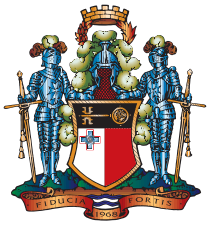

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UPDATED ESTIMATES OF INFLATION PERSISTENCE IN MALTA

Article published in the Quarterly Review 2020:2, pp. 44-49

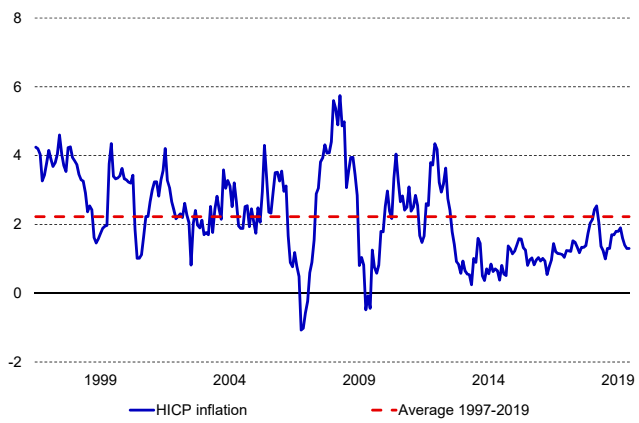
BOX 3: UPDATED ESTIMATES OF INFLATION PERSISTENCE IN MALTA[1]

In the aftermath of the European sovereign debt crisis in 2012, inflation has been unexpectedly low across most of the euro area and EU countries. This led economists to speak of a "missing inflation" puzzle, namely the expectation of higher inflation given the ongoing recovery in economic activity.[2] Malta has also experienced relatively low inflation in recent years, despite the period of strong economic growth and a decline in the unemployment rate to historical lows.

Chart 1 plots the annual growth rate of consumer prices in Malta between 1997 and 2019, as measured by the HICP. Until 2012, despite the various factors influencing its rate, inflation in Malta tended to remain remarkably stable and fluctuated around a mean of 2.7%. Since 2013, however, inflation has remained persistently lower than its long-run average, having reverted back to this average only once for a brief period of time in the second half of 2018. In addition, this relatively low inflation period has also reduced the long-term average, which declined from 2.7% for the period 1997-2012 to 2.3% in the full sample period ending 2019. This suggests changes in the persistence of inflation, which is usually defined as the tendency of inflation to gradually return to its long-term mean following a shock.

Against this background, this box updates our previous estimates of inflation persistence, which were published in *Quarterly Review* 2013:2.[3] A full understanding of the underlying patterns and determinants of inflation persistence remains crucial for policymakers as they have important consequences for the conduct of monetary policy. Indeed, the appropriate response of monetary policy to a shock depends on the degree to which the effect on inflation is persistent. Good estimates of inflation persistence for Malta – both at the aggregate and sectoral level – also allow researchers to enhance existing macroeconometric models, which should eventually lead to improved tools for

Chart 1
HICP INFLATION IN MALTA: 1997-2019
(year-on-year percentage change)



Sources: Eurostat; authors' calculations.

[1] Prepared by Reuben Ellul and Brian Micallef. Mr Ellul is a Principal Economist in the Bank's Economic Analysis Department and Dr Micallef is the Manager of the Research Department. Any errors, as well as the opinions expressed in the article, are the authors' sole responsibility.

[2] Ciccarelli, M. and Osbat, C. (2017), "Low inflation in the euro area: causes and consequences", *Occasional Paper* No 181, European Central Bank.

[3] Ellul, R. and Micallef, B. (2013), "Estimating inflation persistence in Malta", *Quarterly Review* 2013:2, Central Bank of Malta.

forecasting and simulation analysis.[4] Finally, in the context of a monetary union, different degrees of inflation persistence compared with the euro area average could be a source of inflation differentials vis-à-vis the rest of the monetary union, which, in turn, will affect the country's external price competitiveness.

Methodology

Following Ellul and Micallef (2013), we measure persistence as the sum of auto-regressive coefficients.[5] Equation (1) was estimated for the overall HICP index and various sub-indices:

