

BOX 1: MEASURING THE CREDIT GAP FOR MALTESE PRIVATE CORPORATIONS USING THE HAMILTON FILTER¹

In the aftermath of the great financial crisis, credit to the private sector in Malta ramped up, but underneath the headline figures, at a sectoral level, there was an interplay of differing dynamics. While the corporate sector underwent a deleveraging process, lending to households remained strong, prompting the Central Bank of Malta to implement BBMs in 2019 and later, in 2023, a targeted sectoral sSyRB.^{2,3} These measures targeted the mortgage market since this underpinned the primary source of credit growth. Following the onset of the COVID-19 pandemic, lending to corporates picked up momentum, growing by more than 9% by the end of 2020, supported by loan guarantee schemes. As the need for such support measures subsided, growth slowed down to nearly 2% by June 2022, to pick up momentum thereafter. By the end of 2023, credit to resident firms grew by about 7%, necessitating the need to investigate such segment further.

Since it is well established that unsustainable excessive credit growth and leverage can be a source of financial instability, macroprudential authorities carry out exhaustive assessments to unearth budding risks and to try to balance the risk of crises with the cost of policy interventions. The Central Bank of Malta has more recently augmented its assessment of cyclical risk through the construction of the cyclical Systemic Risk Indicator (cSRI), and the multivariate filter credit gap, published in the Bank's 2022 *Financial Stability Report* (FSR) and the 2023 *Interim FSR*, respectively.^{4,5} However, the cSRI is an aggregate measure of cyclical risk, and while the multivariate filter credit gap analyses risk within the household and corporate sectors, it is not designed to shed light on different corporate sectors at a disaggregated level. To this end, it was deemed important to enhance such analyses by monitoring the cyclical credit to Maltese firms by sector to identify whether the buildup in credit is being driven by sector-specific developments.

This box uses the approach proposed in Hamilton (2018) as it facilitates the construction of credit gaps by sectors of economic activity (NACE).⁶ Such application contributes to existing studies by international organisations including the International Monetary Fund (IMF), and other national central banks, which have adopted the Hamilton Regression Filter (HRF) for detrending purposes.^{7,8}

The HRF was originally developed by James D. Hamilton as an alternative method to the traditional Hodrick-Prescott (HP) filter. The HP filter has been cited to suffer from a number of limitations, including its susceptibility to generate spurious cycles and its tendency to 'over-shoot' results when data exhibits turning points.^{9,10} Rather than applying a smoothing parameter to construct a gap, Hamilton proposes using a variable's own lags to construct a measure of the underlying trend. This is represented by the following regression:

$$Y_t = \beta_0 + \beta_1 Y_{t-h} + \beta_2 Y_{t-h-1} + \dots + \beta_j Y_{t-h-p} + v_t \quad (1)$$

where Y_t is the observed variable, which for the purpose of this study represents credit in logarithmic form at time t . The value of h reflects beliefs about the duration of the cycle inherent in the variable,

¹ Written by Ms Joanne Ciantar, Senior Expert within the Financial Stability Surveillance Office of the Central Bank of Malta. The author would like to thank Dr William Gatt Fenech, Mr Andrew Spiteri, Ms Wendy Zammit and Mr Alan Cassar for their helpful comments and suggestions.

² See Central Bank of Malta Directive No.16 'Regulation on Borrower-Based Measures'.

³ See Central Bank of Malta (2023) 'Statement of Decision on the implementation of a sectoral Systemic Risk Buffer on RRE domestic Mortgages in Malta'.

⁴ See Vella, S (2023). Box 1: A cyclical Systemic Risk Indicator for Malta, in *Financial Stability Report 2022*, Central Bank of Malta.

⁵ See Gatt Fenech, W (2023). Special Feature: A measure of the credit gap for Malta, in *Interim Financial Stability Report 2023*.

⁶ See Hamilton, J (2018): 'Why you Should Never Use the Hodrick-Prescott Filter'.

⁷ See Baba, et. al (2020): 'How Should Credit Gaps Be Measured? An Application to European Countries'. In *IMF Working Paper*.

⁸ See Schüller, Y (2018): 'On the cyclical properties of Hamilton's regression filter'. In *Deutsche Bundesbank Discussion Paper*.

