BANK ĊENTRALI TA' MALTA
EUROSISTEMA
CENTRAL BANK OF MALTA

RESEARCH BULLETIN 2019

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ISSN 2617-5657 (print)
ISSN 2617-5665 (online)

FOREWORD

Last year, as part of the 50th anniversary since inception, the Central Bank of Malta launched a new publication: the Research Bulletin. Its scope is to complement the other economic publications of the Bank by showcasing, in a non-technical and approachable manner, research carried out by its economists.

This second edition of the Research Bulletin, in fact, includes four articles which cover a broad range of research areas.

The first article presents an update of STREAM, the Central Bank of Malta's main macro-econometric model of the Maltese economy. STREAM is a traditional model built around the neo-classical synthesis, but in contrast to similar models, it includes fully-fledged fiscal and financial blocks. Since the model has been re-estimated over a longer time series, it now generally features smaller error-correction terms compared to previously published versions. Despite considerable changes in the macroeconomic environment in recent years, namely a period of very strong economic growth, many of the key relationships underlying the Maltese economy remained broadly unchanged. However, results indicate that Malta's price dynamics have become less dependent on foreign prices and increasingly sensitive to developments in the domestic labour market. The rising share of services within Malta's economy, together with a reduction in fossil fuel demands due to reforms in the energy sector, have also meant that the islands have become less sensitive to oil price fluctuations.

To complement STREAM, the Bank has in recent years, with the assistance of experts from the Banca d'Italia, constructed another model: MEDSEA. The latter is a dynamic stochastic general equilibrium model, thus adopting what has gradually become the leading framework used by macroeconomists to assess outcomes of policy changes. The article outlines the extension of MEDSEA to include housing and credit frictions. In the new version of the model, households have access to collateralised borrowing, which is subject to a maximum loan to value (LTV) constraint. As a result, shocks that impact house prices are amplified as the changing value of collateral affects households' borrowing limits. The article then shows how a counter-cyclical LTV rule dampens economic responses to a positive house price shock, highlighting the potential for macroprudential policy to limit systemic risks. Future versions of MEDSEA will try to extend the usefulness of the model to assess macroprudential policy, by refining the modelling of the banking system to reflect better current regulations, such as minimum capital requirements.

The third article in this year's edition of the Research Bulletin presents the main findings from the third wave of the Household Finance and Consumption Survey (HFCS) for Malta which was conducted in 2017. The HFCS is part of a co-ordinated research project led by the European Central Bank which involves national central banks from most member states of the European Union. The results from this survey of over 1,000 Maltese households provide very detailed information on their real and financial assets, liabilities, net wealth, income, consumption and savings. The article also compares how these indicators evolved compared to the two previous waves of the survey carried out in 2010 and in 2014. The latest results suggest that the share of households stating that their annual expenses were lower than their income is rising (45.6% of households managed to save part of their gross income, up from 36.6% in 2013, and 23.7% in 2010). While average net wealth rose by 24.0% over the three waves, the increase in the median value was less steep, up by 17.5% from 2010. This indicates that wealth inequality has risen over time. These micro-level household data contribute to a better understanding of behavioural trends and developments underlying macro statistics and open up various avenues for further research.

The final article of the Research Bulletin also uses a new set of data to conduct policy research. It is the fruit of a collaboration with an American academic, who was hosted by the Bank as a Fulbright Scholar. This was the first time that the Central Bank of Malta participated in this prestigious and competitive academic exchange program, with the assistance of the US Embassy in Malta. The article utilises a novel dataset derived from mortgage contracts granted by the major credit institutions in Malta to compute a range of hedonic house price indices for the period 2010-2018. This dataset contains information about house prices and a number of important property characteristics, and is augmented by geographic and socio-demographic variables. After considering a number of

methodologies suggested by Eurostat, the study finds that after a period of relatively muted growth in house prices over the period 2011-2014, ranging between 1.1% and 1.5%, subsequent years saw a marked pick-up, averaging between 7.8% and 8.4%. The wider range estimated between the hedonic indices in the later years suggests that the implicit prices attached to a property's attributes have undergone a significant change. However, the study also notes that the mortgage market now typically covers only around half of the property market in Malta, with the other half dominated by other means of financing. This may limit the generalisation of the article's results to the overall property market.

Similar to the articles in the first edition of the Research Bulletin, these four research articles give a very good overview of some of the most pertinent questions facing policymakers in Malta. Due to the rapid pace of change of the Maltese economy, policymakers require new datasets and new analytical tools to be able to adequately monitor developments. This is particularly true in areas such as the study of inequality and the housing market. At the same time the development of new models and new datasets takes considerable time and resources, which sometimes may jar with the short time span available for policymakers to take their decisions. This is why it is fundamentally important that economic research is forward looking and proactive, to ensure that it remains relevant to policymakers.

Dr Aaron G. Grech
Chief Officer, Economics

STREAM: A MACRO-ECONOMETRIC MODEL OF THE MALTESE ECONOMY

Ian Borg, Brian Micallef and Noel Rapa

This article presents an update of STREAM, the Central Bank of Malta's macro-econometric model of the Maltese economy. The model's database has been updated until 2018Q4 and the behavioural equations, specified in error-correction form, have been re-estimated. The newly estimated model generally features smaller error-correction terms mainly due to longer time-series used for estimation. The properties of the re-estimated model are illustrated using four standard simulations to foreign demand, interest rates, oil prices and the exchange rate. Despite considerable changes in the macroeconomic environment in recent years, including a period of very strong economic growth and the decline in the unemployment rate to historical lows, many of the key relationships underlying the Maltese economy have remained broadly unchanged.

Introduction

Modern economies are considerably complex and Malta is no exception. Economies allocate limited resources and output produced is consumed by a large number of agents, mainly individuals, firms and governments, with the action of these agents being interlinked. A macro-econometric model is a simplified description of this complex interaction in reality. It is intended to capture the key economic relationships underpinning an economy, usually on the basis of both economic theory and empirical evidence, and thus serves to assist analysts and policymakers in understanding the dynamics observed in the data and the linkages between the various agents and sectors of the economy.

This article presents an update of STREAM, the Central Bank of Malta's core macro-econometric model of the Maltese economy.[1] This model was developed with three key uses in mind. First, the model is used to conduct simulations and thus assess the impact of various shocks on the domestic economy. Examples of such studies include the impact of the reduction in electricity tariffs (Grech, 2014) and income taxes (Grech, 2015), the extension of hotel height limitations (Micallef and Attard, 2015) and the potential impact of Brexit on the Maltese economy (Rapa, 2017a). Second, the model is used for forecasting purposes, such as in the projection exercises carried out by the Bank as part of the Eurosystem staff macroeconomic projection exercises. Although other tools are used in the forecasting process, such as satellite models, complemented by expert judgement, the model serves as a useful input, particularly with regards to the medium-to-long run where the role of economic theory becomes prevalent. Finally, it is intended to deepen our understanding of how the Maltese economy functions and to stimulate further debate in this regard.

"One of the key features of STREAM is that it contains fully-fledged fiscal and financial blocks, which is not common in traditional structural models of this kind"

STREAM is a traditional macro-econometric model built around the neo-classical synthesis, in other words, output is driven by supply in the long-run but by demand forces in the short-run. The model's database has been updated until 2018Q4 and the behavioural equations, specified in error-correction form, have been re-estimated. Economic agents are assumed to have adaptive expectations. One of the key features of STREAM is that it

[1] STREAM refers to 'Structural and Traditional Econometric model for Malta'. A detailed description of the model is available in Grech and Rapa (2016).

contains fully-fledged fiscal and financial blocks, which is not common in traditional structural models of this kind. These features were introduced following the last two economic crises in Europe, the global financial crisis and the sovereign debt crisis, which served as a bitter reminder of the strong inter-linkages that exist between the financial and fiscal sectors, respectively, and the broader economy.

The model is composed of five blocks: (i) a supply block, (ii) a demand block, (iii) a price-wage block, (iv) a fiscal block, and (v) a financial block. It consists of 257 equations, 29 of which are estimated behavioural equations, and 319 variables; 257 of them are determined endogenously, while the remaining 62 are exogenous. STREAM can thus be considered a medium-scale model that strikes a reasonable balance between containing sufficient detail to capture the key economic relationships characterising the domestic economy, while at the same time remaining manageable and tractable. This is in line with the current modelling practice among many central banks worldwide.

Re-estimation of STREAM

The previous version of the model, documented in Grech and Rapa (2016) and denoted below as Version 3, was estimated until 2013Q4. In the current exercise, the database has been updated until end-2018 and all equations were re-estimated over the period between 2000Q1 and 2016Q4.[2] The update of the database and the re-estimation of the model with recent data were meant to ensure that STREAM remains a faithful representation of how the domestic economy functions. Despite considerable changes in the macroeconomic statistics during this period, including a period of very strong economic growth and the decline in the unemployment rate to historical lows, many of the key relationships underlying the Maltese economy have remained broadly unchanged.

"The update of the database and the re-estimation of the model with recent data were meant to ensure that STREAM remains a faithful representation of how the domestic economy functions"

Table 1 describes the key short run elasticities in STREAM and compares them with those in the previous version. Despite some difference in point estimates, most elasticities remain broadly similar. The main differences refer to a somewhat stronger response of prices to domestic cyclical conditions, measured by the output gap, and a weaker response of prices to foreign price pressures. This is most likely due to two factors. First, in these last years, the Maltese economy has continued its shift toward becoming a more service-oriented economy, a process which has reduced its reliance on imported goods but increased its dependence on labour as the main factor of production (Grech and Rapa, 2019). Secondly, as shown in the simulation results below, the economy has become less sensitive to oil price fluctuations, most probably due to a restructured energy production setup and oil hedging agreements that are intended to keep utility prices stable. These two factors are expected to reduce local price sensitivity to foreign prices while increasing the contribution that wage dynamics are likely to have on domestic price pressures. On the contrary, most long-run elasticities are calibrated in line with economic theory.

Table 1
SHORT RUN ELASTICITIES

	Version 3	Updated
Consumption wrt disposable income	0.30	0.30
Consumption wrt unemployment rate	-1.42	-1.58
Exports wrt world demand	1.04	1.18
GDP deflator wrt foreign prices	0.14	0.09
GDP deflator wrt output gap	0.34	0.41
Import deflator wrt foreign prices	0.50	0.44

Source: Authors' calculations.

[2] The last two years were not included in the estimation period given the tendency of most recent data vintages to be revised. See Grech (2019) for an analysis of revisions to GDP data in Malta.

Table 2
ERROR-CORRECTION TERM IN KEY EQUATIONS

	Version 3	Updated
Private consumption	-0.55	-0.22
Non-dwelling private investment	-0.52	-0.42
Non-SPE exports of goods and services	-0.24	-0.36
GDP deflator	-0.35	-0.34
Import deflator	-0.23	-0.19
Employment	-0.36	-0.35
Private wages	-0.51	-0.42

Source: Authors' calculations.

Furthermore, the re-estimation has improved the fit of most equations, mostly as a result of more degrees of freedom due to longer time series used for estimation. In most instances, the re-estimated behavioural equations also feature a lower error-correction term, implying a more gradual adjustment of any imbalances towards the long-run equilibrium, also mostly due to the longer time series used in the estimation.

"The Maltese economy has continued its shift toward becoming a more service-oriented economy, a process which has reduced its reliance on imported goods but increased its dependence on labour as the main factor of production"

Table 2 describes the error-correction terms in key equations in STREAM. The error-correction term is a principal feature of co-integrated variables and influences the time it takes for any short-run disequilibrium to be corrected before the relationship returns to its long-run equilibrium. For stability purposes, the error-correction term has to be negative and less than one in value. Larger values of this term imply that the endogenous variable in question moves faster to its long-run equilibrium. For instance, an error-correction term of -0.33 implies that 33% of any short-run disequilibrium will be corrected in each quarter. With few exceptions, Table 2 shows that the updated version of STREAM has smaller speed-of-adjustment coefficients, implying a more gradual adjustment towards the long-run equilibrium, which tends to improve its forecasting and simulation properties.

Simulation properties of STREAM

This section presents the results of four simulations to illustrate the properties of the re-estimated model. The simulations are standard: a foreign demand shock, an interest rate shock, an oil price shock and an exchange rate shock. The scope of simulation analysis is largely twofold. First, it sheds light on the dynamic properties of the model and the main propagation channels. Second, it allows us to examine the plausibility of the simulation results the model generates, both from a theoretical and an empirical perspective.

