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A MACRO-ECONOMETRIC MODEL OF THE HOUSING MARKET IN MALTA

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This article presents a small macro-econometric model to explain house price developments in Malta. The core model consists of a stock-flow framework that models the relationship between house prices, residential investment and housing stock. The housing block is augmented with a stylised real economy block determining potential and actual gross domestic product (GDP), employment and wages, thus allowing the assessment of macro-financial linkages. Using an error-correction modelling (ECM) framework, the model is used to quantify the degree of misalignment in Maltese house prices over the period 1980-2017. Parameter estimates suggest that the price responsiveness to changes in housing supply has changed significantly in recent years, compared to the pre-crisis boom. The recent rise in house prices seems to differ significantly from that observed in the mid-2000s, with house prices more closely aligned to fundamentals, while the recent increase in housing supply should attenuate house price inflation, in contrast to what happened in the mid-2000s when higher supply fuelled higher prices in the short term.



Introduction

An important factor in determining the appropriate functioning of the property market is the responsiveness of house prices to changes in the supply of housing. A better understanding of the supply side is of key importance since it determines the extent to which the housing market responds to demand shocks – with either more construction or higher prices – which has broad implications, including on housing affordability. The responsiveness of housing supply also has implications on the functioning of labour markets and their adjustment to shocks. For instance, the increase in demand for labour by firms, following a demand shock, may result in upward pressure on wages in areas where building new housing units to accommodate the inflow of workers is more difficult.

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The Model

The housing block models the dynamics of house prices and residential investment in a stock-flow framework. This approach makes a distinction between the housing stock, which is rigid in the short run, and the flow of residential investment that reacts faster to macroeconomic conditions. This modelling approach is based on the seminal paper by DiPasquale and Wheaton (1994), which was later implemented in an error-correction framework by McCarthy and Peach (2002). The error correction process, both on the demand and supply sides, is intended to take into account the slow adjustment of the housing market.

Real house prices in the long run depend on the following specification (lower case letters denote variables in logarithms):

$$p_t = \alpha_1 + \alpha_2 ypd_t + \alpha_3 cr_t + \alpha_4 s_t + \alpha_5 r_t + \varepsilon_t^p \quad (1)$$

In the long run, real house prices (p_t) depend on demand shifters (including real disposable income (ypd_t), real credit for mortgages (cr_t) and the real interest rate (r_t)) and the housing stock per capita (s_t). The real interest rate is a simple measure of the user cost, which measures the opportunity cost of capital tied to housing or taken on

credit. The coefficient of interest in this equation is α_4 , which measures the price elasticity to a change in housing supply. A priori, the coefficients on income and credit are expected to be positive, while the coefficients on the housing stock per capita and the interest rates are expected to be negative.

Short-run dynamics of house prices, in turn, depend on demand variables, as well as on the level of disequilibrium between actual and equilibrium house prices in the previous period.

The long-run housing investment equation can be expressed as:

$$i_t = \beta_1 + \beta_2 p_t + \beta_3 cost_t + \beta_4 r_t + \varepsilon_t^i \quad (2)$$

Housing investment (i_t) in the long run depends on real house prices and cost-shifting variables, such as construction costs ($cost_t$) and interest rates (r_t). The coefficient on house prices is expected to be positive, while the coefficients on construction costs and interest rates are expected to be negative. The error term, ε_t^i , tracks the level of over or under-investment in housing investment that cannot be explained by the explanatory variables in equation (2). The short-run dynamics of residential investment depend on the past disequilibrium in residential investment, ε_t^i , which is slowly corrected in each period, as well as on various factors that can influence short-run dynamics in housing investment. Another error-correction form equation links investment to building permits, which are then used to construct a housing stock measure via the following equation:

$$S_t = (1 - \delta)S_{t-1} + PR_{t-1} \quad (3)$$

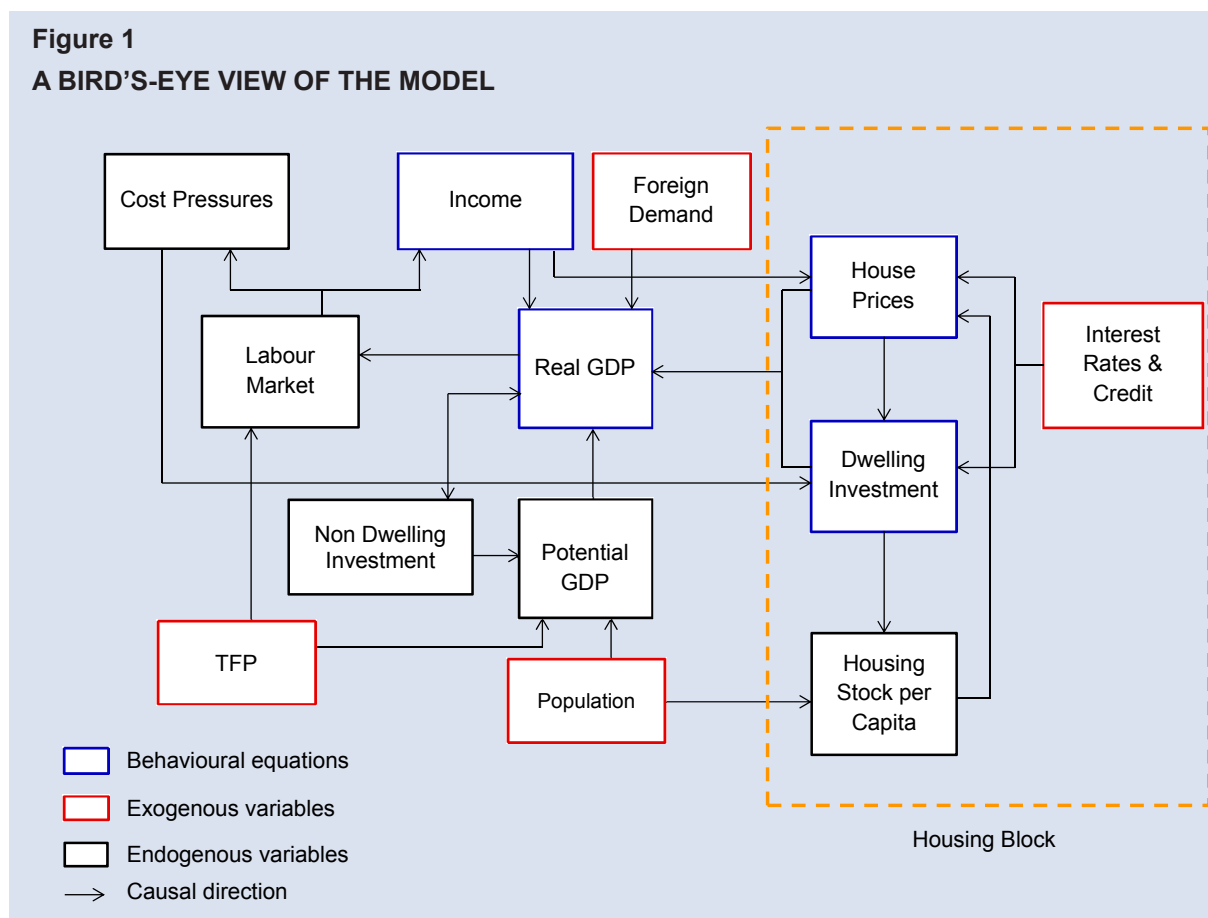
The accumulation identity states that the housing capital stock in period t , S_t , consists of the housing stock in the previous period net of depreciation, augmented by new permits granted, PR_{t-1} . We assume that a permit approved in year t takes a year to be developed into a housing unit. To capture the interlinkages between the housing market and the real economy, the ‘housing’ block described above is augmented with a stylised ‘real’ economy block determining potential and actual output, employment and wages.

Figure 1 provides a stylised representation of the econometric model and the linkages between the ‘housing’ and the ‘real’ blocks of the model. In the long run, the economy’s output is determined by its supply-side potential GDP, which is characterised by a Cobb-Douglas production function, with two factors of production – capital and labour – as well as total factor productivity (TFP). In the short run, real GDP is demand-driven and determined by real house prices (capturing wealth effects associated with home ownership), overall investment, real disposable income and foreign demand. In the long run, employment depends positively on real GDP and negatively on TFP and real wages. Activity and wages also exert short-term effects on employment growth. Real wages are a function of labour productivity, both in the short and long term.