⁹ See Hamilton, J (2018) and Baba, C, et. al (2020).

¹⁰ See Lang, J. H. and Welz, P. (2017): 'Measuring credit gaps for macroprudential policy'. In European Central Bank *Financial Stability Review* 2017.

with higher values translating into longer cycles. In this regard, Hamilton (2018) recommends a value of five years ($h = 20$ quarters) for the detrending of the credit variable, reflecting the property that financial cycles are long. Three lags of the variable are also included ($p = 3$), which were found to be sufficient for the applications below. The model in equation (1) is typically estimated using Ordinary Least Squares, and the residuals v_t constitute the cycle.

The model is estimated using quarterly credit data for the period 1993-2023 for overall resident private firms and for several sectors.¹¹ As can be observed in Table 1, the availability of sectoral credit

Table 1
CREDIT DATA REPORTING BY SECTOR OF ECONOMIC ACTIVITY

March 1993-September 2003	September 2003-May 2010	June 2010-to date
Transport, storage and communication	Transport, storage and communication	Transportation and storage
		Information and communication
Manufacturing	Manufacturing	Manufacturing
Building and construction	Construction	Construction
	Real estate, renting and business activities	Real estate activities
Hotel, restaurant and tourist trades	Hotels and Restaurants, excluding related construction activities	Accommodation and food service activities
Wholesale and retail trades	Wholesale and retail trade, repairs	Wholesale and retail trade; repair of motor vehicles and motorcycles
Energy and water	Electricity, gas and water supply	Electricity, gas, steam and air conditioning supply
		Water supply; sewerage waste management and remediation activities
Other ⁽¹⁾	Agriculture	Agriculture and forestry
	Community, recreational and personal service activities	Arts, entertainment and recreation
	Education	Education
	Extraterritorial organisations and bodies	Activities of extraterritorial organisations and bodies
	Financial intermediation	Financial and insurance activities
	Fishing	Fishing and aquaculture
	Health and social work	Human health and social work activities
	Mining and quarrying	Mining and quarrying
	Public administration	Public administration and defence; compulsory social security
		Administrative and support service activities
		Professional, scientific, and technical activities
	Other service activities	

Sources: Eurostat; Central Bank of Malta.

⁽¹⁾ Includes loans to agriculture and fishing, mining and quarrying, public administration, education, health and social work, financial and insurance activities (including interbank loans), professional, scientific and technical activities, administrative and support service activities, arts, entertainment and recreation, other services activities, and extraterritorial bodies and organisations.

¹¹ Since only the private sector is being considered, loans to the general government and public corporations were excluded both on a sectoral basis as well as from the overall figure.

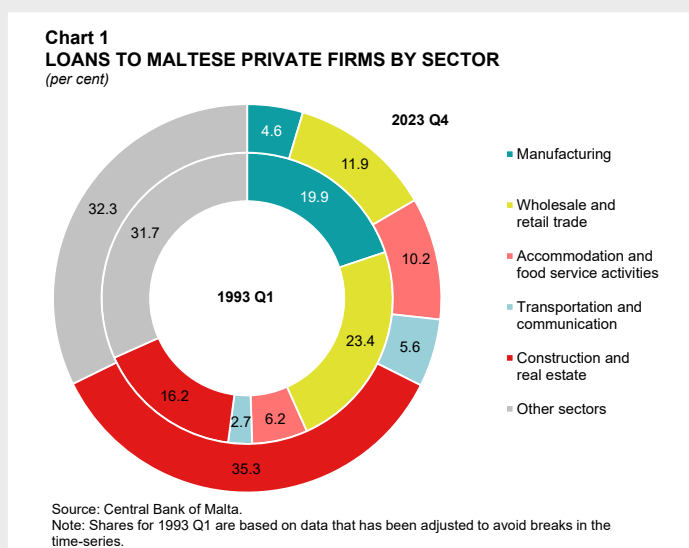
data varied throughout the period observed, with historical data available at a less granular form.¹² As a result, the oldest sectoral composition was used to benefit from the entire time-series available.¹³ This resulted in the development of seven credit gaps, including one for overall credit to private firms, as well as for the below sectors:

1. Manufacturing sector (NACE C)
2. Wholesale and retail trade sector (NACE G)
3. Accommodation and food service activities sector (NACE I)
4. Transportation and communication sectors (NACE H and NACE J)
5. Construction and real estate sectors (NACE F and NACE L)
6. Other sectors^{14,15}

1. Sectoral and overall private firms' credit gaps for Malta

The construction and real estate sectors are key drivers of credit to the Maltese private corporations, as reflected in the sizeable share of loans granted by the domestic banks (see Chart 1). However, this was not always the case, with the share of 16.2% growing significantly over the last 30 years to reach over 35%. The second most prominent sector as at the end of 2023 is the 'other sectors' category, which is composed of several sectors, including the financial sector. This cannot be disaggregated further due to historical statistical methodologies.

The application of the HRF on overall Maltese private firms' credit evidences a long credit cycle ranging between ten to 15 years (see Chart 2). This is in line with existing literature that financial cycles are typically of a longer duration compared to business cycles.¹⁶ Three periods of possible excessive credit are identified; the first captured at its final stages in the late 1990s likely reflecting the impact of the financial liberalisation introduced at the time, the second during the



¹² The NACE classifications reflect the main economic activity as reported in Central Bank of Malta data.

¹³ Due to the minor representativeness of credit facilities to the Energy and Water sectors within overall credit to resident private firms, these have been considered within Other Sectors for the purpose of this study.

¹⁴ Based on Eurostat NACE Rev. 2 terminology, this incorporates the following sectors: Agriculture, forestry and fishing (NACE A), Mining and quarrying (NACE B), Electricity, gas, steam and air conditioning supply (NACE D), Water supply; sewerage, waste management and remediation activities (NACE E), Financial and insurance activities (NACE K), Professional, scientific and technical activities (NACE M), Administrative and support service activities (NACE N), Public administration and defence; compulsory social security (NACE O), Education (NACE P), Human health and social work activities (NACE Q), Arts, entertainment and recreation (NACE R), Other service activities (NACE S), and Activities of extraterritorial organisations and bodies (NACE U).

¹⁵ In December 2023, data for Other Sectors is composed as follows: 50.5% pertain to the Financial sector (NACE K), 0.7% to Agriculture (NACE A1 and A2), 5.1% to Fishing (NACE A3), 20.1% to Professional services (NACE M), 11.9% to the Administrative sector (NACE N), 2.9% to the Education sector (NACE P), 4.9% to Human health activities (NACE Q), 2.2% to the Arts and entertainment sector (NACE R), and 1.5% to Other Services (NACE S). The Mining and quarrying (NACE B), Public administration (NACE O) and Extra-territorial activities (NACE U) represented a negligible amount.

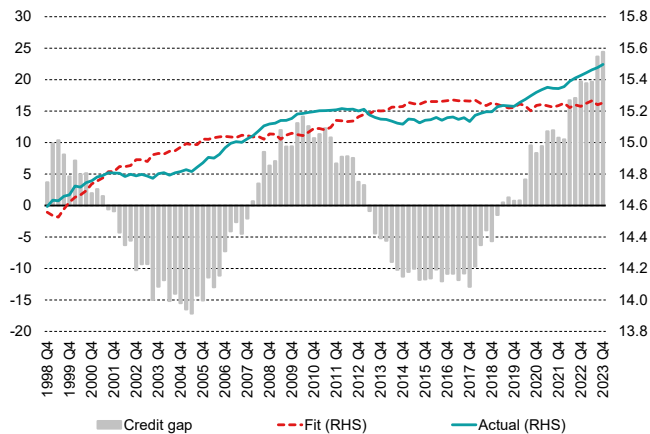
¹⁶ See Drehmann and Yetman (2020): 'Which credit gap is better at predicting financial crises? A comparison of univariate filters'. In Bank for International Settlements Working Papers.

global financial crisis, which persisted until the first quarter of 2013, and the third starting in 2019 Q2. The latter positive credit gap persisted to reach 24.4% in the last quarter of 2023, the highest throughout the 30-year period being analysed.¹⁷ Since the period assessed was characterised by exceptional events, namely the COVID-19 pandemic, the credit gap was re-generated to adjust for its impact on credit growth. When considering two different approaches, namely when excluding loans granted through the Malta Development Bank (MDB) COVID-19 Guarantee Scheme (CGS) and when introducing a dummy variable, results for December 2023 would remain unchanged (see Chart 3).¹⁸

As outlined earlier, one of the main advantages of this study is the ability to estimate credit gaps for each of the sectors specified above. The sectoral credit gaps could then be combined to better identify the importance of each sector in driving credit to resident private firms, resulting in a second measure of the overall credit gap to be produced (see Chart 4).¹⁹ At 21.9% in December 2023, it stood very close to that estimated for overall credit.