A word of caution is in order in the interpretation of the simulation results. The individual shocks in the simulations are assumed to be orthogonal to the other shocks in the system. In other words, the simulations reported below will only have an impact on one exogenous variable, leaving the other shocks unchanged. To give an example, changes in, say, monetary policy in the euro area by the European Central Bank will affect not only the policy interest rates but will also have an impact on the exchange rate, other asset prices, demand conditions and, eventually, prices, reflecting the usual lags in the monetary policy transmission mechanism. In this particular example, the design of the simulation will only report how domestic endogenous variables react to an increase in interest rates, while keeping the other exogenous foreign variables, such as foreign demand and prices, unchanged. These simulations are best interpreted as a partial equilibrium analysis and should not be construed as representing real-life scenarios, the design of which would require considerable expert judgement.

Foreign demand shock

This shock is defined as a permanent 1% increase in foreign demand for Maltese goods and services. An increase in foreign demand has a positive impact on exports, which in turn raises GDP (see Table 3). This

Table 3
THE MACROECONOMIC IMPACT OF AN INCREASE IN FOREIGN DEMAND
Percentage change from baseline levels unless otherwise specified

	Year 1	Year 2	Year 3	Year 4
Economic Activity				
Real GDP	0.58	0.68	0.59	0.49
Private consumption	0.09	0.40	0.39	0.18
Government consumption	0.21	0.23	0.08	0.14
Gross fixed capital formation	0.27	0.64	0.57	0.41
Exports of goods and services	1.08	0.87	0.64	0.57
Imports of goods and services	0.73	0.67	0.48	0.36
Prices and Costs				
HICP	0.01	0.11	0.34	0.53
GDP deflator	0.03	0.27	0.62	0.76
Unit labour costs	-0.21	0.23	0.47	0.59
Labour Market				
Unemployment rate	-0.04	-0.12	-0.11	-0.05
Employment	0.16	0.52	0.69	0.71
Compensation per employee	0.20	0.39	0.37	0.37
Fiscal Developments				
Balance[(1)]	0.05	0.13	0.18	0.19
Gross debt[(1)]	-0.32	-0.63	-0.93	-1.11

Source: Authors' calculations.
[(1)] Absolute change from baseline as per cent of GDP.

boosts employment and wages, and hence disposable income, which, in turn, raises private consumption. Higher GDP results in lower unemployment. Buoyant economic activity stimulates investment and also gives rise to an increase in government consumption. These developments stimulate GDP further although this is partially offset by an increase in imports, given the relatively high import content of domestic demand components, which is usually the case in small and open economies. The increase in GDP exerts upward pressure on prices and cost pressures, which eventually leads to a loss in competitiveness and consequently to a gradual slowdown in export growth. Turning to fiscal developments, buoyant economic activity boosts government revenues. At the same time, government expenditure also increases due to the rise in public compensation of employees, public intermediate consumption and government investment. The net effect translates into an improvement in the government balance, which causes the government debt ratio to fall.

Interest rate shock

This shock is defined as a permanent increase in the policy interest rate by 50 basis points.[3] A contractionary monetary policy shock set by the European Central Bank raises bank lending rates and thus reduces the demand for credit. In line with results shown in Micallef et al. (2016), the transmission of monetary policy shocks to Maltese market rates is imperfect. Following the shock, private consumption falls as a result of the higher lending rate to households, as well as lower demand for credit and the deterioration in the labour market, with lower employment and a slight increase in the unemployment rate (see Table 4). Investment also contracts due to an increase in the user cost of capital together with weaker demand for credit by businesses. The decline in private consumption and investment lowers GDP, which in turn leads to a decrease in employment and wages, albeit with a lag. All these effects dampen GDP even further though the effects are to some degree offset by lower imports and a slight improvement from exports, owing to the downward pressure on prices that improves the country's competitiveness.

On the fiscal side, government revenue shrinks due to weaker macroeconomic performance. This adverse impact on government finance is reinforced by an increase in government expenditure as a result of higher

[3] This shock differs from the monetary policy shock reported in Grech and Rapa (2016). In the latter study, the simulation consisted of a 50 basis point increase in interest rate combined with an appreciation of the euro against the other currencies by 0.5%.

Table 4
THE MACROECONOMIC IMPACT OF AN INCREASE IN INTEREST RATES
Percentage change from baseline levels unless otherwise specified

	Year 1	Year 2	Year 3	Year 4
Economic Activity				
Real GDP	0.00	-0.11	-0.20	-0.21
Private consumption	-0.31	-0.92	-1.19	-1.26
Government consumption	0.00	-0.04	-0.08	-0.08
Gross fixed capital formation	-0.10	-0.63	-0.87	-0.90
Exports of goods and services	0.00	0.02	0.09	0.13
Imports of goods and services	-0.17	-0.46	-0.52	-0.51
Prices and Costs				
HICP	0.00	0.00	-0.02	-0.08
GDP deflator	-0.01	-0.03	-0.06	-0.11
Unit labour costs	0.00	0.04	-0.02	-0.10
Labour Market				
Unemployment rate	0.00	0.01	0.03	0.03
Employment	0.00	-0.03	-0.12	-0.19
Compensation per employee	0.00	-0.04	-0.10	-0.12
Fiscal Developments				
Balance[(1)]	-0.08	-0.18	-0.28	-0.35
Gross debt[(1)]	0.08	0.32	0.64	1.01

Source: Authors' calculations.
[(1)] Absolute change from baseline as per cent of GDP.

interest payments. As a result, the deterioration in the fiscal balance leads to an increase in the government debt ratio.

Oil price shock

This shock is defined as a permanent increase in oil prices by 10% from the price level of €85. As expected from a supply-side shock, higher oil prices lead to an upward pressure on prices and an adverse effect on economic activity (see Table 5). The increase in price pressures translates into a loss in competitiveness and a decline in export growth. The labour market situation also deteriorates, with a decline in employment and a slight increase in the unemployment rate. The increase in nominal compensation per employee is outweighed by higher prices, resulting in a decline in the real wage and in real household disposable income, which depresses private consumption. Subdued economic activity also leads to a drop in investment. The overall contraction in GDP is offset to some degree by lower imports.

With regard to fiscal developments, even though GDP shrinks, government revenue increases because some macroeconomic bases expand in nominal terms on the back of higher prices. Similarly, government expenditure rises, albeit with a lag, due to an increase in nominal public compensation of employees, brought about by the gradual pass-through of elevated prices, coupled with higher social benefits resulting from rising unemployment. Overall, these developments give rise to a slight improvement in the government balance ratio in the first year but a deterioration thereafter. The government debt ratio follows similar dynamics, though in the opposite direction.

It is also likely that the impact of oil prices on prices and economic activity is dependent on the starting level of oil prices. In other words, the pass-through from, say, a 10% increase in oil prices is different at oil prices of €50 per barrel and €150 per barrel. One explanation for this level-dependency is the presence of fixed excise taxes in consumer energy prices, which imply a larger direct impact of oil price changes on consumer prices at higher price levels.[4] These effects are modelled by first estimating the impact on consumer prices using the Narrow Inflation Projection Exercise (NIPE) satellite framework, which is used by the Bank to prepare highly disaggregated inflation

[4] See Structural Issues Report (2010) for further details on energy level dependency.

Table 5
THE MACROECONOMIC IMPACT OF AN INCREASE IN OIL PRICES
Percentage change from baseline levels unless otherwise specified

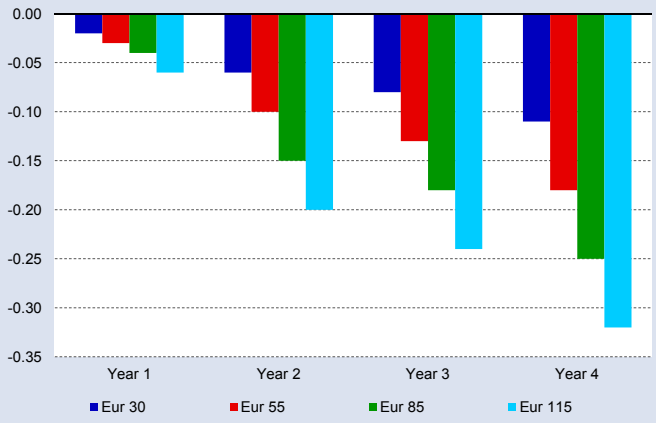
	Year 1	Year 2	Year 3	Year 4
Economic Activity				
Real GDP	-0.04	-0.15	-0.18	-0.25
Private consumption	-0.10	-0.17	-0.26	-0.27
Government consumption	-0.01	-0.01	-0.09	-0.11
Gross fixed capital formation	-0.01	-0.17	-0.19	-0.26
Exports of goods and services	-0.10	-0.20	-0.21	-0.27
Imports of goods and services	-0.12	-0.20	-0.24	-0.27
Prices and Costs				
HICP	0.15	0.22	0.23	0.24
GDP deflator	0.12	0.06	0.06	0.03
Unit labour costs	0.09	0.21	0.17	0.21
Labour Market				
Unemployment rate	0.00	0.02	0.04	0.04
Employment	0.00	-0.08	-0.17	-0.24
Compensation per employee	0.05	0.14	0.15	0.20
Fiscal Developments				
Balance[(1)]	0.02	-0.01	-0.02	-0.02
Gross debt[(1)]	-0.05	0.03	0.06	0.12

Source: Authors' calculations.
(1) Absolute change from baseline as per cent of GDP.

forecasts at a monthly frequency. In a second step, the shocks to energy in STREAM are calibrated to replicate the impact on consumer prices obtained from NIPE.

Chart 1 shows the impact of a 10% increase in oil prices on GDP from four different oil price levels: €30, €55, €85 and €115. By the fourth year, the adverse impact of higher oil prices range from 0.11% if the increase takes place from a very low oil price (€30 per barrel) to 0.32% in the high oil price scenario (€115 per barrel). The spirit of these results is in line with Rapa (2017b), who noted that the macroeconomic effects of energy reforms in Malta are dependent on both the generation setup but also on the level of oil prices.[5]

Chart 1
IMPACT OF 10% INCREASE IN OIL PRICES ON GDP AT DIFFERENT PRICE LEVELS
(per cent deviation from baseline levels)



Source: Authors' calculations.

An exchange rate shock

The exchange rate shock is defined as a permanent appreciation of the euro vis-à-vis the dollar by 10%. The appreciation of the euro leads to a deterioration in the country's price competitiveness and a subsequent decline in exports and GDP (see Table 6). The slowdown in economic activity dampens investment and leads to a softening in labour market conditions. Despite the reduction in employment and wages, real disposable income rises on the back of lower consumer prices. The latter is due to the effects of lower import prices from the exchange rate appreciation. The rise in real disposable income exerts a positive effect on private consumption, which increases through-

[5] Expectations in STREAM are adaptive and backward-looking. Hence the model does not take into account forward buying practices or longer term contracts between economic agents.

Table 6
THE MACROECONOMIC IMPACT OF A EURO APPRECIATION AGAINST US DOLLAR

Percentage change from baseline levels unless otherwise specified

	Year 1	Year 2	Year 3	Year 4
Economic Activity				
Real GDP	-0.11	-0.21	-0.17	-0.03
Private consumption	0.13	0.13	0.11	0.17
Government consumption	-0.06	-0.13	0.01	0.12
Gross fixed capital formation	-0.02	-0.09	-0.12	0.01
Exports of goods and services	-0.21	-0.36	-0.21	-0.05
Imports of goods and services	-0.07	-0.17	-0.06	0.08
Prices and Costs				
HICP	-0.23	-0.40	-0.51	-0.62
GDP deflator	-0.15	-0.22	-0.39	-0.53
Unit labour costs	-0.06	-0.32	-0.53	-0.66
Labour Market				
Unemployment rate	0.01	0.02	0.02	0.01
Employment	-0.03	-0.10	-0.15	-0.14
Compensation per employee	-0.13	-0.43	-0.54	-0.55
Fiscal Developments				
Balance[(1)]	-0.04	-0.06	-0.08	-0.10
Gross debt[(1)]	0.16	0.31	0.45	0.54

Source: Authors' calculations.

[(1)] Absolute change from baseline as per cent of GDP.

out the simulation horizon. Subdued economic activity exerts downward pressure on prices, which compensates for some of the loss in competitiveness from the exchange rate appreciation, in turn gradually reducing the negative impact of the shock on exports. On the fiscal front, government revenue shrinks due to weaker macroeconomic performance, which outweighs the decline in government expenditure. Consequently, the government balance ratio deteriorates, which causes the government debt ratio to increase.

Conclusion

This article presented an update of STREAM, the Bank's traditional macro-econometric model of the Maltese economy. Since its development, STREAM has become a valuable input in the Bank's forecasting toolkit and has been used to assess the impact of various policies on the Maltese economy.

