macroprudential policy tools to some of the world's economies. Lozej and Rannenberg (2018) examine the implementation of macroprudential policy through LTV and LTI on the economy of Ireland. A DSGE model of the Central Bank of Ireland is used, and the results suggest that the introduction of both policies dampens economic activity in the short run but yields significant benefits in the medium and long run. Modelling LTV constraints is also common in Asian economies. Lee and Song (2015) model the Korean economy and show a significant effect of LTV constraints on the behavior of credit constrained households. Next, we present two papers that choose Hong Kong as a model economy - Rabanal (2018) and Funke and Paetz (2013). Rabanal (2018) shows that the introduction of prudential policies in Hong Kong significantly reduced house price appreciation. Funke and Paetz (2013) argue that shocks to property preferences are the main source of consumption volatility and, conversely, shocks to LTV settings have negligible effects. It is also worth mentioning Robinson and Robson (2012) who extend Iacoviello and Neri (2010) to the foreign block and estimate this model on Australian data. The authors capture joint movements in consumption and house prices in response to a shock to housing preferences, but only at high LTV settings. At a lower LTV setting (which fits the data better), they fail to show this phenomenon for Australia.

Finally, the paper by Funke, Kirkby and Mihaylovsky (2017) used in the paper should be mentioned. The model is built on the foundations of Iacoviello (2005), extended for a small open economy and supplemented with New Zealand specifics. In particular, the authors focused on the causes of New Zealand's rapid house price growth and how it can be prevented. They therefore added two independent macroprudential instruments to the model and examined the interaction of these instruments with monetary policy. The results suggested that a restrictive LTV helps regulate house prices movements with only a negligible effect on consumer prices. The introduction of LTV policy alone is estimated to be able to reduce house prices. Although New Zealand may appear to be quite distant from the Czech Republic, the nature of the economies is partly similar. We have based our choice of model primarily on the assumptions that New Zealand, like the Czech Republic, is a small open economy with a floating exchange rate and historically similar property market price trends.

III. Methodology

The model is taken from an article by Funke, Kirkby and Mihaylovski (2017). We classify the chosen model among the models of small open economy, which has a developed real estate market and consists of four sectors: households, goods producers, government, and foreign sector.

Figure 1 Model scheme



Source: own construction

We distinguish the household sector into patient and impatient households. The difference between individual households is captured by the discount factor β, where households that generate savings (patient, discount factor β_s) have a higher discount factor compared to households that borrow free funds from the financial market (impatient, discount factor β_b). The representation of individual households is expressed by the parameter, where ω denotes the number of impatient households and 1 - ω the number of patient households. Patient and impatient households consume the consumer basket X, which is formed by the weighted average of goods of short-term consumption C and long-term consumption D. The amount of work of both households is expressed by the variable N_j, where $j \in [C, D]$ and receive wage belonging to the given sector W_j. Both households invest in real estate I, whose real price is expressed by the variable Q and the real debt of households is expressed by the variable B_H. Households also receive transfers T from the government. In contrast to patient households, impatient households are limited in their decision-making by a credit restriction in which the term $1 - \chi$ denotes the LTV share. Unlike impatient households, patient households receive creditor profit F_j from the ownership of business firms and at the same time have access to the international market, where they buy foreign bonds B_F.

Firms are divided into entrepreneurs and retailers, and it is also possible to divide them according to the type of goods they produce - short-term and long-term consumption goods. The production process starts with entrepreneurs, who produce intermediate products, which are then bought by retailers and used to produce the final products, which are then sold to households. The price of a retailer's product is set according to Calvo's rule.

In the model economy, the government collects taxes and provides transfers, assuming a balanced state budget. Monetary policy is inflation-oriented and is expressed by using Taylor's rule for interest rates R, product Y and inflation Π_C. The foreign sector is exogenous, and we assume that changes in the foreign market may have an impact on the domestic market. Log-linearized model equations are given in the Appendix.

Seven quarterly time series covering the period from the first quarter of 1998 to the last quarter of 2018 were used to estimate the model. The used time series are described in Table 1. Namely, we use data for gross domestic product, consumption, interest rate, CPI inflation, real estate price inflation, real estate investment and employment from Czech Statistical Office (CZSO) and Czech National Bank (CNB). Output, consumption and investment in housing are transformed into per capita form and then transformed using logarithmic transformation and decomposed into cyclical and trend component using Hodrick-Prescot filter. Employment is transformed using logarithms and H-P filter. CPI inflation, house price inflation and interest rate PRIBOR are demeaned.