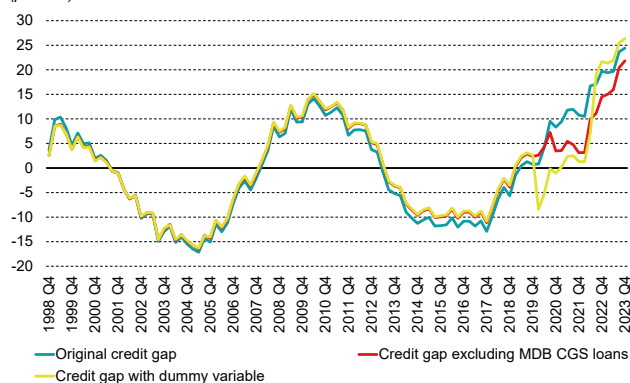
The credit cycle of the construction and real estate sectors mirrors very closely that observed for resident private firms (see Chart 5). These two sectors were the primary contributors in the early stages of the positive credit gap during the global financial crisis as the gap for these sectors peaked and exceeded 50%. Activity in these sectors started to exceed the estimated levels again in the 2020s, with data for the last quarter of 2023 suggesting that the credit gap stood at 33.8%. While this is significant, it is still

Chart 2
CREDIT GAP OF RESIDENT PRIVATE FIRMS BASED ON THE HRF
(per cent; log)



Sources: Author's estimates; Central Bank of Malta.

Chart 3
CREDIT GAP OF OVERALL RESIDENT PRIVATE FIRMS WHEN ADJUSTING FOR COVID-19
(per cent)



Sources: Author's estimates; MDB; Central Bank of Malta.

Note: MDB CGS outstanding loans are excluded from 2020 Q2 onwards. The dummy variable takes the value of one between 2020 Q1 and 2022 Q2.

¹⁷ These results remain unchanged when considering varying values of h and p in the HRF application.

¹⁸ MDB CGS loans granted between 2020 Q2 and 2023 Q4 were excluded, while the dummy variable took the value of one between 2020 Q1 and 2022 Q2 and zero for all remaining periods.

¹⁹ This was done by weighting the credit gaps of each sector according to their share within overall credit to resident private firms. These weights reflect the changing compositions of each sector over time. The sum of the contributions of the sectoral gaps does not necessarily equate to the credit gap estimated over the aggregate time series.

below the peak observed in the past property boom of 2007-2008. Representing 11.9 percentage points of the accumulation of weighted positive gaps as at December 2023, these two sectors were the primary driver behind recent developments within the credit to Maltese private firms, as also shown in Gatt Fenech (2023).

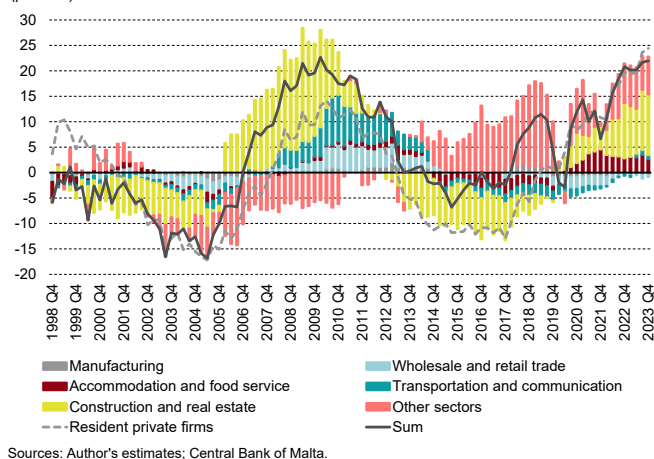
However, other sectors also played a role in the recent positive credit gap. One such sector is the accommodation and food service activities sector. Recent results of the HRF show that the credit gap of this sector is at its highest level over the 30-year period examined. Nevertheless, as it constitutes a lower share in overall credit, its contribution to the combined gap is much more contained at 2.6 percentage points as at the end of 2023. Similarly, despite ending 2023 with a positive credit gap, the transportation and communication sectors contributed just 0.8 percentage point, suggesting minimum impact on overall credit to Maltese