"Areas of further model development include aspects related to migration, the housing market and supply side aspects of the model"

When compared to the current model, the newly estimated STREAM generally features smaller error-correction terms mainly due to longer time-series used for estimation. Moreover, results indicate that Malta's price dynamics have become less dependent on foreign prices, reflecting its reduced reliance on imported goods but increasingly sensitive to developments in the domestic labour market. Moreover, results to oil price shocks also indicate that in the last few years Malta has become less sensitive to oil price fluctuations. The latter results reflect the continued transformation of Malta's economy into an increasingly services oriented one, reforms in the energy sector and long-term agreements between government and energy providers on electricity prices. All in all, the overall conclusion is that despite the update of the underlying dataset and the re-estimation of the behavioural equations, this process has not substantially changed our view of how the domestic economy works.

Models can always be improved and we anticipate to further our research to refine STREAM in the future. Areas of further model development include aspects related to migration, the housing market and supply side aspects of the model.

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MEDSEA-FIN: A DSGE MODEL WITH FINANCIAL FRICTIONS FOR MALTA[1]

William Gatt Fenech and Noel Rapa

The events that led to the great financial crisis have led economists in academia and central banks to take into account the role of financial frictions in the amplification of economic shocks. In this article we describe efforts to extend MEDSEA, the Bank's dynamic stochastic general equilibrium model, with housing and credit frictions. Households have access to collateralised borrowing, which is subject to a maximum loan-to-value (LTV) constraint. As a result, shocks that impact house prices generate amplification through the changing value of the collateral, raising or lowering the borrowing limit. We show how a counter-cyclical LTV rule dampens economic responses to a positive house price shock, highlighting the potential for macroprudential policy to limit a rise in systemic risk. Although the model captures the key collateral channel which matters for macroprudential policy, we plan to add more features in the near future to bring it closer to the data and extend the number of policy questions that the model can answer.

Introduction and motivation

Financial frictions, a term summarising some form of impediment to the flow of credit, were not considered to play an important role in advanced economies prior to the great financial crisis (Christiano et al., 2018). As a result, quantitative models used in policy institutions typically did not include any meaningful role for finance. Recent history has taught us that when financial frictions do matter, they can matter a lot. The origins of the financial crisis that started in late 2008 can be traced back to the housing market in the United States and the United Kingdom. Mortgage lending rose significantly in the run-up to the crisis, credit was extended to risky households, with lenders willing to extend such credit as long as property prices kept rising. In this way, there was a strong reinforcing effect where rising demand due to looser credit raised house prices, improving collateral values and leading to more borrowing, which sustained the rise in house prices. This phenomenon is typically referred to as the collateral channel (Kiyotaki and Moore, 1997; Iacoviello, 2005).

> *"Since borrowing constraints are binding in these models, borrower-based macroprudential policies that tighten borrowing limits during an upswing can be effective in controlling excessive leverage"*

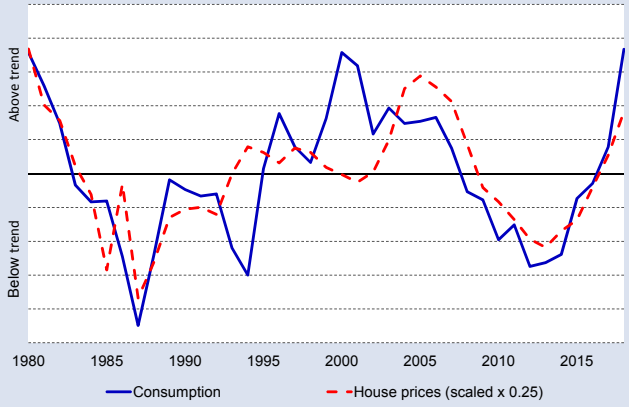
A model with a housing market and credit-constrained households captures this phenomenon by predicting a wealth effect arising from higher house prices to higher consumption (Iacoviello, 2005). Since borrowing constraints are binding in these models, borrower-based macroprudential policies that tighten borrowing limits during an upswing can be effective in controlling excessive leverage (Rubio and Carrasco-Gallego, 2014). Indeed, Crowe et al. (2013) find a positive empirical relationship between the maximum LTV ratio in an economy and the extent of house price appreciation. Although not necessarily causal, it illustrates an important link between these two variables. Alam et al. (2019) recently provide empirical evidence in favour of a causal relationship from a reduction in LTV limits to lower credit growth, especially when maximum LTV regulation is introduced in an environment of a generally loose LTV cap.[2]

[1] We would like to thank Alexander Demarco, Brian Micallef and Margarita Rubio for helpful comments and suggestions. We thank colleagues from the Financial Stability Department for fruitful discussions on leverage ratios. We thank Reuben Ellul and John Farrugia for assistance with house price data and fiscal aggregates respectively. Luca Brugnolini contributed to this project while at the Central Bank of Malta.

[2] See Gatt (2019a) and the references cited within for country case studies of borrower-based macroprudential policy implementation and its relative success.

Iacoviello (2005) shows that a model with collateral effects is able to match the empirical evidence of positive co-movement between house prices and private consumption in the United States. Chart 1 shows that there is also a strong positive relationship between these two variables in Malta. While this relationship is not necessarily causal, it is suggestive evidence of a link between house prices and household demand. We interpret this link through the lens of the model we describe below.

Chart 1
HOUSE PRICES AND CONSUMPTION IN MALTA



Sources: Central Bank of Malta, National Statistics Office and authors' calculations.
Notes: Cyclical data are residuals from a regression of the log of the dependant variable on a constant and a quadratic trend, estimated from 1980 to 2018. House price data are based on the Central Bank of Malta's advertised property price index. The cyclical component of house prices is scaled by a quarter to improve readability.

Household-level data reveal that a significant proportion of house purchases in Malta are highly leveraged. Indeed, about half of all mortgages are at an LTV at origination of between 70-90% and a debt-servicing to income ratio of 20-35% (Spiteri, 2019).[3] These figures imply that bank finance, and hence borrowing constraints, matter for this subset of households. Therefore, a counter-cyclical macroprudential policy framework can in principle be effective in controlling an excessive rise in leverage.

"To capture these interactions we extend MEDSEA, a dynamic stochastic general equilibrium model of the Maltese economy with housing and borrowing constraints"

To capture these interactions we extend MEDSEA, a dynamic stochastic general equilibrium model of the Maltese economy with housing and borrowing constraints. MEDSEA features a rich production sector that reflects the small and open nature of the Maltese economy (Rapa, 2016). In this extension, households are only allowed to borrow up to a fraction m of their housing asset, which is henceforth referred to as an LTV constraint. The latter is allowed to vary over time to capture the ability of the macroprudential authority to change it counter-cyclically from time to time to control excessive risk-taking and a rise in economy-wide leverage.

Bird's eye view of the model

This section provides a sketch of the model, focusing on households and the macroprudential authority. A bird's eye view of the model is presented in Chart 2.

The household sector

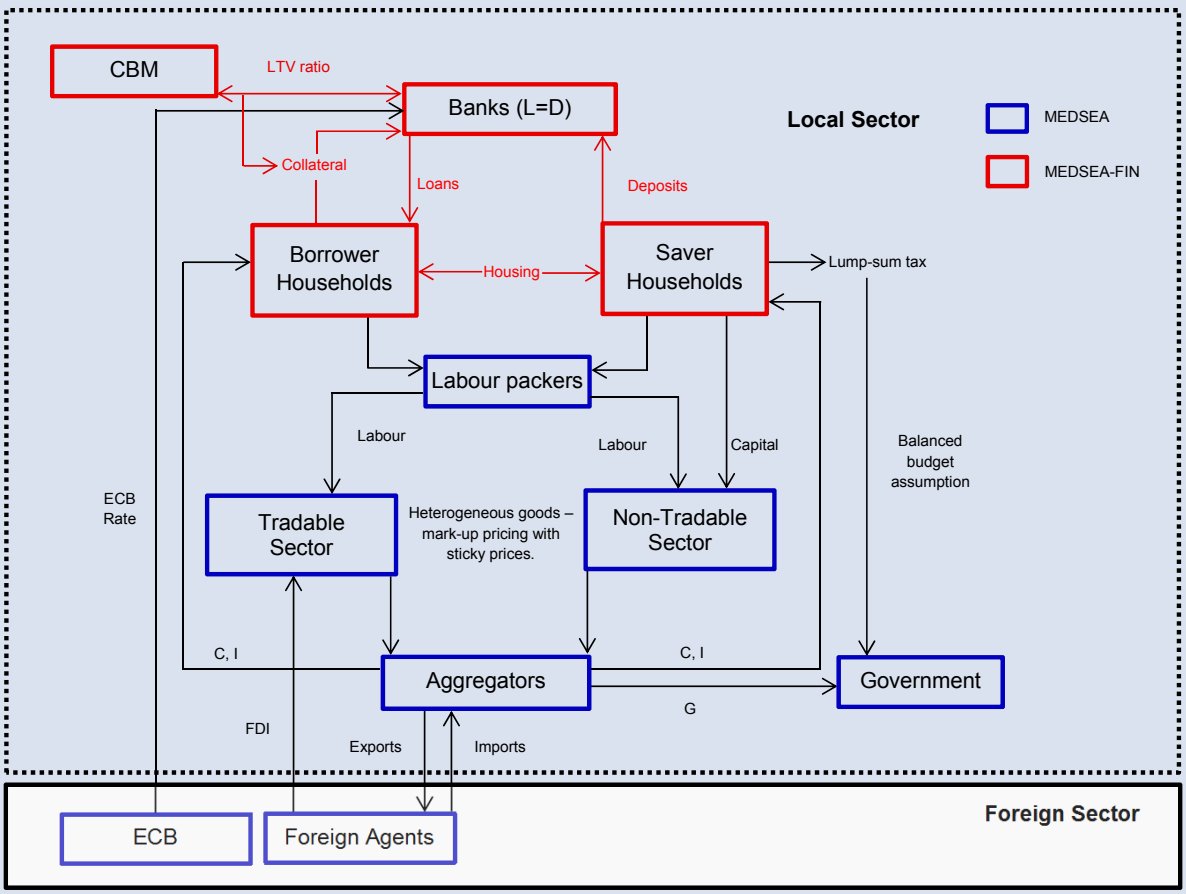
There are two infinitely-lived household types, patient and impatient, making up a share $\bar{\omega}$ and $(1-\bar{\omega})$ respectively of the total population.[4] Both types derive utility from consuming a final good C_t, leisure, defined as the fraction of time not spent working, $1-N_t$, and housing H_t. The latter is multiplied by a time-varying utility weight ε_t^H, which captures housing preference shifters, as in Iacoviello and Neri (2010).

Patient households (savers) can save through various assets. These include liquid assets, made up of local deposits $D_{s,t}$ and foreign bonds $B_{s,t}^*$, as well as illiquid assets in the form of housing $H_{s,t}$ and capital $K_{s,t}$. It is assumed that patient households own all firms such that their total income is made up of labour income, return on local deposits and foreign bonds, rental income on capital and firm profits.

[3] There was no major difference between the leverage of first-time and second-time buyers in 2018. Around 70% of all first-time buyers and around 60% of all second-time buyers had an LTV ratio between 70-100%.

[4] The two types of households are termed patient and impatient respectively because they discount the future at different rates. In equilibrium, patient households will accumulate resources and are therefore termed savers, while impatient households consume more than their labour income and therefore borrow to fund this gap. We use the subscripts s and b to denote savers and borrowers respectively.

Chart 2
MEDSEA-FIN – A BIRD'S EYE VIEW



For simplicity we assume that impatient households (borrowers) do not participate in the international capital market and can borrow from domestic sources at a given interest rate. We further assume that this household type does not accumulate private capital and can only store wealth in the form of housing $H_{b,t}$. Following Iacoviello (2005) and Kiyotaki and Moore (1997), we assume that when borrowing, impatient households face a collateral constraint defined as a fraction of their expected housing wealth. Thus the maximum amount impatient households can borrow is bound by:

$$R_t L_{b,t} \leq m_t E_t\{p^H_{t+1} H_{b,t} \pi^C_{t+1}\} \quad (1)$$

such that the total amount to be repaid at a given period including interest rates, $R_t L_{b,t}$, is less than a fraction m_t of the expected value of the total housing wealth of borrowers $E_t\{p^H_{t+1} H_{b,t} \pi^C_{t+1}\}$. Moreover, the assumption that impatient households discount the future more heavily than patient ones guarantees an equilibrium in which impatient households are borrowing-constrained.[5] Since housing is a durable good, it is demanded by both household types because it yields utility from housing services but also because it is a store of value. Additionally, impatient households also want to hold housing because a house price appreciation relaxes their borrowing limit.

