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EUROSISTEMA  
CENTRAL BANK OF MALTA

## AN EVALUATION OF CORE INFLATION MEASURES FOR MALTA

### BOX 3: AN EVALUATION OF CORE INFLATION MEASURES FOR MALTA<sup>1</sup>

In his 2006 Nobel prize lecture, Edmund Phelps stated that “the function of the central bank is the management of inflation expectations”.<sup>2</sup> Tasked with the duty of maintaining price stability, central banks need a reliable gauge for inflationary trends beyond indications given by the overall change in the official national price index. While headline inflation is an important indicator, it is bound to contain “statistical noise”, which can be both transitory (such as changing seasonality of price movements, fiscal shocks and changes in weather), as well as permanent (such as sampling and measurement bias, and quality adjustment). These elements may cloud the true signal about prices that interests the monetary policy-maker.<sup>3</sup> Transitory changes would not require any immediate action in the conduct of monetary policy, whereas broad-based inflationary or deflationary pressures would.<sup>4</sup> For this reason, central bankers tend to resort to measures of *core inflation* – an approximation of so-called “underlying” inflation, or price pressures – which are related to medium to long-run dynamics of the economy. Furthermore, estimates of underlying inflation have been shown to possess good predictive power to forecast headline inflation, as well as to lead to better estimates of structural relationships in the economy.<sup>5,6</sup>

There are various definitions of core inflation, and therefore different methods have been proposed over time to measure this signal.<sup>7</sup> Perhaps the most well known measure of core inflation is “overall inflation excluding the effects of energy and food prices”, but many other measures exist, inspired by different definitions of this concept. For instance, some authors argue that core inflation is equivalent to the steady state growth rate of unit labour costs.<sup>8</sup> Another definition, given by Bryan and Cecchetti, is “the long-run or persistent component of the measured index, which is tied in some way to money growth”.<sup>9</sup> Similarly, others have defined core inflation as “that component of measured inflation that has no medium to long-run impact on real output”, making reference to the long-run neutrality of money with respect to economic activity.<sup>10</sup>

<sup>1</sup> Written by William Gatt, Senior Research Economist at the Modelling & Research Department. The author would like to thank Dr Aaron Grech for useful comments and suggestions, and acknowledges any errors and opinions solely as his own.

<sup>2</sup> Phelps, E. S., “Macroeconomics for a modern economy”, *The American Economic Review*, Vol. 97 No. 3, June 2007, pp. 543-561.

<sup>3</sup> Cecchetti, S. G., “Measuring short-run inflation for central bankers” *Review*, Federal Bank of St. Louis, May 1997, pp. 143-155, and Clark, T. E., “Comparing measures of core inflation”, *Economic Review*, Vol. 86 (2), Federal Reserve Bank of Kansas City, 2001, pp. 5-32.

<sup>4</sup> “Measures of underlying inflation in the euro area”, *Monthly Bulletin*, ECB, February 2001.

<sup>5</sup> Clark, T. E., “Comparing measures of core inflation”, *Economic Review*, Vol. 86 (2), Federal Reserve Bank of Kansas City, 2001, pp. 5-32; Cristadoro, R., Forni, M., Reichlin, L., and Veronese, G., “A core inflation indicator for the euro area”, *Journal of Money, Credit and Banking*, Vol. 37 No. 3, July 2005, pp. 539-560, and Stavrev, E., “Measures of underlying inflation in the euro area: assessment and role for informing monetary policy”, *Working Paper* No. 06-197, IMF, 2006.

<sup>6</sup> Two economists have shown that using a measure of core inflation in the estimation of a New Keynesian Phillips curve improved both the fit and the forecasting accuracy over other estimates based on headline measures. See Norman, D. and Richards, A., “The forecasting performance of single equation models of inflation”, *Economic Record* 88, no. 280, 2012, pp. 64-78.

<sup>7</sup> See Clark, T. E., “Comparing measures of core inflation”, *Economic Review*, Vol. 86 (2), Federal Reserve Bank of Kansas City, 2001, pp. 5-32. The Federal Reserve Bank, for example, publicly states that more than one measure of core inflation is used in its rate-setting analysis.

<sup>8</sup> Eckstein, O., *Core inflation*, Englewood Cliffs, New Jersey, Prentice-Hall, 1981 and Parkin, M., “On ‘Core Inflation’ by Otto Eckstein: A review essay”, *Journal of Monetary Economics*, Vol. 14 No. 2, 1984, pp. 251-264.

<sup>9</sup> Bryan, M. F. and Cecchetti, S. G., “Measuring core inflation”, in *Monetary Policy*, The University of Chicago Press, 1994, pp. 195-219.