firms. Meanwhile, the manufacturing and wholesale and retail trade sectors ended 2023 with negative credit gaps and are thus not considered to be contributing to the most recent developments observed within the overall private firm credit. The remaining share of the gap is in fact largely attributable to the other sectors, primarily reflecting loans to the financial sector. Should these be excluded, the credit gap for Maltese private NFCs corresponds to 21.0% in December 2023.²⁰ In contrast, when excluding the financial sector, the credit gap of the other remaining sectors would turn negative to -1.7% during the same period.

2. HRF results compared with other gap extraction methods

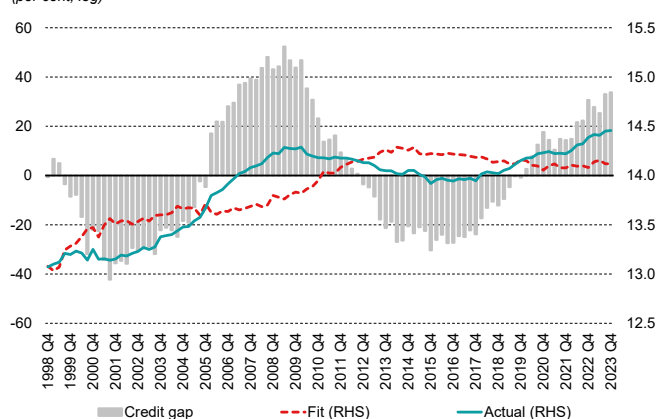
To assess the performance of the HRF as a robust mechanism for signalling excessive credit growth within the private firms' sector in Malta, its results are being compared with alternative metrics. One

Chart 4
SECTORAL CREDIT GAPS BASED ON THE HRF
(per cent)



Sources: Author's estimates; Central Bank of Malta.

Chart 5
CREDIT GAP OF THE CONSTRUCTION AND REAL ESTATE SECTORS
BASED ON THE HRF
(per cent; log)



Sources: Author's estimates; Central Bank of Malta.

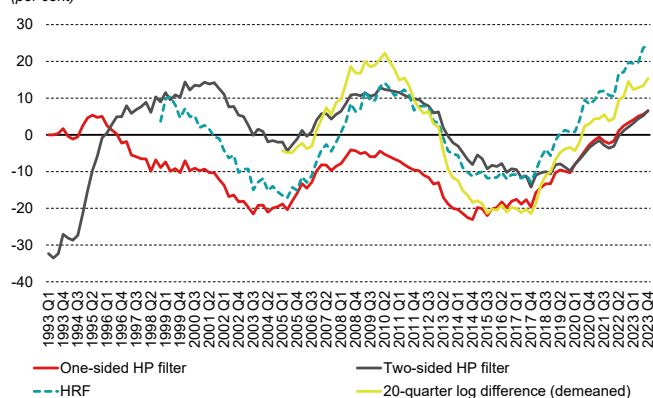
²⁰ The separate credit gaps generated for Maltese private NFCs and other non-financial sectors were generated from 2003 Q1, reflecting data availability on financial loans.

of this, used by Drehmann and Yetman (2018) and Hamilton and Leff (2020), is the five-year (or 20-quarter) log differences.^{21,22,23} The other metric is the HP filter, including both a one-sided application for detrending as proposed by Borio and Lowe (2002) and as used in the assessment of the countercyclical capital buffer (CCyB), as well as its two-sided application. The former considers only past observations to estimate the trend, while the latter considers both past and future observations.²⁴ As guided by literature, a smoothing parameter of 400,000 was used in both applications.