Labour market

Households supply a continuum of labour types. For simplicity we assume that they delegate their wage setting problem to h labour packers[6], each of which represents one type h of worker, in line with Gali et al. (2007). Each

[5] In this version of the model we assume that banks are not bound by capital requirements and can therefore channel all deposits to borrower households as loans.

[6] Labour packers are a modelling device that is commonly used in literature to simplify the labour market of general equilibrium models. They act as aggregators and combine the labour hours supplied by patient and impatient households. The single wage that clears the labour market will therefore reflect the marginal disutility of labour effort of both types of households. This assumption ensures more tractable developments in the real wage and hours worked.

packer in turn represents $\bar{\omega}$ patient and $(1-\bar{\omega})$ impatient households. In each period, it sets the wage of its workers by trading off the utility value of labour income with the disutility of total work effort, taking as given the demand for each labour type. This therefore assumes labour packers allocate labour demand uniformly across households, irrespective of their type, such that each household in the economy works the same number of hours, and earns the same wage. We then introduce nominal rigidities in the labour market by assuming that real wages respond sluggishly, in line with Hall (2005).

Macroprudential authority

The financial authority operates macroprudential policy with the objective of ensuring financial stability. Its main tool is the LTV ratio m_t that affects the borrowing limit faced by impatient households through their collateral constraint. Although there are many indicators which can be used to signal a rise in systemic risk, we use the deviation of the household credit-to-GDP ratio from its value in the steady state, which is typically referred to as the credit gap. The authority therefore revises the LTV ratio counter-cyclically to the credit gap, tightening borrowing limits during a credit boom and relaxing them during a bust. The linearised macroprudential policy rule is given by

$$m_t = \rho_m m_{t-1} + (1-\rho_m)\left[\bar{m} - \tau L_t^{gap}\right] \quad (2)$$

where L_t^{gap} is the credit gap, defined as the log deviation of the credit-to-GDP ratio from its steady state level. The parameter τ controls the strength of the revisions in the LTV ratio following a change in the leverage ratio, while ρ_m controls how smooth these revisions are.

Rest of the model

The production sector is identical to that found in Rapa (2016). The model contains three intermediate good firms, those producing tradable and non-tradeable output, and those responsible for importing goods and services. The economy produces four final goods: private consumption, government consumption, private investment and exports. Each of these goods is made up of a varying proportion of domestic and imported output. This setup allows us to exactly pin down the different import intensities of aggregate demand components. The fiscal authority is assumed to follow a balanced budget in each period, where government expenditure, which is made up of non-tradable production and imports, is financed by a lump-sum tax levied on saver households.

Calibration

The model is calibrated on a quarterly frequency and replicates key Maltese Great Ratios, as in the core version of the model (Rapa, 2016). The addition of impatient households, housing and the collateral constraint introduce new parameters which we briefly discuss next. The discount factor for impatient households β_b is calibrated at 0.975 as in Iacoviello (2005) (compared with 0.9926 for patient households). This value ensures that the borrowing constraint is binding in the steady state and for small shocks which move the economy off but close to the steady state. The share of patient households in the economy $\bar{\omega}$ is set to 0.57, such that their consumption share out of aggregate consumption is 0.75.[7] The steady-state weight on housing in the utility function ε^H is set to 0.21, which implies an aggregate housing wealth-to-GDP ratio of 4, as in the data.[8] We set the maximum LTV ratio $\bar{m}$ at 0.9, which is the typical maximum leverage limit observed on mortgages in Malta.[9] These two parameters imply an aggregate ratio of loans to GDP at 38.5% in the model, in line with the mortgage credit-to-GDP ratio registered over the period 2004-2018. Other parameters are calibrated at values that are standard in the literature.

We set the LTV sensitivity parameter τ in the macroprudential policy rule (2) to an arbitrary small number to assess the role of LTV tightening on the economy. We set the persistence parameter ρ_m to 0.95, to reflect the fact that the

[7] Iacoviello and Neri (2010) and Gerali et al. (2010) calibrate the income share of patient households at 0.8. Since we assume a labour market with a common wage rate and hours worked, we calibrate the consumption share instead. The parameter $\bar{\omega}$ then implies significant economic size for saver households, as in the literature.

[8] This ratio is based on mean and median hedonic prices from Ellul et al. (2019) and estimates of housing stock are taken from Gatt (2019b). Hedonic house price data are only available from 2010 onwards.

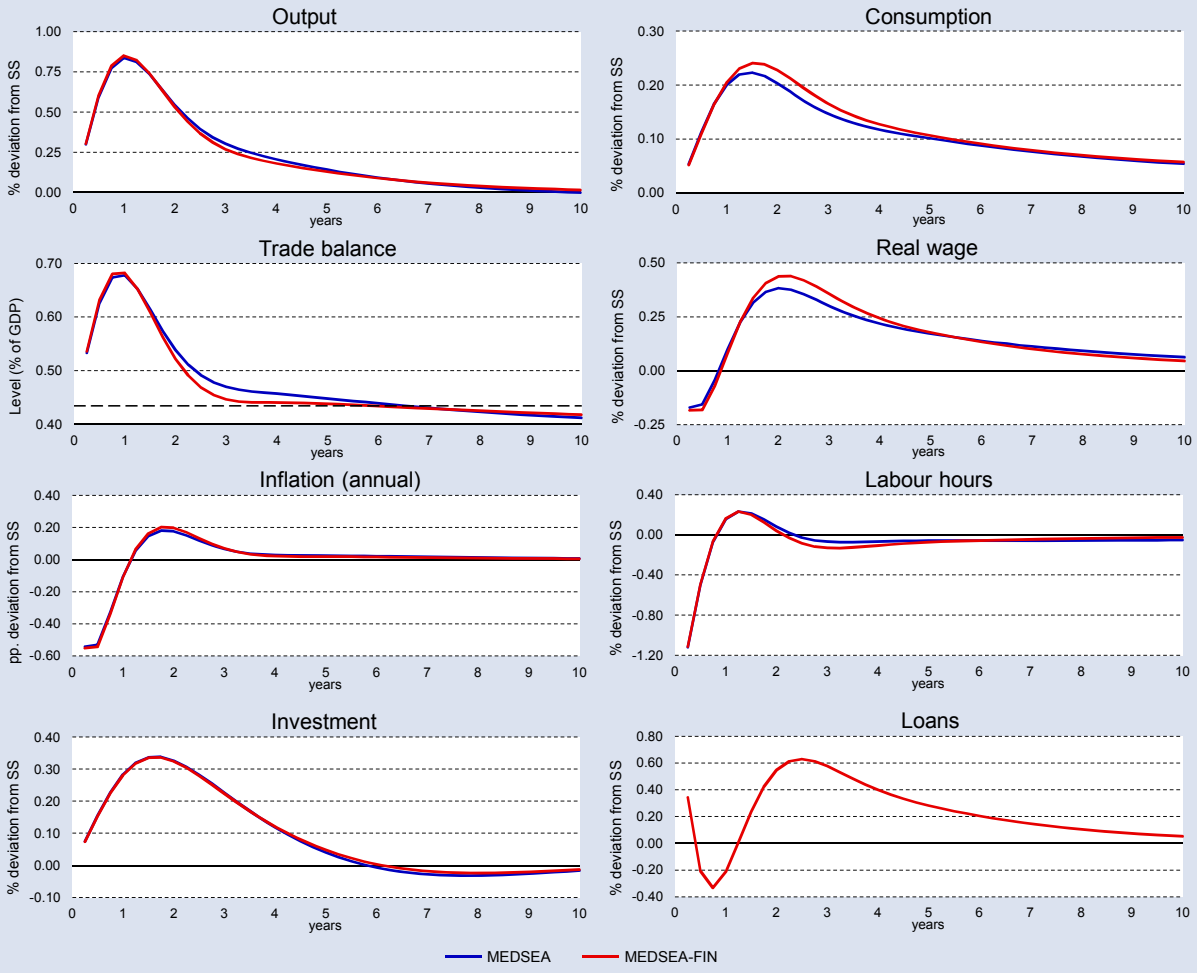
[9] See Spiteri (2019). This is a value which is also commonly used in the literature.

borrowing limit is not revised frequently in most countries with an active LTV policy.[10] We solve the model with a first-order perturbation around the stochastic steady state using Dynare.[11]

Properties of the model

We first analyse the dynamics of the model by simulating a technology shock that is common to the production of tradable and non-tradable goods. We compare the reaction of the economy in MEDSEA-FIN to that in MEDSEA, which abstracts from financial frictions. We show the respective impulse response functions in Chart 3.[12] Note that we switch off the macroprudential policy rule, such that the LTV in MEDSEA-FIN is constant throughout the adjustment path.[13]

Chart 3
TECHNOLOGY SHOCK



Source: Authors' calculations.
Notes: These figures show the response of the endogenous variables to a 1% shock to total factor productivity in the tradable and non-tradable sectors simultaneously. The dashed lines refer to the steady state levels in the case of the trade balance.

[10] These values do not necessarily characterise the LTV macroprudential policy implementation of the Central Bank of Malta.
[11] Higher-order approximations produce very similar results. This means that we do not miss important non-linearities implied by financial frictions for the shocks that we study below.
[12] Note that some parameters, such as the intertemporal elasticity of substitution and elasticity of substitution between final export good varieties, are calibrated differently in the core version. We re-calibrate MEDSEA accordingly in the simulations that we report. In addition, we also re-model the labour market block in MEDSEA with the wage frictions as described above. This ensures that any differences in the reactions of the economy across models are due solely to the financial frictions present in MEDSEA-FIN.
[13] The shock is unanticipated and no other shocks are expected to hit. Therefore, total factor productivity decays slowly back to its steady state value.

The shock produces very similar dynamics across the two versions of the model. The rise in total factor productivity temporarily increases the output production frontier and lowers marginal costs. This fall in marginal costs translates into lower overall prices which has a positive impact on the economy's competitiveness, leading to a more favourable trade balance. Positive wealth effects allow households to supply less labour hours. This effect is in the short-run outweighed by a reduction in labour demand brought about by an improvement in the productive efficiency of the factors of production leading to a marginal and short-lived fall in the wage rate. These positive wealth effects together with a steadily increasing wage rate drive up private consumption. Government expenditure on domestic non-tradable goods rises on account of the fall in price of such goods, with no changes in taxes, keeping the government budget in balance.

The main differences between the two versions of the model emerge after the first year following the shock. Consumption and the real wage rise and labour hours fall by more in the presence of constrained households although the effects are relatively small. This minor amplification occurs due to the collateral constraint, as the boost to economic activity also raises house prices. Borrower households use the increased value of their housing wealth to increase their borrowing, financing consumption. This pushes up demand for the consumption good, raising prices, including wages. The effect of the financial accelerator dies off by the fifth year following the shock, and the two economies follow close adjustment paths back to the steady state.

The effectiveness of LTV ratio tightening

To study the effectiveness of macroprudential policy in containing a rise in credit stemming from rising asset prices, we simulate a 1% rise in house prices through a temporary but persistent shock to housing preferences common across saver and borrower households.[14] As discussed in Iacoviello and Neri (2010), this shock can account for shifts in tastes for housing relative to other goods as well as other factors that are not explicitly modelled, such as population changes. We simulate this shock with passive macroprudential policy in which the LTV ratio is fixed throughout, and again with the LTV responding endogenously as specified in the policy rule (2) above (see Chart 4). This simulation is meant to illustrate the theoretical channel through which a credit boom leads the macroprudential authority to tighten the borrowing limit by lowering the LTV ratio.

> *"This simulation is meant to illustrate the theoretical channel through which a credit boom leads the macroprudential authority to tighten the borrowing limit by lowering the LTV ratio"*

First we look at the case with a fixed LTV ratio. The rise in house prices boosts the collateral value of impatient households, which allows them to borrow more. As a result credit rises and borrower households use these additional resources to finance higher consumption of the final good as well as the purchase of real estate. As discussed in the model description, housing serves the dual role of providing shelter services as well as a store of value. Borrowers are therefore willing to increase their holdings of housing as long as prices are higher than in the steady state, and as long as they are able to keep up with interest payments on additional credit that they take on. They also experience a wealth effect and supply less labour hours, which causes the equilibrium wage to rise.