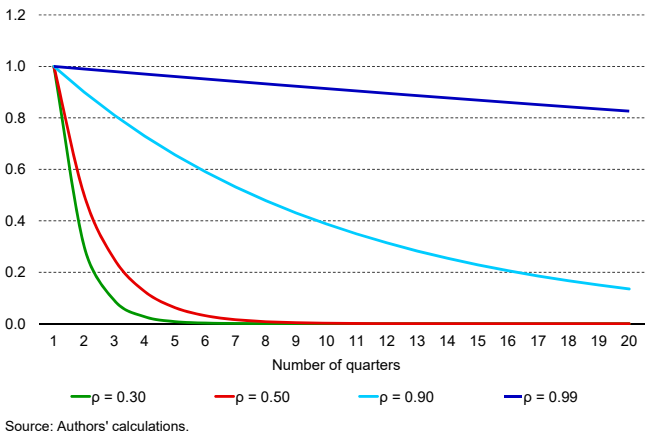
$$\pi_{i,t} = c_{i,t} + \sum_{k=1}^{K^*} \beta_{i,k}\pi_{i,t-k} + \varepsilon_{i,t} \text{ with } \rho_i = \sum_{k=1}^{K^*} \beta_{i,k} \quad (1)$$

where $\pi_{i,t}$ refers to the average year-on-year inflation rate in quarter *t* for index *i*, while the persistence parameter, ρ_i, refers to the sum of autoregressive coefficients. K^* stands for the optimal lag length identified by the Akaike information criterion. The optimal lag length for each regression is determined separately. Each equation also includes a constant term.

A process is said to be mean-reverting – that is, tending to revert to a constant, long-term mean – if the autoregressive coefficient ρ lies within the range $0 < |\rho_i| < 1$. A positive autoregressive coefficient implies the process reverts to its long-term mean in a smooth fashion while a negative coefficient implies that it converges to its mean in an oscillatory pattern. On the other hand, if $|\rho_i| = 1$, we have a unit root process, in which case the process does not return back to its mean after a shock. The term (1- ρ) is called the speed of mean-reversion. A common way to measure the speed of mean-reversion is to compute the half-life of a shock. The latter counts the number of periods in which the effect of a shock remains above half its initial impact. Half-life measured in years is computed by the following formula: $\ln(0.5)/\ln(|\rho_i|)$.

Chart 2 illustrates graphically the concept of persistence and mean-reversion in a first-order autoregressive process. It shows that the time it takes for a process to return to its mean following a shock depends on the autoregressive coefficient, with lower values of ρ being associated with a faster return to its mean, and vice versa. For instance,

Chart 2
PERSISTENCE
Back to baseline after 1% shock
(deviations from baseline; percentage points)



Source: Authors' calculations.

[4] A detailed overview of the inflation forecasting process at the Central Bank of Malta is available here.
[5] See footnote 3.

the half-life associated with a persistence parameter of 0.3 and 0.5 is around seven months and one year, respectively. A highly persistent process, say with an autoregressive parameter of 0.9, has a half-life in excess of 6.5 years.

Estimates of inflation persistence using equation (1) are based on disaggregated HICP indices published by Eurostat and covering the period from January 1996 to December 2019. The analysis focuses on year-on-year inflation rates measured at a quarterly frequency. Estimates were computed at high and intermediate levels of aggregation for Malta, the euro area and a number of small and open economies that share similar characteristics with Malta or those with significant trade links with the local economy. The countries covered include Cyprus, Estonia, Ireland, Italy, Luxembourg, Slovenia and the United Kingdom. The persistence parameter was calculated for the overall HICP inflation as well as at various levels of disaggregation.

At the outset, it is important to highlight two points. First, data quality tends to be more problematic in disaggregated series. The latter can be prone to significant structural breaks, such as those involving changes in the composition of the indices or in data collection methods. Similarly, one-off events tend to have a more pronounced impact on disaggregated series. Second, the weights of the different indices may have changed significantly over the years. Thus, while individual disaggregated series may exhibit high levels of persistence, at a more aggregated level estimates could be lower, reflecting offsetting developments in the separate sub-indices over time. Aggregation effects show up when the degree of persistence at an aggregate level differs from that shown by its constituent parts. These effects can also appear across time, as the weights of the different components change over the years.

Results

Table 1 shows the estimates of the autoregressive coefficients at various levels of aggregation and across a number of countries. The persistence parameter for the overall HICP inflation in Malta is estimated at 0.66, a significant increase compared to our previous estimate of 0.27 (covering the period between 1997 and 2012). The half-life associated with the updated parameter has increased to 20 months, up from six months in the previous estimate. The extent of the aggregation bias – the disaggregated sub-components of the HICP having higher estimates of persistence than the overall HICP – has significantly diminished.