Chart 6 illustrates the results for credit to Maltese private firms extracted using the above three methods, compared to those derived using the HRF. All gap extraction methods, except for the one-sided HP filter, are largely consistent in their estimates of the cycle and its turning points, with some having more pronounced peaks and troughs than others throughout the period analysed. In fact, all metrics, bar the one-sided HP filter, indicate that credit was above historical levels during the global financial crisis. Importantly, all gap extraction methods signal a positive credit gap for resident private firms by the end of 2023, with the one formulated by the HRF opening at a faster pace. Such consistency in results was also observed from a sectoral perspective.²⁵

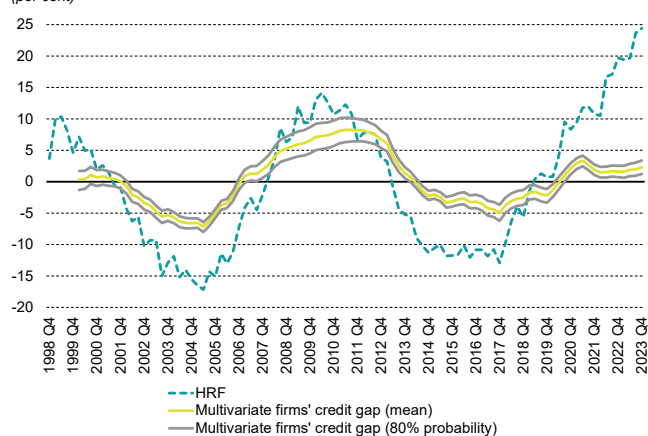
The HRF results for the credit gap extracted for resident private firms are also assessed against the findings of the firms' credit gap derived using the multivariate filter (see Chart 7).²⁶ As

Chart 6
THE HRF VERSUS OTHER GAP EXTRACTION METHODS
(per cent)



Sources: Author's estimates; Central Bank of Malta.
Note: A lambda of 400,000 is applied for the one-sided and two-sided HP filters. 20-quarter log difference represents growth rates and is being worked on a time-series starting from 2000 Q1.

Chart 7
THE HRF VERSUS THE MULTIVARIATE FIRMS' CREDIT GAP
(per cent)



Sources: Author's estimates; Gatt Fenech (2023).

²¹ See Drehmann and Yetman (2018): 'Why you should use the Hodrick-Prescott filter – at least to generate credit gap'. In Bank for International Settlements Working Papers.

²² See Hamilton and Leff (2020): 'Measuring the Credit Gap'.

²³ The 20-quarter log differences have been demeaned and extracted based on data starting from 2000 Q1 to adjust for the impact of the financial liberalisation programme in Malta in the 1990s.

²⁴ See Borio and Lowe (2002): 'Asset prices, financial and monetary stability: exploring the nexus'.

²⁵ More details will be published in Ciantar, J. (forthcoming), 'Analysing the Credit Gap in Maltese Private Firms: Insights from the Hamilton Filter methodology', *Central Bank of Malta Working Paper*.

²⁶ See Gatt Fenech, W. (2023).

can be deduced from Chart 7, both credit gaps are positive with the duration and the turning points of the credit cycle also consistent across both methods.²⁷

3. Conclusion

The need for a sectoral credit gap measure for Maltese private firms has been mainly motivated by strong growth rates observed in recent years and the need to ascertain any potential sources of risks at a sectoral level.

This box proposed a univariate statistical filter as recommended in Hamilton (2018) to facilitate the extraction of seven separate credit gaps. Results for the last quarter of 2023 show a positive credit gap for resident private firms of 24.4%, with similar conclusions when adjusting for the COVID-19 pandemic period and excluding credit to financial entities.

When benchmarked with other gap measurement techniques, the results produced by the HRF are largely consistent. Credit developments within the construction and real estate industry and, to a lesser extent, the accommodation and food service activities sector have particularly contributed to the conclusions observed within the overall credit gap. Although at 33.8%, the HRF credit gap for the construction and real estate sectors is positive, it is still lower than peaks observed during the global financial crisis. Results for the accommodation and food service activities sector reflect the significant expansion of the industry over a prolonged period, which has become more pronounced following the substantial aid received during the COVID-19 pandemic. Nonetheless, its impact on the overall credit gap was more limited given the relatively small share of credit granted to this sector.

The robustness checks performed have all produced identical outcomes, especially for overall credit. As a result, this analysis can enhance the Bank's current toolkit in assessing cyclical risk, by shedding light on sector-specific developments. Such insights are useful in calibrating the appropriate macroprudential policy stance and tools in Malta.

²⁷ The observable difference in magnitude is due to differing methodologies.