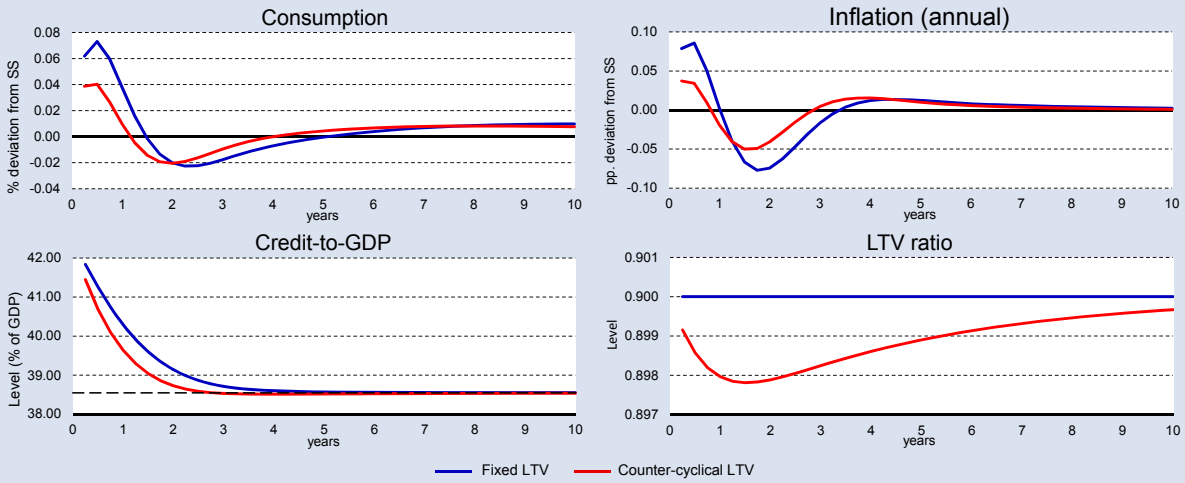
Although in our calibration around 60% of households are savers, the dynamics of aggregate consumption track closely the consumption behaviour of borrower households, since their reaction to the rising house prices is larger throughout. This can explain the observed correlation between house prices and consumption in Malta as shown in Chart 1 above. Aggregate consumption rises on impact and remains higher up to six quarters after the shock, falling below the steady state level thereafter. This reflects the deleveraging process by borrower households, as the initial inflationary effects of the shock start to fade and the real interest rate rises, increasing the debt burden. This causes aggregate credit to GDP to return to its steady state level. Lower consumption reduces demand for consumption goods, easing pressure on wages and prices. The shock takes more than ten years to die out of the system, highlighting the endogenous persistence present in the model. Despite the deleveraging process by borrowers, house prices remain above steady state levels throughout.

We now analyse the effect of moving the LTV ratio counter-cyclically with the credit-to-GDP gap, with an arbitrary calibration of the responses parameter in the policy rule.[15] A positive credit-to-GDP gap lowers the LTV ratio, which

[14] This shock is also unanticipated and in expectation the housing preference term reverts to its steady state level over many quarters.

[15] We emphasize that the discussion that follows is neither a characterisation of borrower-based policy implementation of the Central Bank of Malta nor is it meant to be interpreted as the optimal macroprudential policy response to a housing demand shock. Rather, it is meant to showcase the potential impact on the economy under the scenario that we consider.

Chart 4
HOUSING PREFERENCE SHOCK: WITH AND WITHOUT ENDOGENOUS LTV REACTION



Source: Authors' calculations.
Notes: These figures show the response of the endogenous variables to a shock to housing preferences that generates a 1% rise in house prices. The dashed line in the bottom left panel refers to the steady state level of the credit-to-GDP ratio.

in turn tightens the borrowing constraint, limiting the rise in housing wealth that can be pledged as collateral against further borrowing. In the simulation the LTV ratio falls by about 0.1 percentage points on impact as a result of the rise in housing demand which pushes houses prices up by 1%. This has a strong dampening effect on the total credit-to-GDP ratio, which leads to a smaller rise in aggregate consumption.

The response of the LTV ratio reflects the inertia built into the policy rule, adjusting slowly to the rise in credit and reaching the lowest value about a year and half following the onset of the shock.[16] Note that the policy does not have any direct effects on house prices as it operates through the collateral constraint, lowering the borrowing potential of impatient households. House prices remain elevated in both scenarios as they are driven by the exogenous housing demand shock, which is invariant to the level of the LTV ratio, and is common to both borrower and saver households. To this end, LTV policy can reduce the build-up of systemic risk without intervening directly in the property market.[17]

Conclusion

The last financial crisis has been a stark reminder of the important role of financial frictions in developed economies. In the run-up to the crisis, mortgage lending rose significantly on the back of a sustained increase in house prices, which produced a reinforcing effect between the value of collateral and demand for mortgages. The presence of a collateral channel with binding borrowing constraints implies that a macroprudential authority is able to control excessive leverage by imposing countercyclical borrower-based measures.

"The model predicts that counter-cyclical movements of the LTV ratio have considerable dampening effects on the total credit-to-GDP ratio, and consequently on consumption and other GDP components"

In this light we extend MEDSEA with borrowing constraints, where households are allowed to borrow a fraction, denoted by a maximum LTV ratio, of the value of their housing assets. Moreover, we allow the macroprudential authority to implement counter-cyclical policy by varying the maximum LTV ratio in response to an excessive rise in the economy-wide leverage. The introduction of a collateral channel can have minor amplification effects especially for shocks that emanate in the housing market. A boost in housing wealth induces borrowers to demand more housing, allowing them to increase their borrowing to finance consumption. The model predicts

[16] Although in practice a macroprudential authority is likely to revise the LTV ratio in large, discrete steps, it is also likely to wait until it receives enough information from indicators correlated with systemic risk. The LTV rule in the model therefore represents a compromise between these two policy considerations while remaining stylised and tractable.

[17] It is useful to reiterate that in our model the macroprudential authority uses the household credit gap as an indicator for systemic risk. In practice, the relevant authority is likely to analyse an array of indicators before setting policy.

that counter-cyclical movements of the LTV ratio have considerable dampening effects on the total credit-to-GDP ratio, and consequently on consumption and other GDP components.

While already useful for policy analysis purposes, the model together with the results described in this article need to be interpreted as a first step towards a model that can answer more policy-oriented questions. More importantly, in its current state, MEDSEA-FIN assumes a stylised banking system in which banks are not bound by capital requirements. In future versions of this model, this assumption can be dropped in favour of a more realistic banking setup in which banks are subject to a minimum regulatory capital requirement. Apart from bringing the model closer to the data, these intermediation frictions will also help expand the policy relevance of this model by introducing the possibility of using the capital requirement as an additional macroprudential policy tool.

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HOUSEHOLD FINANCE AND CONSUMPTION SURVEY 2017: SALIENT RESULTS FOR MALTA

Silvio Attard[1]

This article presents the main findings from the third wave of the Household Finance and Consumption Survey for Malta which was conducted in 2017. The results from this survey of Maltese households provide detailed information on households' real and financial assets, their liabilities, net wealth, income, consumption and savings. The article also compares how these indicators evolved compared to the two previous waves of the survey carried out in 2010 and in 2014. These micro-level household data contribute to a better understanding of behavioural trends and developments underlying macro statistics and open up various avenues for further research.

Introduction

During 2017, the Central Bank of Malta conducted the third wave of the Household Finance and Consumption Survey (HFCS) in Malta. The two previous waves were carried out in 2010 and in 2014.[2] This survey is part of a co-ordinated research project led by the European Central Bank (ECB) and involves national central banks (NCBs) of all euro area countries and selected non-euro area EU member states.[3] The survey provides detailed information on households' real and financial assets, their liabilities, net wealth, income and consumption.

The results are obtained from household-level data collected during 2017 from households residing in Malta.[4] Data on households' assets and debt relate to the stock position as at end-2016, whereas data on income and consumption relate to the entire calendar year 2016. The HFCS questionnaire consists of two main parts. The first part relates to the household as a whole, with questions on their asset holdings and their financing, liabilities incurred by the household, credit constraints, as well as consumption and saving patterns. The second part of the survey relates to individual household members and covers demographics, employment, pension entitlements and income (for all household members aged 16 and over).

The Bank, with the assistance of the National Statistics Office, selected a representative sample of Maltese households to take part in this survey. The probabilistic sample design involved a systematic sampling of households. The initial sample consisted of 1,547 addresses. In total 1,004 households participated in the survey, in line with the preset target of 1,000 completed questionnaires. The panel component, that is, households that also participated in the 2014 survey (second wave), consisted of 539 households, whereas the remaining 465 households participated for the first time. The overall response rate was of 64.9%, notably higher than the 51.0% achieved in the second wave.

This article summarises the main findings for Malta, focusing on characteristics of households, their income and savings, assets, liabilities and net wealth. Since this survey has now been carried out three times, the descriptive analysis also sheds some light on evolving trends in domestic household behaviour over time.

Household characteristics

The survey confirms the trend decline in household size. According to the survey, in 2016 there were close to 170,000 households in Malta, with an average of 2.5 members per household, slightly lower than in 2013, and down from 2.9

[1] The author would like to acknowledge the assistance provided by various officials at the National Statistics Office who were responsible for carrying out this survey and who assisted in the compilation of the data.

[2] More information on the main results of the first three waves of the Household Finance and Consumption Surveys conducted in Malta, including previous research, are available on: https://www.centralbankmalta.org/en/household-finance-and-consumption-survey

[3] More detailed information on the HFCS can be retrieved from the ECB's website: https://www.ecb.europa.eu/pub/economic-research/research-networks/html/researcher_hfcn.en.html

[4] It should be noted that in the HFCS a household is defined as a person living alone or a group of people who live together in the same private dwelling and share expenditures, including the joint provision of essentials for living.

members in 2010 (Caruana and Pace, 2013; Gaskin et al., 2017). The most common household structure relates to households with two members. This category accounts for close to 30% of households (see Table 1). One-person households were the second largest category, with a share of almost 25%. Moreover, the importance of the latter category has increased over time. In contrast, the share of larger households, that is, those with four or more persons, has been in decline, and amounted to slightly less than one-fourth in 2016 compared with 33% in 2010. These trends are also in line with other surveys, including the Survey on Income and Labour Conditions (SILC).

With reference to housing status, the share of households owning their main residence (either outright or with a mortgage) edged up to 80.6%, from 80.1% in 2013, while the remaining 19.4% of households were tenants occupying their residence through rent, usufruct or rent-free agreements. The rise in the share of home owners is largely driven by an increase in the number of home-owners with a mortgage. Once again, the results from the survey are in line with the outcomes from the SILC for the same period, as well as from the Census of population and housing.

"The educational attainment level of the Maltese households continued to improve"

The distribution of households based on the age of the reference person remained broadly similar to that observed in the second wave. The share of households whose reference person is employed continued to rise, reaching 42.9% in the latest wave. At the same time, the share of households with a self-employed reference person decreased marginally in the period 2010 to 2016, remaining the smallest household category on the basis of labour market status.

Table 1
HOUSEHOLD STRUCTURE
(in % of households, unless otherwise stated)

	2010	2013	2016
Average household size (in members)	2.9	2.6	2.5
Household size			
1 person	18.8	23.6	24.6
2 persons	25.7	28.7	29.0
3 persons	22.3	21.5	21.6
4 persons	22.1	18.6	18.4
5 and more persons	11.1	7.5	6.4
Housing status			
Owner-outright	64.9	64.3	63.5
Owner-with mortgage	12.4	15.8	17.1
Other	22.7	19.9	19.4
Age (in years) of reference person			
16-34	8.8	12.8	12.7
35-44	22.2	17.2	18.2
45-54	21.0	20.0	18.0
55-64	23.1	20.3	20.4
65+	24.9	29.7	30.6
Work status of reference person			
Employee	36.2	39.5	42.9
Self-employed	7.3	7.8	6.4
Retired	27.3	28.8	28.2
Other	29.3	23.9	22.4
Education level			
Primary	23.2	23.8	21.6
Secondary	61.6	59.4	59.7
Tertiary	15.2	16.8	18.7

Source: HFCS.

The educational attainment level of the Maltese households continued to improve. According to the survey, 18.7% of the households in the latest wave had a reference person with a tertiary level of education, compared to 15.2% in 2010. Although the prevalence of households with primary and secondary education decreased since 2010, down by 1.6 and 1.9 percentage points respectively, households whose reference person has a secondary level of education continue to dominate, accounting for almost 60% of all households.

Household income and savings

The survey defines gross household income as the sum of all pre-tax income and social contributions, including labour/pension income, rents from real estate assets, return from financial assets, regular social/private transfers, and any income from other sources.

"Employee income remained the main source of income, totalling 67.4% of total gross household income"

Employee income remained the main source of income, totalling 67.4% of total gross household income, whereas income from self-employment activities represented 8.8% of total income. Income from pensions and social transfers accounted for 13.6% and 2.9%, respectively. At the same time, income from financial investment stood at only 2.1% of total household income.