“Despite its stylised nature, the model is able to capture the key macro linkages between activity and the labour market, which, in turn, feed back into the housing market”

Despite its stylised nature, the model is able to capture the key macro linkages between activity and the labour market, which, in turn, feed back into the housing market. Take, for instance, an increase in population. Taking the housing block in isolation, an increase in population lowers the housing stock per capita, thus putting upward pressure on house prices. Taking in consideration the real block, however, higher population will also affect the economy’s supply potential, raising economic activity and income, which will, in turn, feed back into higher house prices and, with a lag, dwelling investment. Increases in activity could also exert cost pressures, which will eventually lower investment in housing.

Figure 1
A BIRD'S-EYE VIEW OF THE MODEL



Data

Most of the variables used for estimation purposes are derived from the annual historical macroeconomic database described in Grech (2015). Property prices refer to the Central Bank of Malta house price index, which is based on advertised prices.¹ A key missing variable from this database refers to the housing stock series. To the best of our knowledge, official data for the housing stock exist only as snapshots across different censuses carried out for Malta. There are five observations for the housing stock since the 1960s (1967, 1985, 1995, 2005 and 2011). As described in equation (1) above, the model-consistent variable refers to housing units rather than the value of the housing investment, with development permits linking residential investment to the housing stock.² Chart 1 plots the model estimates of the housing stock, together with the official data points from the census. According to our estimates, by 2017 the housing stock had increased by around 8%, compared to the 223,850 units reported in the

¹ Another house price index available in Malta is that published by the National Statistics Office (NSO), which is based on contract prices. The main limitation of the NSO house price index is that this series is only available from 2005. On the contrary, the advertised price series goes back to 1980. In recent years, the advertised house price index has been increasing at a much faster pace compared to the index based on contract prices. See Micallef (2018) for a discussion on the differences between the two indices.

² The computation of the historical series of the housing stock differs slightly from equation (3) and is specified as follows: $S_t = (1 - \delta_t) S_{t-1} + \gamma_t PR_{t-1}$ whereby γ is the utilization rate. The depreciation rate accounts for both the natural destruction of housing units due to low maintenance or due to the dwellings becoming uninhabited, as well as for the destruction of dwellings for re-development purposes. The depreciation and utilisation rates are both time varying, which allow us to control the rate at which the housing stock accumulates, such that our estimates pass as close to the official census data points as possible. Official data on development permits start in 1993. For pre-1993, we use an estimated relationship between permits, dwelling investment and the lending interest rate for the period 1993-2015, and assume that the same relationship held in the earlier period. After 2011, there are no official housing stock figures that would help the calibration of the depreciation and utilisation rates. In this regard, from 2012 onwards, we use information on permits for net new units after controlling for any dwelling units that are destroyed in conversion or re-development projects. This information can be found on the Planning Authority website: <https://www.pa.org.mt/file.aspx?f=12616>.

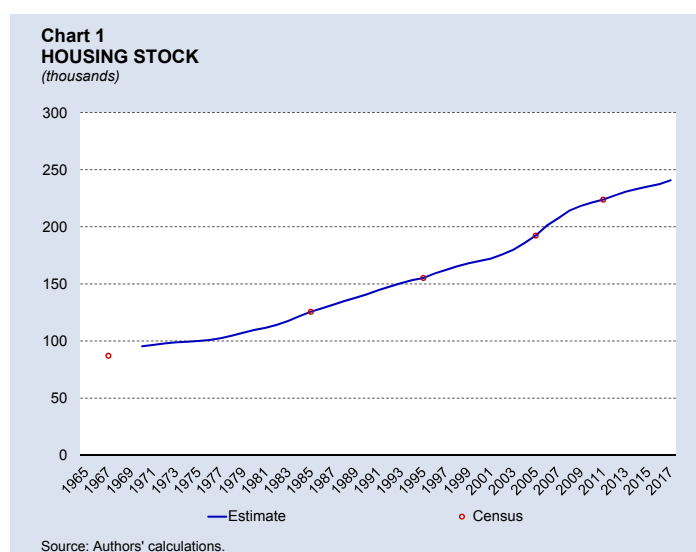
census in 2011. The key housing supply variable in the model (s_t in equation 1) is computed as the housing stock per population head.

In the absence of a long time series of construction costs in Malta, unit labour costs are used as an imperfect proxy of cost pressures.