Table 1 Data

Variable	Source	Transformation
Real GDP per capita	CZSO	Per capita, log, HP filter, $\hat{Y}$
Real consumption per capita	CZSO	Per capita, log, HP filter, $\hat{C}$
Real investment in housing per capita	CZSO	Per capita, log, HP filter, $\hat{I}$
Employment	CZSO	log, HP filter, $\hat{N}$
Inflation (Consumer Price Index)	CZSO	demeaned
Property price inflation	CZSO	demeaned
PRIBOR	CNB	demeaned

Source: own construction

IV. Calibration and estimation

Some parameters are generally more difficult to estimate, so calibration is more appropriate. For our model, we calibrated based on available literature or stylized knowledge of the modeled economy. The first parameters calibrated were the discount factors β_s and β_b. The discount factor of patient households β_s was calibrated to a value of 0.99, which is the most used value in the available literature, see for example Iacoviello (2005). The parameter β_b was calibrated to 0.95, like that reported, for example, in Hloušek (2012) or Toner and Brůha (2014). Another calibrated parameter was the weight of housing on consumption γ, which was set to 0.1 based on a standard (e.g., Walentin, 2014). Habit in consumption h, which is usually modelled as relatively strong and persistent in the Czech economy, also seemed to be a suitable parameter for calibration, so we chose a value of 0.7. The parameter δ indicating the degree of asset depreciation was calibrated to a value of 0.01, like, for example, Walentin (2014) or Funke and Paetz (2013). We calibrated the key parameter χ, which captures the fraction of the property that cannot be used for collateral and thus determines the size of the LTV, to a value of 0.25. This value corresponds to an LTV of 75%, which is a common level in the Czech Republic. Next, we chose the value of the parameter $\tau = 0.04$. The choice of parameter here corresponds to the Czech 4% property tax. The degree of openness of the economy, $\alpha = 0.6$, was determined by calculating the average of the IMPORT/GDP indicator over the time period under study. Finally, it seemed appropriate to calibrate the parameters η and ζ, which denote the elasticities of substitution for domestic and foreign goods. We kept these elasticities at the values from the sample paper, i.e. $\eta = \zeta = 2$. We followed a similar procedure for the elasticity of substitution between differentiable goods $\epsilon = 6$. Table 2 provides a complete summary of the calibrated parameters.

Table 2 Calibrated parameters

Symbol	Description	Value
β_s	Discount factor of savers	0.99
β_b	Discount factor of borrowers	0.95
γ	Weight of housing in utility	0.10
h	Habit in consumption	0.70
δ	Depreciation rate of residential stock	0.01
χ	Fraction of housing that cannot be used as collateral	0.25
τ	Property tax	0.04
α	Degree of openness	0.6
ζ	Elasticity of substitution between goods produced in different foreign countries	2.00
η	Elasticity of substitution between domestic and foreign goods	2.00
ϵ	Elasticity of substitution between differentiated goods	6.00

Source: own construction

After calibrating the parameters, we proceeded to set the apriori information for the estimated parameters. Again, we drew on the literature, in particular the model paper by Funke, Kirkby, and Mihaylovski (2017). Apriori values were chosen as follows: Intertemporal elasticities of substitution with respect to consumption and labor $\sigma = 1$, $\varphi = 2$, share of impatient households$\omega = 0.4$, parameters in the Taylor rule $\rho_r = 0{,}5$, $\phi_\pi = 2$ and $\phi_y = 0.2$, sectoral Calvo parameters $\theta_c = 0.8$ and $\theta_d = 0.4$, and indexation degrees in both sectors $\iota_c = \iota_d = 0.5$. The persistence of the AR parameters ρ_{ac}, ρ_{ad}, ρ_c^*, ρ_{μ_c}, ρ_{μ_d}, ρ_γ was set to 0.5 in all cases, and the corresponding shocks e_{ac}, e_{ad}, e_m, e_c^*, e_{μ_c}, e_{μ_d}, e_γ were set to 1. The apriori parameter information is shown in Table 2.