The median gross income of Maltese households in 2016 was estimated at €25,417, while the average income stood higher, at €31,203. These figures are slightly lower than the comparable mean and median derived from the SILC. Utilising the three waves of the survey, the median gross income of Maltese households increased by €4,856, or 23.6% from 2010 to 2016. As can be seen in Chart 1, this increase was largely driven by a rise in employee income.

The distribution of income by gross income quintiles shows that the highest three quintiles derived most of their income from employment income (see Chart 2). On the contrary, the bottom two quintiles relied significantly on pensions and regular social transfers. Income generated from productive engagement in the labour market, either as employees or self-employed, amounted to only 7.4% of total income of the bottom quintile, drastically less than the 84.8% for the top quintile. Although the median income increased across all quintiles since 2013, the most significant increase was estimated for those households in the fourth quintile, where median income is estimated to have grown by 12.4% on 2013.

Chart 1
HOUSEHOLD GROSS INCOMES: MEDIAN VALUES
(euro)

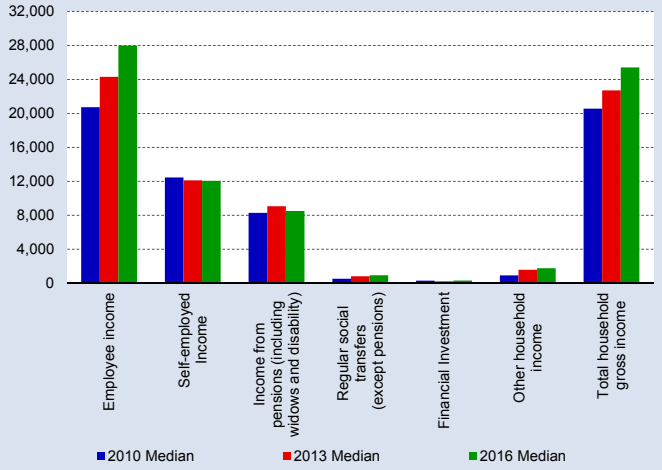
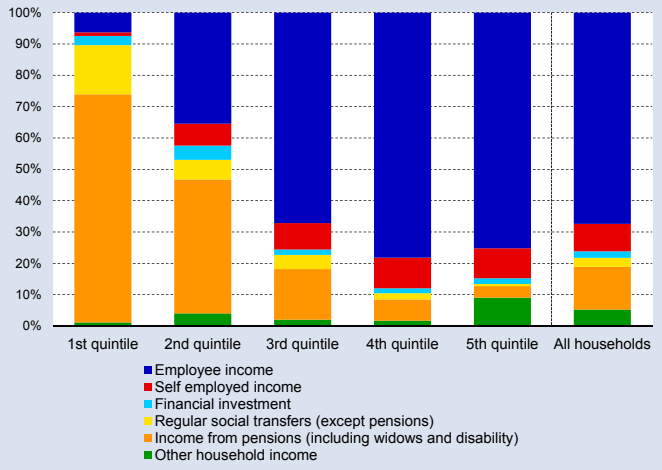


Chart 2
DISTRIBUTION OF INCOME BY GROSS INCOME QUINTILES
(per cent)



During 2016, the share of households stating that their annual expenses were lower than their income increased when compared to previous rounds. This ability-to-save indicator shows that 45.6% of households managed to save part of their gross households' income, up from 36.6% in 2013, and 23.7% in 2010. Moreover, the survey shows that the share of households who are able to get financial assistance from friends or relatives in case of an emergency increased from 60.3% in 2013 to 62.8% in 2016.

Assets

The survey makes a distinction between real and financial assets. Real assets include the value of the household main residence, other holdings of real estate, value of self-employment businesses, as well as the value of vehicles and other valuables of all household members. Financial assets consist of deposits, mutual funds, bonds, equities, voluntary private pension plans, as well as money owed to households as private loans.

At 86.7%, real assets continued to constitute the largest share of households' total assets, with financial assets accounting for the remaining 13.3%. When compared to the previous two waves of the survey, these ratios remained broadly unchanged.

Real assets

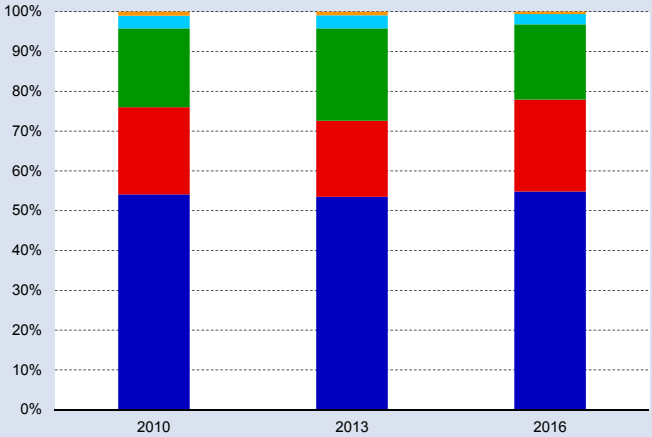
The share of households holding some form of real assets increased from 93.3% in 2013 to 95.4% in 2016. In monetary terms, the median value of real assets held by Maltese households increased from €193,511 in 2010 to €225,752 in the latest wave. The conditional mean value, which is based on households who own real assets, stood at €382,895 in 2016.

"Around 78% of all households' real assets are in real estate properties"

Chart 3 shows that around 78% of all households' real assets are in real estate properties.[5] When compared to 2013, this share rose by 5.3 percentage points, predominantly on the back of increasing assets in the form of other real estate properties. Nevertheless, households' main residence constitutes the most valuable real asset in the household asset portfolio with the perceived median value increasing from €180,600 in 2013 to €200,000 in 2016. This value is more than double the median value of other real estate properties, which at €87,501, is the second most valuable real asset. Self-employment businesses come third, with a median value of €74,736, while the values for vehicles and valuables are, as expected, markedly lower.

Overall, the highest median value for real estate asset holdings is reported for those aged between 55 and 64 years. At the same time, the most valuable total real assets were held by those aged between 35 and 64 years. The value of assets was also found to be positively associated with income and net wealth, and it is considerably larger for households with self-employed reference persons in comparison to other employment statuses (employees, retired persons or unemployed).

Chart 3
SHARE OF REAL ASSETS
(per cent)



[5] Real estate properties include the household's main residence and any other real estate asset held by any member of the household.

Financial assets

According to the latest survey, 97.1% of all households held at least one type of financial asset, two percentage points more than in 2013. The median value of financial assets stood at €22,512 while the conditional mean value was estimated at €57,498, which is slightly higher than the unconditional mean of €55,823. In relative terms, both means are significantly larger than the median, indicating a high positive skewness of the distribution. This is further confirmed by a steeper increase in the financial assets holding, especially above the 75th percentile.

Bank deposits are the most commonly held financial assets by households. Indeed, bank deposits were the most prevalent financial asset with a holding rate of 96.4% of all sampled households in 2016. Deposit holdings are also widespread in lower income and wealth quintiles, where the participation rate exceeds 90%. Ownership rates of other forms of financial assets were relatively limited; securities were owned by 21.7% of all households, while around 15.9% of households held mutual funds and listed shares. Furthermore, 13.3% of households disclosed that they were covered by a voluntary pension scheme or by a life insurance policy.

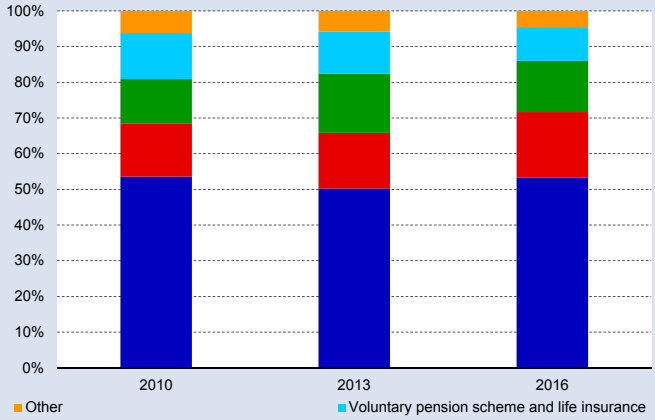
"Bank deposits accounted for 53.3% of all financial assets in 2016, slightly higher than in the previous wave"

Chart 4 shows that bank deposits accounted for 53.3% of all financial assets in 2016, slightly higher than in the previous wave. In 2016, the share of securities and investment funds & listed shares stood at 18.4% and 14.3%, respectively. When compared to 2013, the share of securities increased, whereas the shares of investment funds & listed shares – which are considered riskier – declined.

When looking at the distribution of financial assets by net wealth quintiles it emerges that deposits account for close to 90% of all financial assets held by the bottom quintile. This share decreases gradually as wealth increases. By contrast, an inverse relationship is noted with regards to securities, mutual funds and listed shares, which tend to account for a more sizeable share of financial asset holdings in the wealthier quintiles.

Ownership of financial assets and their portfolio allocation is linked to a combination of a household's characteristics, such as household income and financial literacy. However, households' investment in more complex assets such as financial securities, funds or voluntary pension funds is likely to reflect other factors including educational attainment, risk appetite, age and employment status of the reference person. An assessment of the different components of financial asset holdings by the age of the household's reference person also confirms the prevalence of deposits. On average, ownership of bank deposits exceeds 95% across all age cohorts. Holdings of securities increases up to the 45-54 year age group and levels off thereafter. Furthermore, those aged between 35 and 44 years are the cohort most covered by pension schemes or life insurance.

Chart 4
SHARE OF FINANCIAL ASSETS
(per cent)



Household debt

According to the survey, 34.2% of all households had some form of liability in 2016. The median value of total household debt, which includes both mortgage and non-mortgage debt such as debt on credit cards and other assets, was estimated at €40,000, significantly higher than in the previous wave. The unconditional mean of household liabilities amounted to €21,877, while the conditional mean – the mean value of debt for those households having some form of debt – stood at €63,937.

"34.2% of all households had some form of liability in 2016"

Comparison with the previous two rounds suggests that the increase in the median value of total debt was predominantly driven by higher mortgage debt, whereas non-mortgage liabilities remained small in comparison. The median value of mortgage debt stood at €80,000 in the latest wave. Overall, 20.8% of households held mortgage-related debt. While participation in non-mortgage debt exceeded that of mortgage debt, the median value of the former stood at only €3,502.

The median mortgage debt-to-gross household income ratio stood at 221.7% in 2016, an increase of 8.8% from the previous wave. This increase reflects the above-mentioned increase in median mortgage debt, which may partly reflect increasing property prices and longer loan maturities. Notwithstanding the increase in the median mortgage debt, the mortgage debt servicing cost as a proportion of the gross household income of indebted households was estimated at 14.5%, only half a percentage point more than in the previous round, reflecting declining interest rates.

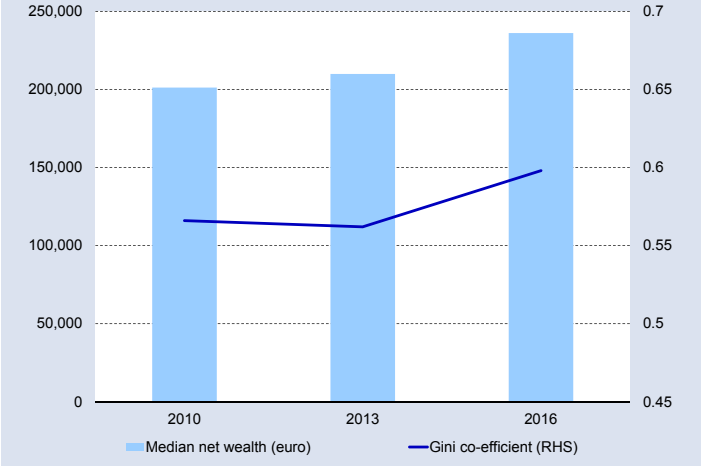
Net wealth

"Estimated household median net wealth, which is defined as the total holdings of real and financial assets net of liabilities, stood at €236,529 in 2016"

The estimated household median net wealth, which is defined as the total holdings of real and financial assets net of liabilities, stood at €236,529 in 2016. At the same time, the average net wealth was calculated at €402,611. Both values vary considerably across wealth quintiles; the median net wealth value of the lowest quintile of households stood at €12,612, increasing to €366,585 for the fourth quintile, before almost doubling to €692,554 for the wealthiest quintile of households.[6]

Since the first wave, the median value of net wealth increased across all household quintiles. However, while average net wealth rose by 24.0% over the three waves, the increase in the median value was less steep, up by 17.5% from 2010. The HFCS-based Gini coefficient, which measures inequality, shows that in 2016, inequality in household net wealth edged up to 0.60, up from 0.57 in 2010, indicating a marginal increase in the level of wealth inequality over the last two waves of the Survey (see Chart 5).