Estimation

Table 1 reports the parameter estimates of the two key equations in the housing block – real house prices and real dwelling investment – making a distinction between the short and long-run elasticities. All equations in the model are estimated using ordinary least squares (OLS) on annual data from 1980 to 2017. The coefficients have the expected sign and are statistically significant.

House prices tend to increase with households' disposable income, mortgage credit and population, with these variables being related to higher demand for housing. The sum of the coefficients of disposable income and credit are restricted to unity in the long run. On the contrary, the effects of the housing stock and real interest rates have



**Table 1
ESTIMATION RESULTS**

| Real house prices | | | Real dwelling investment | | |
|-----------------------------------|-------|-----|--------------------------------------------|-------|-----|
| Long-run elasticities | | | Long-run elasticities | | |
| Real disposable income | 0.83 | *** | Real house prices | 0.56 | * |
| Real mortgage credit | 0.17 | *** | Real unit labour costs | -2.62 | ** |
| Housing stock per capita | -1.3 | *** | Real lending rate | -5.44 | *** |
| Real lending rate | -2.17 | *** | | | |
| Short-run elasticities | | | Short-run elasticities | | |
| Δ Lagged real house prices | 0.29 | *** | Δ Lagged real dwelling investment | 0.4 | *** |
| Δ Real mortgage credit | 0.17 | ** | Δ Real construction lending | 0.22 | *** |
| | | | Δ Real GDP growth between Y1 and Y2 | 0.66 | |
| Error correction term | -0.4 | *** | Error correction term | -0.32 | *** |
| Adj R2 | 0.71 | | Adj R2 | 0.79 | |
| DW | 1.76 | | DW | 2.25 | |

Note: (*), (**) and (***) denote statistical significance at the 10%, 5% and 1% level, respectively.

Estimation period: 1980-2017.

Source: Authors' calculations.

a dampening effect on house prices. *Ceteris paribus*, a 1% increase in the housing stock per capita, lowers real house prices by 1.30% in the long run. Similarly, a 1 percentage point increase in the real interest rate, lowers house prices by 2.2% in the long run.³ In the short run, real house prices are affected by past developments in house prices and real mortgage credit. The adjustment of house prices to their long-run equilibrium is moderate, with 40% of the adjustment occurring after the first year.

In the supply equation, real house prices have a positive effect on investment, while cost pressures and interest rates have a negative effect. The price elasticity of housing supply, that is, the responsiveness of new supply to changes in house prices, is below unity. *Ceteris paribus*, a 1% increase in real house prices, raises housing investment by 0.56% in the long run. This means that in response to a demand shock, housing output will increase proportionally less than prices. The below unitary price elasticity of supply could be due to limitations on land for development, given the small size of the Maltese islands. Indeed, Caldera and Johansson (2011) find a negative cross-country correlation between estimates of housing supply elasticity and population densities. The Maltese labour market also tends to be quite tight and many large projects would require the importation of expensive capital equipment, which tends to delay the response. Other explanations in the literature, which include local land-use and planning regulations, the provision of infrastructure and other public services complimentary to housing, such as road junctions or water drainage, are also likely to influence supply, although the magnitudes of these effects are uncertain.

In the short run, real housing investment is affected by real lending to the construction sector, the change in real GDP growth compared to a year earlier (capturing accelerator effects), as well as by lagged housing investment. The adjustment of investment to its long-run equilibrium is more sluggish than house prices, with only around 32% of past misalignment corrected after the first year.