In the next step, the Metropolis-Hastings algorithm was used to generate the posterior distribution of the parameters, which generated two independent strings, each with 2 000 000 replications. The first 45% of the generated replications were discarded, so that the posterior information was obtained from the remaining 1 000 000 replications. The estimated posterior distributions of the parameters are reported in Table 3 along with the 90% HPDI intervals. It is clear from the table that the posterior distributions for most parameters are broadly consistent with the literature findings. We see a more pronounced difference between the a priori and posteriori information for the share of impatient households ω. The estimated value here is lower than the set a priori information. Thus, according to the model estimate, impatient households constitute only a minority of the total labor force in the economy. This claim is not entirely consistent with the similarly focused Czech literature or our assumptions. For example, Hloušek (2016) estimates the share of impatient households at 0.28. Reichel, Němec and Chalmovianský (2019) then estimate a share equal to 0.32. In contrast, the estimates of the Calvo and Taylor rule parameters are hardly different from their a priori settings. For the persistence of the individual shocks, we see that the values are slightly above the a priori setting but deviate significantly only in the case of the technology shock in the housing sector and the foreign shock. In both cases, the persistence is significant. However, these findings are again consistent with the literature, cf. Reichel, Nemec, and Chalmovianský (2019).

Table 3 Estimated parameters

Parameter		Prior		Posterior	
Symbol	**Description**	**Dist.**	**Mean**	**Mean**	**90% Interval**
σ	Intertemp. elasticity of substitution with respect to consumption	Γ	1	1.06	(0.98,1.14)
φ	Intertemp. elasticity of substitution with respect to labor	Γ	2	1.94	(1.79,2.10)
ω	Share of impatient households	β	0.4	0.13	(0.11,0.15)
ρ_r	Taylor rule parameter	β	0.5	0.83	(0.80,0.87)
ϕ_π	Weight of inflation in Taylor rule	Γ	2	1.72	(1.56,1.88)
ϕ_y	Weight of output in Taylor rule	Γ	0.2	0.18	(0.05,0.31)
θ_c	Fraction of firms in sector C that does not adjust prices	β	0.8	0.82	(0.79,0.85)
θ_d	Fraction of firms in sector D that does not adjust prices	β	0.4	0.35	(0.30,0.41)
ι_c	Degree of indexation to the past period's inflation in sector C	β	0.5	0.41	(0.27,0.54)
ι_d	Degree of indexation to the past period's inflation in sector D	β	0.5	0.40	(0.25,0.56)
ρ_{ac}	Persistence of shock in technology in sector C	β	0.5	0.62	(0.56,0.69)
ρ_{ad}	Persistence of shock in technology in sector D	β	0.5	0.96	(0.95,0.97)
ρ_c^*	Persistence of shock in foreign demand of domestically produced goods	β	0.5	0.75	(0.70,0.80)
ρ_{μ_c}	Persistence of cost-push shock in sector C	β	0.5	0.47	(0.40,0.54)
ρ_{μ_d}	Persistence of cost-push shock in sector D	β	0.5	0.63	(0.58,0.69)
ρ_γ	Persistence of housing preference shock	β	0.5	0.50	(0.42,0.58)
e_{ac}	Volatility of shock to technology in sector C	Γ^{-1}	1	5.92	(5.15,6.68)
e_{ad}	Volatility of shock to technology in sector D	Γ^{-1}	1	15.85	(13.43,18.23)
e_m	Volatility of monetary policy shock	Γ^{-1}	1	0.55	(0.42,0.68)
e_c^*	Volatility of shock in foreign demand of domestically produced goods	Γ^{-1}	1	1.84	(1.51,2.15)
e_{μ_c}	Volatility of cost-push shock in sector C	Γ^{-1}	1	1.93	(1.53,2.33)
e_{μ_d}	Volatility of cost-push shock in sector D	Γ^{-1}	1	19.32	(13.02,25.43)
e_γ	Volatility of housing preference shock	Γ^{-1}	1	32.52	(28.03,36.93)

Source: own construction

However, relatively significant differences emerge in the case of the volatility of individual shocks. The posterior values for technology shocks in both sectors are significantly overestimated relative to a priori information. The same is true for the cost-push shock in the real estate sector, and the shock to real estate preferences appears to be the most volatile. These fluctuations suggest that the model is not as well able to capture all aspects of the Czech economy and therefore some of the data specificity is reflected in the high volatility of the shocks. Unfortunately, we were not able to change this fact significantly, even when trying other default settings.