Sectoral disaggregation

Chart 3 compares the updated estimates of inflation persistence for Malta with the earlier results, both for the overall HICP inflation and the five main sub-components. The latter refer to energy, unprocessed food, processed food, NEIG and services. The largest increase in persistence originates from the energy sub-component, whose persistence rose from 0.39 to 0.73. The latter reflects not only the drop in the price of oil in euro terms, but also the impact of the energy reforms introduced since 2013, including the reduction in electricity tariffs and hedging agreements aimed at providing stability in energy prices. Indeed, the average annual growth rate in the energy sub-component of the HICP index, estimated at -1.99% over the period 2013-2019, is substantially lower than its long-term average of

Table 1
ESTIMATES OF THE DEGREE OF INFLATION PERSISTENCE (ρ): 1997-2019

	MT	EA[1]	LU	CY	EE[2]	SI[3]	UK	IT	IE
Overall HICP	0.66	0.84	0.78	0.81	0.80	0.94	0.87	0.86	0.93
Food and non alcoholic beverages	0.70	0.69	0.74	0.53	0.71	0.83	0.85	0.73	0.88
Alcoholic beverages, tobacco and narcotics	0.81	0.89	0.84	0.81	0.76	0.85	0.88	0.82	0.79
Clothing and footwear	0.41	0.41	0.54	0.44	0.87	0.83	0.92	0.62	0.83
Housing, water, electricity, gas and other fuels	0.76	0.84	0.70	0.74	0.84	0.83	0.78	0.77	0.82
Furnishings, household equipment and routine maintenance of the house	0.71	0.92	0.67	0.65	0.82	0.94	0.90	0.94	0.95
Health	0.86	0.81	0.74	0.86	0.80	0.92	0.67	0.75	0.95
Transport	0.65	0.73	0.71	0.66	0.79	0.90	0.75	0.77	0.74
Communications	0.85	0.84	0.74	0.87	0.87	0.85	0.89	0.73	0.81
Recreation and culture	0.70	0.61	0.67	0.67	0.76	0.88	0.89	0.82	0.94
Education	0.83	0.78	0.61	0.94	0.91	0.91	0.81	0.79	0.63
Restaurants and hotels	0.51	0.92	0.80	0.84	0.83	0.91	0.81	0.95	0.94
Miscellaneous goods and services	0.61	0.93	0.76	0.90	0.76	0.94	0.87	0.91	0.91
Energy	0.73	0.77	0.73	0.72	0.75	0.75	0.77	0.79	0.70
Unprocessed food	0.52	0.49	0.60	-0.06	0.52	0.49	0.74	0.56	0.79
Processed food	0.68	0.84	0.86	0.86	0.75	0.90	0.88	0.86	0.89
NEIG	0.58	0.74	0.58	0.63	0.80	0.85	0.94	0.90	0.90
Services	0.74	0.90	0.82	0.86	0.84	0.86	0.85	0.94	0.92
Services – Communication	0.86	0.85	0.75	0.87	0.87	0.77	0.89	0.73	0.80
Services – Housing	0.61	0.98	0.87	0.92	0.85	0.84	0.93	0.93	0.90
Services – Recreation	0.66	0.81	0.77	0.86	0.74	0.90	0.86	0.95	0.95
Services – Transport	0.70	0.88	0.83	0.71	0.84	0.88	0.70	0.81	0.64
Services – Miscellaneous	0.76	0.93	0.67	0.94	0.83	0.84	0.86	0.82	0.89

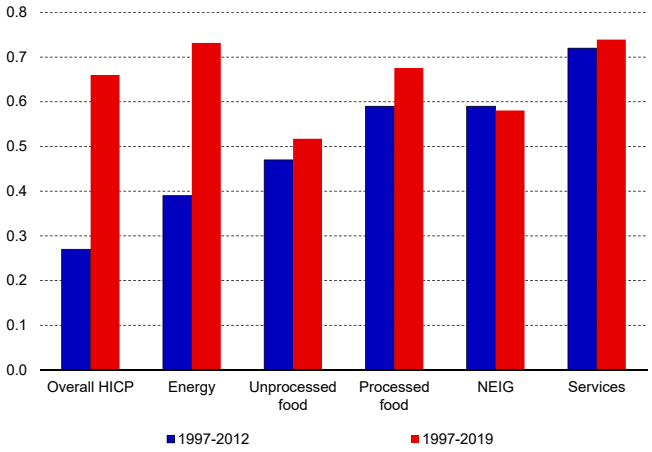
Source: Authors' calculations.

[1] For the euro area, miscellaneous services are unavailable before 1999. NEIG and services are unavailable before 2001.
[2] For Estonia, the indices for NEIG, overall services, housing services, miscellaneous services and services related to recreation, including repairs and personal care are only available from December 1997. Data for energy and transport services are available from December 2000.
[3] For Slovenia, the indices for energy, unprocessed and processed food, NEIG and services are only available from December 1999.