Chart 5
MEDIAN HOUSEHOLD NET WEALTH AND THE GINI CO-EFFICIENT
(euro; Gini points)



[6] Skewness of wealth is common across countries and surveys. For a more detailed treatment of this subject, see HFCN (2016a, 2016b), Boldizsár et al. (2016) and Fessler et al. (2017).

The survey also indicates that net wealth varies according to the age of the reference person, with median net wealth peaking in the 45-64 age bracket, before declining again for the older age cohorts. Net wealth is also positively associated with the size of the household. Households whose reference person is self-employed or with a tertiary level of education also tend to report a higher value of net wealth.

Conclusion

The Survey provides valuable information that is not available from official statistics, thus opening up various avenues for research. The Central Bank of Malta has already published on its website more detailed results of the third wave of the Survey (Attard and Georgakopoulos, 2019), while Georgakopoulos (2019) studies the evolution of income and wealth inequality using data from the three waves of the survey.

A number of caveats need to be highlighted in the interpretation of the results. The main limitation of the HFCS relies on the subjective self-assessed valuation of assets, including real assets and self-employment businesses. Moreover, as with other countries, wealth tends to be relatively unevenly distributed, and hence a relatively small number of households possess a larger portion of total wealth. In order to capture these households correctly, over-sampling of wealthier households is usually conducted in countries were administrative data sources are available. This over-sampling exercise was not possible in the case of Malta since administrative data was not available to the statisticians of the survey.

Currently, the Central Bank of Malta is making the necessary preparations for the collection of data for the fourth wave of the HFCS, which is scheduled to commence in the last quarter of 2020.

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HEDONIC HOUSE PRICE INDICES FOR MALTA: A MORTGAGE-BASED APPROACH[1]

Ian Borg, Jude Darmanin, and Reuben Ellul[2]

This study uses a novel dataset derived from mortgage contracts granted by the major credit institutions in Malta to compute a range of hedonic house price indices for the period 2010-2018. This dataset contains information about house prices and a number of important property characteristics, and is augmented by geographic and socio-demographic variables. On the basis of the two methodologies recommended by the literature for Malta, we find that growth in house prices was relatively muted over the period 2011-2014, ranging between 1.1% and 1.5%. House prices picked-up markedly thereafter, averaging between 7.8% and 8.4%. In particular, house price growth peaked in 2018, at between 14.2% and 14.6%.

Introduction

Due to the limited availability of land and the small size of financial markets, property has over generations served as an important store of wealth for the Maltese. A tightening of rent controls in the aftermath of the Second World War, along with successive policy initiatives aimed at supporting home-ownership, led to a surge in ownership rates throughout the 20th century.[3] For these reasons, reliable measures of property prices are important for both policy-makers, including the Central Bank of Malta, and the public, to be able to assess developments and trends in the housing market.

There are currently two measures of house prices in Malta. The National Statistics Office (NSO) publishes the official Property Price Index (PPI), based on actual contract prices. At the same time, the Central Bank of Malta publishes a complementary index based on advertised property prices on print media. Growth rates for both indices in recent years confirm a buoyant property market driven by a surge in demand, particularly since 2015.

Both these indices capture changes in the median price of property but do not control for changes in the quality and characteristics of the housing units traded. Hence, price trends may reflect changes in the quality and/or type of property being sold, rather than underlying price changes. This calls for a quality-adjusted price index, known in the literature as a hedonic price index, whereby changes in prices are adjusted for variations in the attributes of the transacted properties.

A property's price is determined by the mix of attributes which define it. These attributes reflect both its geographical characteristics, such as locality desirability and transport links, and its structural features, such as size and property type. Hedonic adjustment estimates the marginal contributions of each of these characteristics to the total price, thereby enabling the estimation of a quality-adjusted price index. The first empirical hedonic house price index

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1 This article applies the methodology in Ellul et al. (2019) to a longer dataset.

2 The authors acknowledge the important work done relating to the compilation and use of the data used in this paper by Karen Caruana, Daniel G. Gaskin, Jesmond Pulè, William Gatt Fenech, Joanna Borg Caruana and Erica Caruana. A special thanks also goes to Professor Andrew Narwold who consulted and peer reviewed this work as part of his visit as a Fulbright scholar at the Central Bank of Malta.

3 See Camilleri (2000) for further details on the historical evolution of housing policy in Malta.

was the US Census Bureau's "One-Family Houses Index", first published in 1968. Since then, a number of studies have made use of these methods, some examples being Narwold and Sandy (2010) for the city of San Diego and O'Hanlon (2011) for Ireland.

"A property's price is determined by the mix of attributes which define it. These attributes reflect both its geographical characteristics, such as locality desirability and transport links, and its structural features, such as size and property type."

This study applies the international methodological standards on hedonic house price indices developed by Eurostat (2017) to a novel dataset of anonymised mortgage contracts, collected from Malta's main mortgage lenders under Banking Regulation VI (BR/06). Although there have been previous attempts at constructing a hedonic property price index for Malta (Borg, 2004; Falzon and Lanzon, 2013), this is the first study to apply these methods to mortgage data, supplemented with additional geographic and socio-demographic variables.

Methodology

The basic form of a hedonic regression is shown in (1), where $p_{t,h}$ refers to the price of dwelling h sold at time t and X is a matrix of hedonic characteristics. The random error term $u_{t,h}$ is the unexplained part of dwelling prices.

$$\ln p_{t,h} = \mathrm{X}b_t + u_{t,h} \quad \textbf{(1)}$$

The methodology applied in this study is based on the international standards outlined in the Eurostat et al. (2013) Handbook on Residential Property Prices Indices. Three hedonic methods are considered, which are the time dummy variable (TDV) approach, the rolling time dummy (RTD) method and the average characteristics method. A detailed explanation on each of these methods can be found in Hill (2013) and Eurostat (2017).

The TDV method estimates equation (1) with the addition of a time dummy for each period, excluding the base period. Hence, a single hedonic equation is estimated over the whole dataset. The coefficients on the time dummies represent the underlying price change during the respective time periods, after controlling for the characteristics of the property, while the exponent of these coefficients gives the hedonic index. One disadvantage of this model is that the vector of shadow prices of the property attributes *(b)* is estimated only once and is hence assumed to be time independent. This assumption may be unreasonable for housing markets which experience substantial changes to the assumed worth of an attribute over time.

The RTD method, as developed by Shimizu et al. (2010), is based on the TDV method but estimates multiple regressions through the use of a rolling window procedure, with *Q* being the set window length. An initial regression model is estimated using the first *Q* periods, from which price indices for these periods are obtained. Subsequent regressions are then estimated by successively shifting the window *Q* by one period, such that each regression contains *Q* periods of data. As each new period enters the window, the rate of increase of the index is calculated and used to update the previous sequence of index values. The choice of window length *Q* is arbitrary. O'Hanlon (2011) argues that for a small economy with limited data points, a longer window would increase the robustness of the model. On the other hand, a shorter window ensures that the estimated *b* coefficients are updated more regularly.

Unlike the TDV method, where new period data is added to a single regression model, the coefficients derived from the RTD method are free from revisions (unless new observations are included for past periods). At the same time, because a new regression model is estimated per new period, the vector of coefficients *b* in the RTD method is time variant, a clear advantage over the TDV method in periods when the housing market is undergoing structural change. On the other hand, the TDV may have robustness and significance advantages over the RTD method when using small datasets, because the single regression uses all available observations.

Another way of deriving a hedonic index is the average characteristics approach. Using this method, a separate hedonic model is estimated for every period, thereby ensuring that the *b* coefficients on the property characteristics

are constantly updated. Using these coefficients, the average characteristics method then imputes a price for the 'average' house, given a set of characteristics. From this, the price index is calculated as the ratio of the imputed price of the average house at time *t+1* to the imputed price of the same 'average' house at time *t*. The index is then chained, using either one of the Laspeyres, Paasche, or Fisher chain-linking methods.

Data

The data used in this study are based on an anonymised mortgage contract dataset, which is collected by the Central Bank of Malta from the major domestic credit institutions under BR/06. After cleaning and removing outliers, the dataset consisted of over 28,000 observations, starting from 2010. Three categories of property were considered in the analysis, namely apartments and penthouses, maisonettes, and houses.[4]

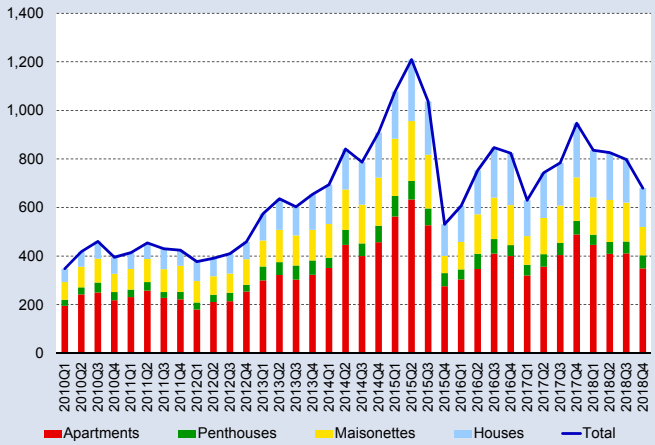
"The data used in this study are based on an anonymised mortgage contract dataset, which is collected by the Central Bank of Malta from the major domestic credit institutions"

The dataset comprises a number of attributes describing the structure and overall characteristics of each transacted property. Of particular importance are the contracted price, the size of the property (in square metres), the property state (shell or finished), and its location. Over the years other attributes have been made available by the data providers, including the presence of a garage/parking space, pool, garden, lift, and views. Since the latter do not span the full sample period, they are not included in the main results presented hereunder, though they do present an opportunity for augmenting the hedonic regression in the future.

Chart 1 gives a general overview of the dataset, plotting the number of transactions per quarter by property type. The number of transactions has increased considerably over time, reflecting the increased activity in the property market over the sample period. In particular, 2015 was a buoyant year in terms of property transactions, probably reflecting house purchase timing decisions relating to the government's first-time buyer scheme.[5] Apartments on average comprised 52% of total transactions over the whole sample period.

The strong increase in property transactions was matched by robust growth in non-quality adjusted house prices. Price growth of contracted mortgages stood at an average rate of 2.0% between 2011 and 2014 (see Chart 2). Growth strengthened thereafter, standing at 7.3% in 2016 and 5.0% in 2017, before accelerating sharply to 12.4% in 2018.[6] The rest of this study attempts to discern whether this acceleration reflects a pure price change or is simply due to changes in the quality and nature of the transacted properties.

Chart 1
NUMBER OF TRANSACTIONS
(counts in the CBM mortgage dataset)



Source: Authors' calculations.

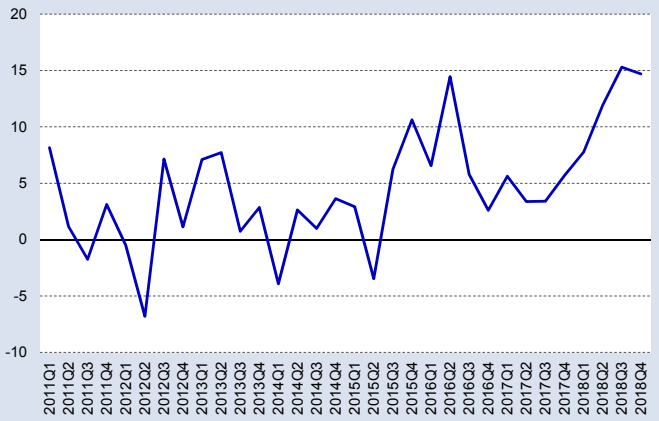
[4] Flats and apartments are defined as units with a communal entrance, with penthouses being the topmost unit in a block of apartments. Maisonettes are units in a block with an independent access. The "house" category comprises houses of character (built before 1900), townhouses (pre-1968 houses), terraced houses (post-1968), and farmhouses (parts of dwelling originally intended to house farm animals). Bungalows, villas, and palazzos were excluded from the dataset.

[5] The scheme allowed first-time buyers to be exempt from the stamp duty on the purchase of immovable property, up to the first €150,000 spent. This is equivalent to savings of up to €5,000 in stamp duty.

[6] Given the low number of observations in each quarter, the data can be volatile. If one compares the index with official figures using moving averages, they are not so different. See Ellul et al. (2019) for further details.