V. Simulated scenarios

In the simulation, we focus on how the combination of a monetary shock, LTV settings and a change in the openness of the economy affect the behaviour of the variables. We were inspired by recent government actions associated with the global pandemic. Recent events have partially reduced the openness of our otherwise open economy. In this scenario, we attempt to show whether the model would be able to reflect the change in the openness of the economy in simulations and to what extent this change would be noticeable compared to the baseline setting. For these scenarios, we have chosen to close the economy quite strongly, which (while not fully reflecting reality) may help us understand how this relatively strong parameter change would be reflected in the dynamics of impulse responses. From the original openness value $\alpha = 0.6$, we have reduced the parameter to $\alpha = 0.1$. Next, we simulated a monetary shock of one standard deviation to the economy while considering three variants of the LTV macroprudential instrument setting. The benchmark setting of LTV at 0.75, as in the model estimation, a high LTV equal to 0.85, at which borrowers find it easy to obtain credit, and a low LTV equal to 0.20, at which borrowers are severely constrained in their ability to borrow. The impulse responses of the selected variables are captured in Figure 2.

In the first step, we discuss the implications of alternative settings of the loan to value ratio. The interpretation will be made for a constant value of the openness of the economy of 0.6, i.e. the discussion of the following paragraphs will only concern the black lines depicted in Figure 2. The different types of lines correspond to alternative values of LTV.

The first graph in Figure 2 represents the short-term increase in the nominal interest rate. We begin our analysis of the effects of this increase with the impulse response of inflation (CPI). As expected, there is an immediate decline in inflation, in our case by about 1.5% for all three LTV settings. A similar value (2%) is also reported by, for example, Hloušek (2016). Similar to the price level, an increase in the interest rate can be expected to lead to a decrease in prices in the property market as well. For the impulse response of house prices, we observe a decline that varies slightly in the first response depending on the magnitude of the LTV parameter setting. Hloušek (2012) also obtained a similar impulse response for all three alternative scenarios, but in his paper the house prices fell by 6%.

The bond variable shows one of the most significant differences between the scenarios. In the case where borrowers are severely constrained, borrowing falls by about 20 percent and the return to steady state is gradual, on the order of years. This happens because a rising interest rate makes the cost of borrowing relatively more expensive. Impatient households are thus less willing to take on new debt, and hence total liabilities (bonds) fall. In both the LTV=0.75 and LTV=0.85 scenarios, the drop is up to twice as large, at 40%. This chart demonstrates the key features of the LTV macro-prudential tool. A more restrictive setting of the instrument moderates the fluctuations in household behaviour associated with an unexpected monetary shock while spreading the fluctuation over a longer period of time.

The impulse response of aggregate consumption provides, at first sight, significantly different results for different scenarios. It drops the most in a situation of relaxed LTV, i.e. when the ability of impatient households to borrow is easier. It is confirmed that under these conditions, the behaviour of impatient households is most sensitive to an unexpected shock and there is a reduction in consumption of less than 3%. In the case of restrictive LTV, the immediate decline is only 1%, but it deepens to 1.5% in the third quarter. A similar shape of the impulse response for consumption is found, for example, in Hloušek (2016). At the same time, the consumption spike is strongly persistent in all three situations, with the return to steady state occurring only after three years. The decline in consumption is quite consistent with our expectations, but usually the difference between the scenarios is more pronounced. For example, Reichel, Němec, and Chalmovianský (2019) observed a difference of up to 3 percentage points in the high and low LTV settings, while in the case of Hloušek (2012) a difference of up to 5 percentage points was observed. In contrast, in Walentin (2014) the difference between the two situations is only about half a percentage point.

Part of the decline in consumption is due to the strong response of impatient households - borrowers are more credit constrained and therefore react more sensitively to interest rate changes. The willingness of impatient households to consume is therefore directly linked to the ability to borrow, based on the value of collateral. The value of collateral in our model corresponds to the value of real estate. As mentioned earlier, house prices fall in response to a restrictive monetary shock, so the value of collateral that impatient households can use falls. As a result, borrowers are forced to reduce their current consumption. The second reason for the reduction in borrowers' consumption is the so-called Fisher debt-deflation effect. This concept, described by Irving Fisher (1933), states that an increase in the nominal interest rate increases the ex-post value of existing debt. Thus, there is a redistribution of wealth from debtors to creditors, and debtors are therefore forced to reduce their current consumption. We therefore observe a significant fall in consumption for both non-durable and durable goods. When the LTV is set relatively loose, the response to a monetary shock is amplified for impatient households. Such strong fluctuations are naturally not desirable and can lead to destabilisation of the economy. We observe from the impulse responses that a restrictively set LTV may be a partial solution. In the case of consumption of goods and real estate (nondurable goods), a more restrictive LTV setting can reduce the fluctuation. Walentin (2014) comes to a similar conclusion, and the reduction in the swing is even more pronounced in Reichel, Němec, and Chalmovianský (2019).