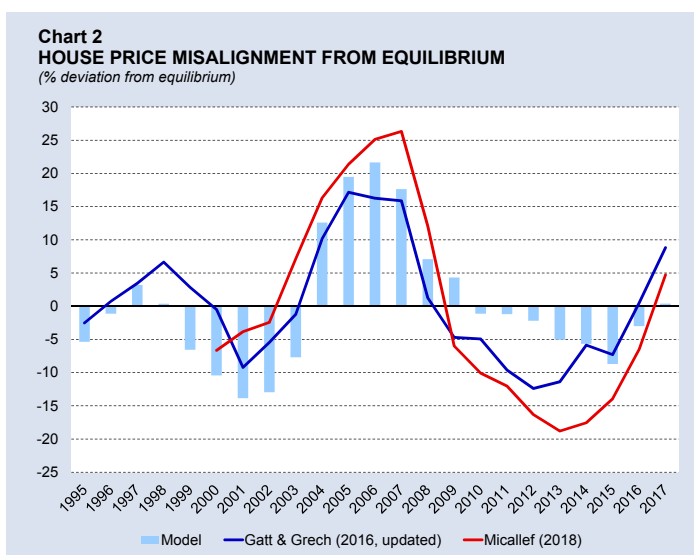
Model applications

The empirical properties of the model are validated by comparing the degree of over or under-valuation of house prices in Malta with other studies in the literature. In addition, we also test the stability of the supply elasticity in the house price equation over the past twenty years to gauge whether the current house price cycle bears any similarity with the pre-crisis housing boom period.

House price misalignment

In addition to examining the impact of shocks to a number of variables on house prices, the model permits an assessment of the misalignment of house prices from their equilibrium value. The equilibrium value of house prices can be determined from the residuals of the long-run house price equation.

Chart 2 compares the deviation of actual house prices from their equilibrium values derived from the model, with two recent studies that also looked at the degree of house price misalignment in Malta (Micallef, 2018; Gatt and Grech, 2016). In all cases, the gaps are based



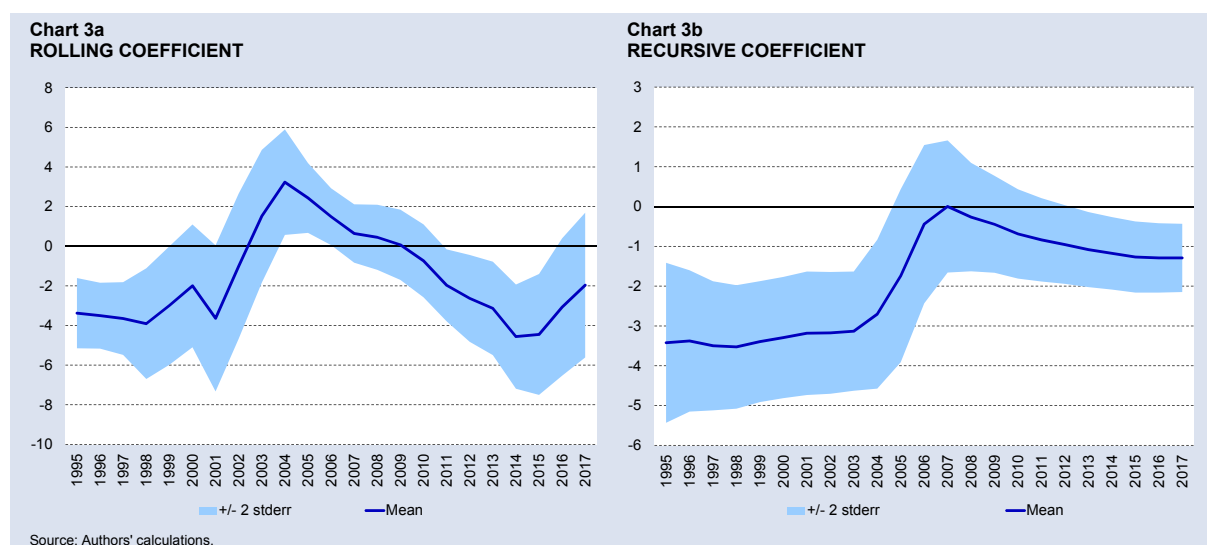
³ In line with literature, we have estimated the house price equation using a number of different supply measures, namely using the number of housing units per household and the vacancy rate of dwellings, thereby controlling for changes in the typical size of households. In both cases, the estimated price elasticity with regards to housing supply is lower than in the baseline version but is not statistically significant at conventional levels. However, the magnitude is well in line with results published in Caldera and Johansson (2011), especially for countries with high population density. Results for the elasticity of house prices with respect to real interest rates are broadly in line with empirical evidence from other countries in which mortgage rates are linked with market rates. For more information, see Tsatsaronis and Zhu (2004).