4.43%. Reflecting these dynamics, Chart 4 shows that energy price inflation since 2013 has never reached its long-term average, which explains the rise in inflation persistence during this period.

The updated estimates have also altered the relative persistence patterns across the main HICP components. In the previous estimates,

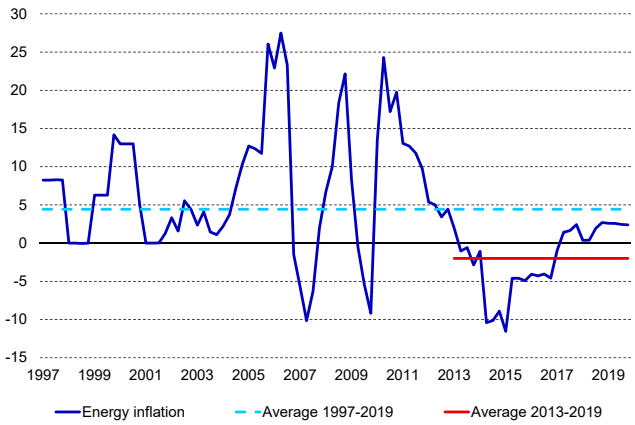
Chart 3
CHANGES IN PERSISTENCE ESTIMATES IN MALTA



Source: Authors' calculations.

services inflation exhibited the highest degree of persistence while, at the other end of the spectrum, energy and non-processed food had the lowest persistence. This pattern was also broadly similar across countries, with services being more persistent compared to the other two components that are relatively more volatile. Estimates for the overall services index, as well as its five sub-components, have remained relatively stable but the updated estimates of energy persistence have increased to a level that is similar to services.

Chart 4
ENERGY INFLATION IN MALTA
(year-on-year growth rate)



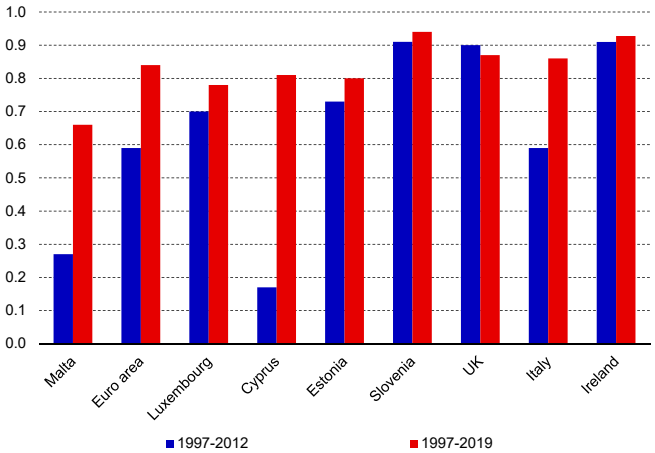
Source: Authors' calculations.

At a further level of disaggregation, the picture is more heterogeneous as one-off events or sector-specific developments become more pronounced. At the 12-level classification, the updated estimates of persistence remained broadly stable and, with few exceptions, all sub-indices have a persistence parameter above 0.5. In terms of changes compared with the previous estimates, a decline in persistence was noted in Clothing and footwear (CP03) while an increase was registered in Furnishings, household equipment and routine maintenance of the house (CP05) and Transport (CP07). As expected, persistence remains highest in indices whose prices are infrequently changed or those that are heavily influenced by government policy.

Cross-country developments

Inflation persistence remains lower in Malta than in the euro area as a whole and lower than in any of the other countries listed in Table 1. Chart 5 shows that, with the exception of the United Kingdom, all countries considered have reported an increase in persistence measured in overall HICP inflation. For the euro area as a whole, the persistence parameter

Chart 5
CROSS-COUNTRY CHANGES IN PERSISTENCE ESTIMATES



Source: Authors' calculations.

is now estimated at 0.84, up from our earlier estimate of 0.59. In addition to Malta, Cyprus and Italy have also registered a substantial increase in their inflation persistence due to prolonged periods of low (or negative) inflation in the aftermath of the European sovereign debt crisis.

With few exceptions, the updated estimates of persistence across countries have converged substantially compared to our previous results. This applies both to the overall HICP index and the main components. A similar pattern is also noticed with regards to energy persistence, which has increased substantially in all countries. The revised estimates of energy persistence now stand in a narrow range between 0.70 and 0.79, whereas previously they ranged from 0.32 and 0.73. Persistence estimates in other sub-indices have remained broadly unchanged. In most countries, services remain the most highly persistent category, with estimates standing between 0.74 and 0.94. The persistence in the prices of services is commonly attributed to this category's high dependence on wage costs, which are not volatile and tend to be changed rather infrequently.