The consumption of goods by patient households also declines, but it is a relatively weaker decline. Patient households thus respond to the fact that current consumption is relatively more expensive, but they are not bound by any constraint, so they do not have to change their behavior significantly. For consumption of durable goods, we observe a marked change in the behaviour of patient households. In a situation of relaxed LTV, the fluctuation is even as high as 60%. Although we could attribute part of this response to substitution between consumption, it does not seem likely that this reason would lead to such a significant change in behaviour. We must therefore conclude that the dynamics of a given consumption are probably not captured correctly by the model.

In a second step, we compare the situation between a less open and an open economy. The responses of the less open model economy to the monetary shock are shown in grey in Figure 2. Again, the different types of lines correspond to alternative values of LTV.

Figure 2 shows that a relatively large shift in the openness of the economy does not significantly change the impulse responses. Focusing on the individual settings of the LTV parameter, we see that the corresponding black and grey lines follow an identical trajectory almost every time. Only in the CPI inflation and patient household consumption graphs is captured a more pronounced change.

In the CPI inflation response, we observe a slightly smaller decline in the less opened economy and a much slower return to steady state. This may be due to the persistent interest rate response in the less opened economy, caused by lower foreign contribution to the dynamics of the modelled economy. The interest rate response in a small open economy is not as persistent, so the return to steady state is faster due to the higher role of foreign participation in the domestic economy. In other words, the effects of restrictive monetary policy on inflation subside (according to the model simulations) more quickly in an open economy.

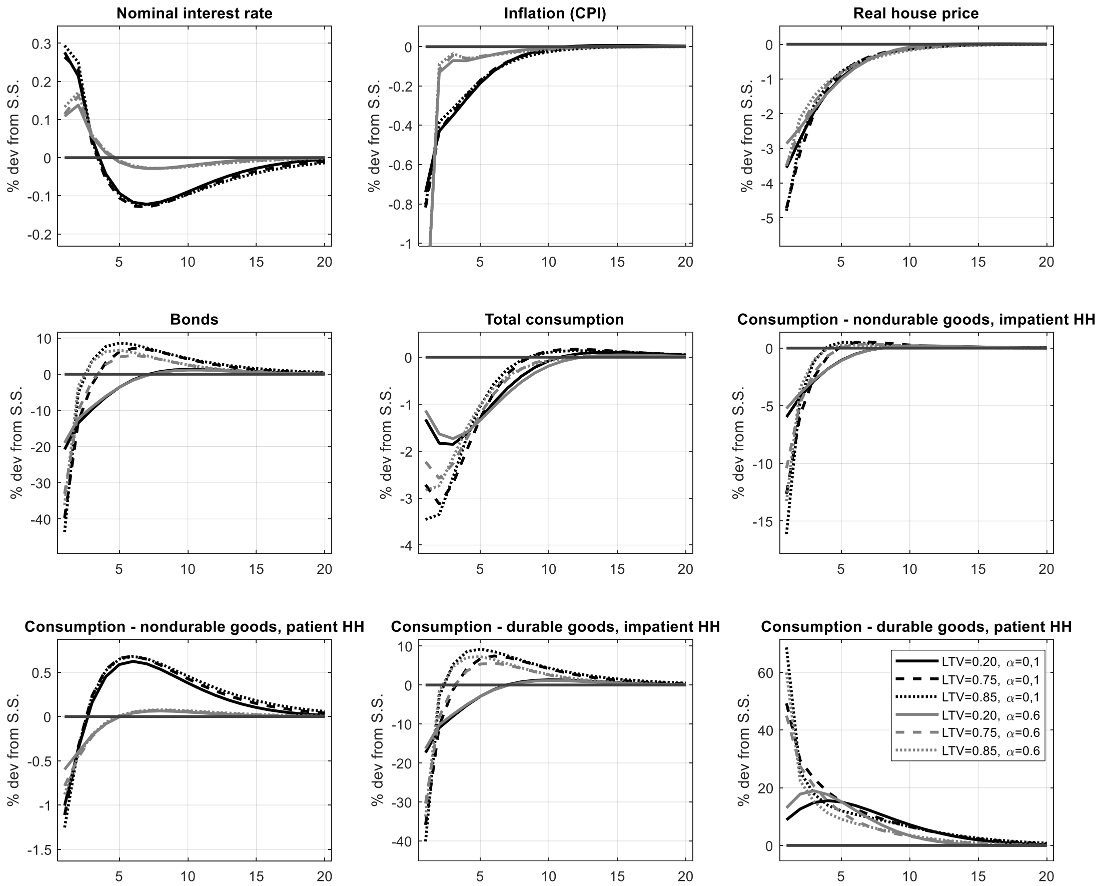
House prices, bonds, and domestic and foreign consumption of impatient households react significantly similarly to monetary restriction in both situations (open vs. less open economy). This is because impatient households are not able to interact with the foreign economy according to the model, so the change in openness does not affect them significantly.