on advertised house prices to ensure comparability, given that the increases in contract prices were much less pronounced in recent years. The model-implied house price misalignment is broadly in line with these studies. According to the model, real house prices in Malta were overvalued by around 20% in the pre-crisis housing boom. All three measures indicate that this overvaluation started to be corrected during and after the financial crisis. The inclusion of housing supply per capita could explain the difference in misalignment compared to the other two measures during 2010-2013. In particular, the sharp decline in development permits, coupled with population growth, led to a slowdown in per capita housing which, in turn, limits the drop in equilibrium prices that would otherwise prevail. However, this was only a temporary factor and a negative misalignment started to emerge from 2013 onwards. Similar to the other two indicators, the undervaluation in house prices started to be corrected such that, by 2017, house prices were either broadly in line with, or slightly above, fundamentals, depending on the house valuation method. The difference in misalignment between the model-implied figures and those of the other methods can also be explained by the supply-side factors that are captured by the model. In recent years, population, and consequently household numbers in Malta, have climbed rapidly on the back of strong inward migration. This has resulted in a reduction in available housing stock, creating upward pressures in the model-implied fundamental house prices.⁴

“The difference in misalignment between the model-implied figures and those of the other methods can also be explained by the supply-side factors that are captured by the model”

Testing the stability of the supply elasticity: is this time different?

One of the key questions that can be answered with this model is whether the current buoyant activity in property prices is different from the pre-crisis housing boom. The deviation of house prices from their long-run equilibrium levels has already indicated that the current period is different from before, at least in terms of house price overvaluation measures. Another approach is to test the stability of some coefficients, in this case, the supply elasticity in the house price equation. This stability is tested using a rolling regression, in which the equation is estimated using a sequence of sample periods, thereby estimating a set of estimated coefficients. Chart 3a applies this technique on the house price equation using a fixed window of 15 years, which broadly constitutes the length of the financial cycle (Runstler and Vlekke, 2016). More specifically, the first equation is estimated over the period 1980-1995, the second one for 1981-1996 and so on, until the final regression includes the last observation from the sample. Alternatively, Chart 3b plots the recursive coefficient, with the first regression estimated over the period 1980-1995



⁴ The discrepancy in the 2017 equilibrium valuation of house prices between the different methods is also present under alternative house price specifications, which include the number of households and the house vacancy rate as housing supply proxies.

and each subsequent regression adding one additional observation until the final regression is estimated over the entire sample.

Both specifications indicate significant time variation in the supply elasticity over the sample period. In particular, during the pre-crisis period, this elasticity even changed the sign, implying that, everything else held constant, an increase in the housing supply per capita would have led to even higher increases in real house prices. This could be indicative of a 'bubble' episode in which the increase in the housing stock, rather than reducing the degree of overheating in the housing market, leads to further house price appreciation, possibly due to speculation and exuberance which, in turn, stimulates additional demand for housing. This trend in the pre-crisis period is clearly visible in both charts and is in line with the conclusion from Chart 3, which indicated a substantial over-valuation of house prices during this period. Perhaps more importantly, especially for financial stability purposes, the current period is different from the pre-crisis housing boom. Increases in housing supply should result in house price growth moderating and reduce overvaluation. However, differences in land use and planning regulations, imply that the supply elasticity estimated on the entire sample is unlikely to return to the levels prevailing when the equation was estimated on the sample covering only the 1980s and early 1990s.

Conclusion

The parsimonious housing model documented in this article is designed to integrate both demand and supply-side factors affecting house prices in Malta. Its main contribution lies in the explicit treatment of housing supply and the linkages of the housing market with the real economy, and can be used to conduct simulation and policy analysis. The model is used to quantify the degree of misalignment in Maltese house prices and test the stability of key parameters. The results presented here suggest that the recent rise in house prices differs significantly from the boom period of the mid-2000s, with house prices more closely aligned to fundamentals, while the recent increase in housing supply should attenuate house price inflation, in contrast to what happened in the mid-2000s, when higher supply drove prices higher in the short term.

Some caveats are in order. The parameters of the model are estimated on past data and assumed to remain fixed in the future. The coefficients of some parameters are likely to have changed over time, due to policy changes, and may continue to do so in the future. The model abstracts from a more explicit treatment of the private rental market, in no small part due to the absence of adequate information on the rental sector. Going forward, however, the rental market is likely to play an increasingly important role, especially with the strong inflow of foreign workers, as well as socio-demographic changes. The current version of the model does not allow any feedback between housing and the banking sector, with credit and interest rates being exogenous. Similarly, demographics are exogenous but one can envisage extensions that model household tenure, making use of micro data from household surveys. All of these are important areas for further research.

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