Despite the presence of numerous structural characteristics, the mortgage dataset was somewhat lacking in the geographical attributes of the transacted housing units. The only available variable is "property location", covering 67 different localities across Malta and Gozo. Since assigning dummy variables to each of these locations would have been impractical given the short sample period, localities were grouped into the 13 electoral regions used in the 2017 general election. The advantage of such a grouping is that electoral districts tend to be divided into contiguous geographical areas consisting of broadly equal-sized populations of voters. However, we acknowledge some degree of heterogeneity in property prices between the localities included in an electoral district.

Chart 2
HOUSE PRICE GROWTH IN CONTRACTED MORTGAGES (NON-QUALITY-ADJUSTED)
(annual percentage changes)



Sources: CBM; authors' calculations.

The "property location" variable allowed for the construction of a number of proxy variables capturing the desirability of a property's location. In order to capture attributes such as the frequency and length of transport links and available employment opportunities, each locality was equated with a specific "distance from centre" variable. The economic and political centre for Malta was defined as the localities of Valletta and Sliema/St Julian's, as well as the surrounding areas. For each locality, the distance from centre was calculated as being the road distance to the mid-point of these central areas.

There may also be instances where a locality is in high demand for reasons other than its proximity to the economic centre of the island. For example, localities such as St Paul's Bay and Mellieħa are popular destinations for residents and tourists alike due to the large availability of amenities and leisure activities such as restaurants, shops and beaches. A good proxy for the desirability of certain locations due to their entertainment and/or historical heritage is the presence of hotels, data on which was made available on an annual basis by the Malta Tourism Authority.

Property prices in a locality may also reflect social factors, such as education or poverty levels within the neighbourhood. To capture these social effects, we augment our dataset with NSO data on benefits intended to combat social exclusion, which are available as a single-point observation per locality.

Apart from residential demand, property in Malta has increasingly been demanded for its rental potential. The rent-likelihood of a locality was captured by the share of foreign residents in each locality, taken as the difference between the total population and the total Maltese population from the NSO's annual Demographic Review. Following Sweeny (1974) and Jackson (1979), the sign on this coefficient is expected to be negative. Although this may seem counter-intuitive, it reflects underlying differences in the characteristics of properties rented to foreign nationals, which could have different characteristics than those demanded by residents.

Results

A number of hedonic indices were computed using each of the methodologies described above (TDV, RTD and average characteristics). In the case of the RTD method, indices were computed using two, three, and five-period rolling windows, while the index derived from the average characteristics method was chained using each of the Fisher, Paasche, and Laspeyres methods. The results shown hereunder are thus presented as a range of estimates incorporating each of these methods.

Table 1 presents a sample of regression results relating to the fourth quarter of 2016. The benchmark property against which these results should be interpreted is a shell apartment in Region 10 (Sliema/St Julian's/Gżira). For

all equations depicted in Table 1, the in-sample fit exceeds 50%, suggesting that they are generally a good representation of house prices in Malta. Moreover, the time dummies in the TDV and the RTD methods (not shown here) are mostly statistically significant, meaning that after controlling for property characteristics we can still satisfactorily capture the time series evolution of house prices in Malta.

With regard to the coefficients on property attributes, these are mostly statistically significant in the right direction. Size positively affects a property's price, while finished units command a higher price compared to those in shell form. Penthouses and houses tend to be purchased for higher prices than apartments, though the coefficient on maisonettes is only statistically significant in one of the three methods. In the latter cases, this implies no statistically significant difference between prices for maisonettes and apartments.

Table 1
REGRESSION RESULTS

	Time-Dummy Variable method	Five-quarter rolling window method (2016Q4)	Average Characteristics Model (2016Q4)
Constant	9.87 ***	9.93 **	10.34 ***
Size	0.55 ***	0.55 ***	0.50 ***
Property State			
Shell (benchmark category)			
Finished	0.11 ***	0.18 ***	0.19 ***
Property Type			
Apartments (benchmark category)			
Penthouses	0.10 ***	0.08 ***	0.01
Maisonettes	0.03 ***	0.00	0.01
Houses	0.18 ***	0.09 ***	0.10 ***
Regions			
Region 1	-0.19 ***	-0.26 ***	-0.26 ***
Region 2	-0.18 ***	-0.28 ***	-0.32 ***
Region 3	-0.23 ***	-0.30 ***	-0.36 ***
Region 4	-0.26 ***	-0.39 ***	-0.49 ***
Region 5	-0.16 ***	-0.15 ***	-0.22 ***
Region 6	-0.14 ***	-0.21 ***	-0.23 ***
Region 7	-0.08 ***	-0.16 ***	-0.19 ***
Region 8	-0.08 ***	-0.06 **	-0.11 *
Region 9	-0.10 ***	-0.08 **	-0.07
Region 10 (benchmark category)			
Region 11	-0.04 ***	-0.11 ***	-0.09
Region 12	-0.20 ***	-0.22 ***	-0.16 **
Region 13	-0.19 ***	-0.21 ***	-0.2 ***
Geographic and socio-demographic			
Collective accomodation units	0.06 ***	0.12 ***	0.14 ***
Distance from centre	-0.01 ***	-0.02 ***	-0.02 ***
Social exclusion	-0.17 ***	-0.16 ***	-0.16 ***
Share of foreigners in a locality	-0.24 ***	-1.12 ***	-1.70 ***
Observations	28,691	3,938	866
Adjusted R-squared	0.53	0.52	0.53

* significant at the 10% level.
** significant at the 5% level.
*** significant at the 1% level.

The time dependency characteristic of the RTD and the average characteristics methods allows us to observe which attributes have increased/decreased in importance over time. In particular, the results indicate that, post-2015, there has been a growing premium attached to penthouses and to properties with a higher state of finish.

In terms of geography, the coefficients on most regions are negative with respect to the benchmark Region 10. This implies that dwellings in the Sliema/St Julian's/Gżira area are purchased at a premium over other areas. These negative coefficients become larger in absolute value the further away the property purchased is from Region 10, while the coefficients on regions close to Region 10 (such as Regions 9 and 11) become smaller and/or insignificant. Indeed, the results of this study show that, over the years, the coefficients attached to regions geographically close to Region 10 have been declining, suggesting some form of price convergence in the surrounding area.

The coefficient on the "distance from centre" variable is negative, capturing the negative premium created by a longer travel distance from the political and economic centre of the island. Conversely, the availability of amenities and leisure activities, captured by the number of collective accommodation units, positively affects property prices. Locations with a higher concentration of households which depend on social benefits tend to have lower property prices.

The coefficient on the "share of foreigners" variable, capturing the rent-likelihood of a locality, is negative and statistically significant. This finding is in line with Sweeny (1974) and Jackson (1979), and is due to rental units and tenants having different characteristics than non-rental units and owner-occupied housing. Another strand of the literature suggests that this negative coefficient is partly due to residential segregation.

Indices

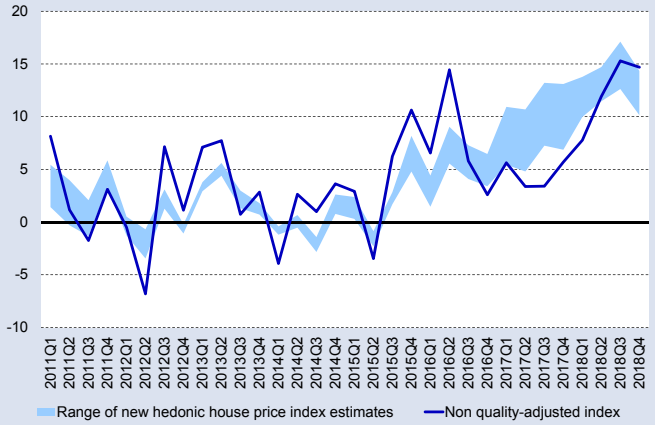
As explained above, the hedonic regressions such as those shown in Table 1 are used to estimate quality-adjusted house price indices. Chart 3 presents the range of house price growth rates obtained from the TDV, the RTD (using three different window lengths) and the average characteristics (using each of the Laspeyres, Paasche, and Fisher methods for chain-linking) methods, and compares it to the non-quality adjusted growth rates shown in Chart 2.

In general, the time series evolution of the indices is broadly similar across methods, implying that the results are quite robust to different hedonic methodologies. With few exceptions, the dynamics of the hedonic and the non-quality adjusted growth rates tend to follow similar trends, though the hedonic indices are less volatile. Overall, hedonic growth in house prices was muted during the period 2011-2014, with an average range of between 0.3% and 2.2% across all the different methods. House price growth picked up markedly in the final three years of the sample period, averaging between 6.9% and 11.3% across all the different methodologies.

Between 2016 and 2017, house price inflation as measured by the hedonic indices exceeded that tracked by the non-quality adjusted index. This indicates that the characteristics of the transacted properties, such as size, changed during the period. By 2018, these differences between the hedonic and the non-quality adjusted indices had largely disappeared.

The relatively wide range in the hedonic indices, particularly toward the end of the sample, is primarily driven by the relatively low growth rates derived from the TDV method. This growing divergence underlines the significant evolution of the housing market in recent years, which the

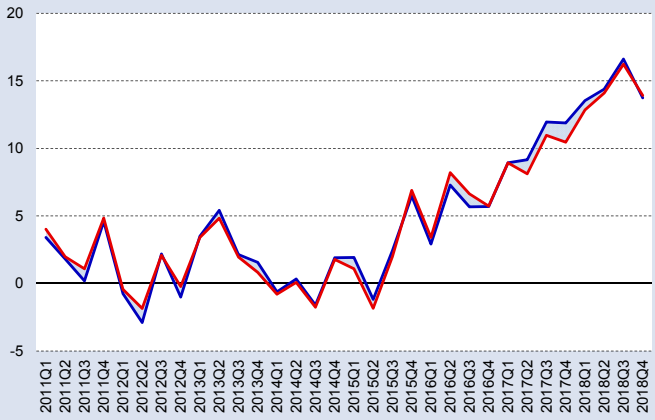
Chart 3
RANGE OF HEDONIC HOUSE PRICES COMPARED TO MORTGAGE NON-QUALITY ADJUSTED INDEX
(annual percentage change)



Source: Authors' calculations.

TDV method is unable to capture due to its constant implicit prices assumption. Chart 4 depicts a much narrower range for the hedonic indices by plotting only the two methods considered as "ideal", namely the RTD method with a five-quarter rolling window, and the average characteristics Fisher-chained index. The five-quarter window for the RTD is more suited for a small economy like Malta with a low number of observations per period, when compared with narrower window lengths (O'Hanlon, 2011). At the same time, the Fisher chained index in the average characteristics method is simply a geometric average of the Paasche and the Laspeyres indices.

Chart 4
HEDONIC HOUSE PRICE RANGES
(annual percentage change)



Source: Authors' calculations.

Using just these two methods, the range of hedonic indices is much narrower and shows a clear upward trend in prices from 2015 onwards. For the years 2011 and 2014, the measures averaged between 1.1% and 1.5%. From 2015 onwards, the measures indicate average house price inflation of between 7.8% and 8.4%, respectively. In 2018, house price growth averaged between 14.2% and 14.6%.[7]

Conclusion and limitations

During the past decade, the Maltese housing market has gone through considerable change, in terms of prices but also, and more importantly, in the underlying characteristics that define the value of a housing unit. This study introduces a novel dataset of mortgage contracts that allows us to gain a deeper understanding of this evolution. Three hedonic computation methods are used based on the international standards outlined in Eurostat (2017), namely the TDV, the RTD, and the average characteristics methods.

"House price growth remained relatively muted over the period 2011-2014 and picked up markedly after 2015"

Overall, the different hedonic measures depict a broadly similar picture of house price growth in Malta over the past few years. House price growth remained relatively muted over the period 2011-2014 and picked up markedly after 2015. The wide range estimated between the hedonic indices in the latter years suggests that the implicit prices attached to a property's attributes have undergone a significant change over the past years, which are better captured by some methods than others.

Although the mortgage dataset used in this study is quite rich, it does have certain limitations which may have impacted on the results presented above. The main limitation is that the mortgage market typically covers only around half of the property market in Malta, with the other half dominated by cash and other transactions. The latter transactions are more common with second-time buyers and in the buy-to-let market, while mortgage transactions tend to be dominated by first-time buyers. If preferences between these groups diverge significantly, then the mortgage dataset might not be fully representative of the property market in Malta. At the same time, the short time-series of the dataset meant that certain property characteristics were unable to be used in the study; this could provide scope for future improvement of the hedonic indices. Similarly, results need to be treated with caution due to the small sample size and the low number of observations per period.

[7] For a comparison with existing house price indices, please refer to Ellul et al. (2019).

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