Patient households, on the other hand, could enter the international market and therefore experience a more pronounced change in consumption. For non-durable goods, consumption falls more sharply in a less open economy and then rises above the steady state level. However, if we focus on the magnitude of the impulse response, the difference with a more open economy is only on the order of tenths of a percentage point. For durable goods, we observe an interesting development in the sense that consumption grows less with a restrictive LTV setting and a less open economy than with the same LTV in a more open economy. However, at benchmark or high LTV settings, consumption of durable goods by patient households in a less open economy grows more than in an open economy.

The difference between the less open and the more open scenario is evident in the response of aggregate consumption for the first four periods or so after the monetary shock, caused by a decline in the current consumption of patient households. After about a year, the two scenarios evolve similarly. Consumption then returns to steady state around Q10 after the intervention of the restrictive monetary shock.

Overall, as expected, the change in the openness of the economy has been reflected in the behaviour of patient households as they are able to trade with foreign countries. However, all observed changes are at the level of tenths of a percent and negligible for our analysis of the appropriate monetary and macroprudential policy mix.

Figure 2 Impacts of the Monetary Shock across alternative scenarios



Source: own construction

VI. Conclusion

The aim of this paper was to describe and then quantify the effects of monetary and macroprudential policy on the housing market when the openness of a small economy is reduced. We chose three options for setting the macroprudential limit for the loan-to-value ratio, namely a model-estimated LTV of 0.75, a restrictive LTV of 0.2 and a relaxed LTV of 0.85. The impulse responses showed that the more restrictive LTV is able to moderate the fluctuations in the variables in response to a monetary shock, while also being able to spread the fluctuations over a longer period of time. These LTV properties were most pronounced for total consumption and for individual consumption of impatient households. Here, the restrictive LTV was able to reduce the size of the fluctuation by more than half of the relaxed LTV. On the other hand, for the price of real estate, the difference between the scenarios does not appear to be significant. The impact of a reduction in the level of openness of the economy was not significant for most variables. Only patient households changed their behaviour significantly in the case of consumption of immediate consumption goods. Here, there was first a more pronounced decline followed by a rapid increase in consumption. Overall, therefore, it was possible to show that the responses of the individual variables are considerably amplified when the LTV is relaxed, and hence that a tightening of the LTV could help moderate the fluctuations of the economy in response to a monetary shock. The same is confirmed in the Czech economy by Reichel, Němec and Chalmovianský (2019) and Hloušek (2016). In contrast, a sensitivity test of the parameters to the openness setting of the economy showed no significant changes. Although the differences in transmission are quantitatively insignificant according to the model results, the analysis used allows us to capture the economic problem currently being addressed. For example, the CNB forecast also works with a sharp reduction in the openness of the economy in the first half of 2020 (see Zpráva o inflaci 2020/III, p. 27). Besides, with a more elaborate exchange rate channel in the model, the results would probably be much more interesting. Enriching the model with an exchange rate channel will be the subject of further research.

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Appendix

Log-linear Model Equations

$$[-\sigma+\gamma(\sigma-1)]\widehat{\tilde{c}_t^b}+\gamma(1+\sigma)\widehat{d_t}^b=[-\sigma+\gamma(\sigma-1)]E_t\widehat{\tilde{c}_{t+1}^b}$$

$$+\gamma(1-\sigma)E_t\widehat{d_{t+1}^b}+\widehat{r_t}-E_t\widehat{\pi_{c,t+1}}+\frac{\overline{\lambda_2}}{\beta_b}\left(\widehat{\lambda_2}+\widehat{r_t}\right)-\frac{\gamma}{1-\gamma}\left(\rho_\gamma-1\right)\epsilon_t^\gamma \qquad Eq.1$$

$$(1+\tau)\widehat{q_t}=\frac{\gamma}{1-\gamma}\frac{\widehat{\tilde{C}^b}}{D^b}\overline{Q}^{-1}\left(\widehat{\tilde{c}_t^b}-\widehat{d_t^b}\right)+$$

$$+\beta_b(1-\delta)(1+\tau)\left([-\sigma+\gamma(\sigma-1)]\left(\widehat{\tilde{c}_t^b}-E_t\widehat{\tilde{c}_{t+1}^b}\right)+\gamma(1-\sigma)\left(\widehat{d_t^b}-E_t\widehat{d_{t+1}^b}\right)+E_t\widehat{q_{t+1}}\right)+$$

$$+(1-\chi)(1-\delta)\lambda_2\left(\widehat{\lambda_2}+E_t\widehat{q_{t+1}}+E_t\widehat{\pi_{c,t+1}}\right)+$$

$$+\frac{\gamma}{1-\gamma}\left[1+\tau+\frac{\widehat{\tilde{C}^b}}{D^b}+Q^{-1}-\left((1-\chi)(1-\delta)\lambda_2\right)-\beta_b(1-\delta)(1+\tau)\rho_\gamma\right]\epsilon_t^\gamma \qquad Eq.2$$

$$\widehat{r_t}+\widehat{b_t^b}=E_t\widehat{q_{t+1}}+\widehat{d_t^b}+E_t\pi_{c,t+1} \qquad Eq.3$$

$$\frac{\overline{C}^b}{\overline{D}^b}\widehat{c_t^b}+\overline{Q}^{-1}\left[\delta\widehat{q_t}+\widehat{d_t^b}-(1-\delta)\widehat{d_{t-1}^b}\right]+\beta^{-1}\frac{\overline{B}^b}{\overline{D}^b}\left(\widehat{r_{t-1}}+\widehat{b_{t-1}^b}-E_t\widehat{\pi_{c,t}}\right)$$

$$=\frac{\overline{B}^b}{\overline{D}^b}\widehat{b_t^b}+\frac{1}{\mu^c}\frac{\overline{N}^b}{\overline{D}^b}\left[[\sigma(1-\gamma)+\gamma]\widehat{c_t^b}+\gamma(1-\sigma)\widehat{d_t^b}+(1+\varphi)\widehat{n_t^b}\right] \qquad Eq.4$$

$$[-\sigma+\gamma(\sigma-1)]\widehat{\tilde{c}_t^s}+\gamma(1+\sigma)\widehat{d_t}^s=[-\sigma+\gamma(\sigma-1)]E_t\widehat{\tilde{c}_{t+1}^s}+$$

$$+\gamma(1-\sigma)E_t\widehat{d_{t+1}^s}+\widehat{r_t}-E_t\widehat{\pi_{c,t+1}}-\frac{\gamma}{1-\gamma}\left(\rho_\gamma-1\right)\epsilon_t^\gamma \qquad Eq.5$$

$$(1+\tau)\widehat{q_t}=\frac{\gamma}{1-\gamma}\frac{\widehat{\tilde{C}^s}}{D^s}\overline{Q}^{-1}\left(\widehat{\tilde{c}_t^s}-\widehat{d_t^s}\right)$$

$$+\beta_s(1-\delta)(1+\tau)\left([-\sigma+\gamma(\sigma-1)]\left(\widehat{\tilde{c}_t^s}-E_t\widehat{\tilde{c}_{t+1}^s}\right)+\gamma(1-\sigma)\left(\widehat{d_t^s}-E_t\widehat{d_{t+1}^s}\right)+E_t\widehat{q_{t+1}}\right)$$

$$-\beta_s(1-\delta)(1+\tau)\rho_\gamma\epsilon_t^\gamma \qquad Eq.6$$

$$(1+\beta\iota_C)\widehat{\pi_{C,H,t}}=\beta E_t\widehat{\pi_{C,H,t+1}}+\iota_c\widehat{\pi_{C,H,t-1}}+K_C\widehat{mc_{C,t}}+\epsilon_t^{\mu_C} \qquad Eq.7$$

$$(1+\beta\iota_D)\widehat{\pi_{D,t}}=\beta E_t\widehat{\pi_{D,t+1}}+\iota_c\widehat{\pi_{D,t-1}}+K_D\widehat{mc_{D,t}}+\epsilon_t^{\mu_D} \qquad Eq.8$$

$$\widehat{\pi_{C,t}}=\widehat{\pi_{C,H,t}}+\alpha\widehat{\Delta s_t} \qquad Eq.9$$

$$\widehat{y_{C,t}}=a_{C,t}+\widehat{n_{C,t}} \qquad Eq.10$$

$$\widehat{y_{D,t}}=a_{D,t}+\widehat{n_{D,t}} \qquad Eq.11$$

$$\widehat{mc_{C,t}} = [\sigma + \gamma(\sigma - 1)]\widehat{\tilde{c}_t^b} - \gamma(1 - \sigma)\widehat{d_t^b} + \varphi\widehat{n_t^b} + \alpha\widehat{s_t} - a_t + \frac{\gamma}{1 - \gamma}\epsilon_t^\gamma \qquad Eq.12$$

$$\widehat{mc_{D,t}} = [\sigma + \gamma(\sigma - 1)]\widehat{\tilde{c}_t^b} - \gamma(1 - \sigma)\widehat{d_t^b} + \varphi\widehat{n_t^b} - a_t - \widehat{q_t} + \frac{\gamma}{1 - \gamma}\epsilon_t^\gamma \qquad Eq.13$$

$$\widehat{y_{C,t}} = (1 - \alpha)\widehat{c_t} + \alpha\widehat{c_t^*} + \alpha[\zeta + \eta(1 - \alpha)]\widehat{s_t} \qquad Eq.14$$

$$[\sigma + \gamma(\sigma - 1)]\widehat{c_t^s} + \gamma(\sigma - 1)\widehat{d_t^s} = \widehat{c_t^*} + (1 - \alpha)\widehat{s_t} \qquad Eq.15$$

$$\widehat{y_{D,t}} = \widehat{\iota_t{}^d} \qquad Eq.16$$

$$\delta\widehat{\iota_t^d} = \widehat{d_t} - (1 - \delta)\widehat{d_{t-1}} \qquad Eq.17$$

$$\widehat{r_t} = \rho_r\widehat{r_{t-1}} + (1 - \rho_r)\left[\phi_\pi\widehat{\pi_t} + \phi_y(\widehat{y_t} - \widehat{y_{t-1}})\right] \qquad Eq.18$$

$$\widehat{q_t} = \widehat{\pi_{D,t}} - \widehat{\pi_{C,t}} - \widehat{q_{t-1}} \qquad Eq.19$$

$$\widehat{n_t} = \frac{\overline{N}_C}{\overline{N}}\widehat{n_C} + \frac{\overline{N}_D}{\overline{N}}\widehat{n_D} \qquad Eq.20$$

$$\widehat{c_t} = \omega\frac{\overline{C}^b}{\overline{C}}\widehat{c_t^b} + (1 - \omega)\frac{\overline{C}^s}{\overline{C}}\widehat{c_t^s} \qquad Eq.21$$

$$\widehat{d_t} = \omega\frac{\overline{D}^b}{\overline{D}}\widehat{d_t^b} + (1 - \omega)\frac{\overline{D}^s}{\overline{D}}\widehat{d_t^s} \qquad Eq.22$$

$$[\sigma - \gamma(\sigma - 1)]\widehat{\tilde{c}_t^b} - \gamma(1 - \sigma)\widehat{d_t^b} + \varphi\widehat{n_t^b} = [\sigma - \gamma(\sigma - 1)]\widehat{\tilde{c}_t^s} - \gamma(1 - \sigma)\widehat{d_t^s} + \varphi\widehat{n_t^s} \qquad Eq.23$$

$$\widehat{n_t} = \omega\frac{\overline{N}^b}{\overline{N}}\widehat{n_t^b} + (1 - \omega)\frac{\overline{N}^s}{\overline{N}}\widehat{n_t^s} \qquad Eq.24$$

$$\widehat{y_t} = \frac{\overline{C}}{\overline{Y}}\widehat{y_{C,t}} + \frac{\overline{I}^d}{\overline{Y}}\widehat{y_{D,t}} - \alpha\left[\frac{\overline{C}}{\overline{Y}} - (1 - \gamma)\right]\widehat{s_t} + \left(\frac{\overline{I}^d}{\overline{Y}} - \gamma\right)\widehat{q_t} \qquad Eq.25$$

$$\widehat{\tilde{c}_t^b} = (1 - h)^{-1}\left(\widehat{c_t^b} - h\widehat{c_{t-1}^b}\right) \qquad Eq.26$$

$$\widehat{\tilde{c}_t^s} = (1 - h)^{-1}\left(\widehat{c_t^s} - h\widehat{c_{t-1}^s}\right) \qquad Eq.27$$