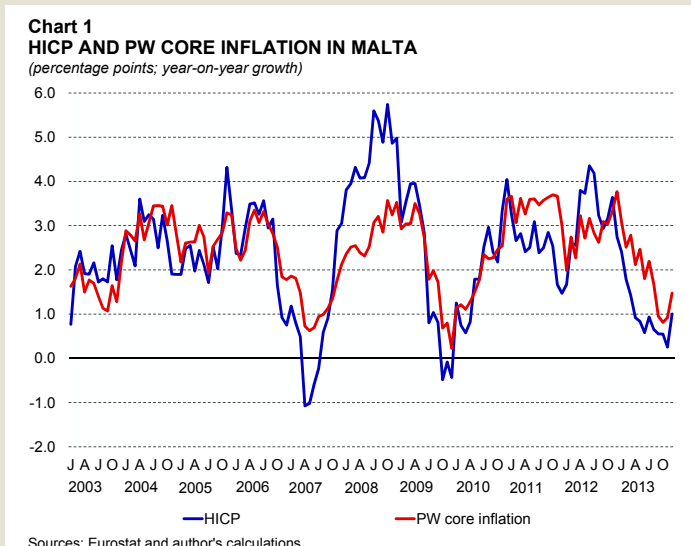
<sup>10</sup> Quah, D. and Vahey, S. P. “Measuring core inflation”, *The Economic Journal*, 1995, pp. 1130-1144.

## Core inflation in Malta

In this Box several approaches to measuring core inflation are applied to the HICP. These include a variant of the persistence-weighted (PW) approach, a trimmed mean (TM) approach and an estimate based on a trend-cycle decomposition. The most popular measure of core inflation, which is overall inflation less the contribution of energy and food price inflation, is not considered to be a good proxy for underlying inflation in Malta, as it tracks overall inflation very closely and is similarly volatile.<sup>11</sup> This motivates the construction of other measures of core inflation.

The Central Bank of Malta already publishes a measure of core inflation in its analysis on price developments. This estimate is based on the PW approach using the ten main product groups that make up the RPI.<sup>12</sup> The PW methodology is motivated by the idea that persistent inflation dynamics should be given more weight in a measure of underlying inflation. Therefore, sub-components for which shocks to inflation do not tend to be long lasting are given a small weight relative to others with more persistent inflation. The process to derive these weights formally involves regression analysis.<sup>13</sup>

The PW methodology is applied to 81 HICP sub-indices, which is a higher level of disaggregation than used in the Bank's current measure. The weights were estimated using data spanning five years at a time on a rolling basis, that is, data for the period 1998-2002 were used to calculate the weights used for 2003, whereas data for the period 1999-2003 were used to calculate the weights for 2004, and so on. The resulting estimate of core inflation, which starts in 2003, is shown in Chart 1



<sup>11</sup> The standard deviations of overall HICP inflation and inflation in HICP excluding energy and food are 1.37 and 1.21 percentage points, respectively, for the period January 2003 to December 2013, compared with 0.67 and 0.86 percentage point for the first two core inflation measures presented in this Box.

<sup>12</sup> That is, aggregates at the two-digit level of the Classification of Individual Consumption by Purpose (COICOP), as published by the National Statistics Office; a recent publication is *News Release* 196/2014. For more information on the Bank's RPI-based core inflation estimates see Demarco, A. "A new measure of core inflation for Malta", *Quarterly Review*, 2004:3, Central Bank of Malta, pp. 43-49.

<sup>13</sup> The weights are established by estimating auto-regressive (AR) models for each sub-component, such as:

$$\pi_t^i = c + \rho\pi_{t-j}^i + \varepsilon_t$$

whereby  $\pi_t^i$  and  $\pi_{t-j}^i$  is current inflation and the lag of inflation in sub-component  $i$   $c$  is a constant,  $\varepsilon_t$  is an error term and  $\rho$  is a measure of persistence. The latter is expected to be between 0 and 1, and higher estimates result in relatively higher weights to the corresponding sub-components. The interested reader is referred to Cutler, J., "Core inflation in the UK", *External MPC Unit Discussion Paper* No. 3, Bank of England, 2001, and Bilke, L. and Stracca, L., "A persistence-weighted measure of core inflation in the euro area", *Economic Modelling*, Vol. 24(6), 2007, pp. 1032-1047. The estimated AR models used in this Box were augmented with a more detailed specification for the error term to ensure well behaved residuals.

along with overall HICP inflation.<sup>14</sup> The results indicate that core inflation is less volatile and tends to display clearer cyclical dynamics.

Table 1 compares the weights for the main aggregates of HICP used in the official estimate with those derived from the PW methodology. The weight given to energy and unprocessed food components falls by about one-half of their weight in the HICP, while that for service components falls by one-tenth. Meanwhile, the weight for the NEIG component, which includes a vast range of consumer goods, increases. It is interesting to note that the re-allocation of weights given by this method happens to be similar in spirit to the “inflation excluding energy and food” measure commonly used as a proxy for core inflation, as the latter removes all weight from the energy and food components. These components tend to be volatile and are hence judged to contain little information about underlying inflation.

Another popular technique used by central banks to derive measures of core inflation in an economy is the Trimmed Mean inflation rate.<sup>15</sup> This technique, similar to the “inflation excluding energy and unprocessed food” measure, is an exclusion method since it strips selected sub-components away before calculating the weighted average inflation rate. This “trimming” is guided by statistical logic: in any month the cross-sectional distribution of inflation rates across sub-components will tend to follow the Normal distribution – many of the inflation rates will cluster around the average inflation rate, while a few will be far away from the average, at the “tails” of the distribution. However, as discussed in the literature, this distribution tends to be skewed to one side from time to time, such that the tails do not balance out.<sup>16</sup> This creates a bias in the calculation of the average inflation rate and can be a source of volatility, as the skewness can also change between different periods.<sup>17</sup>

**Table 1**  
**OFFICIAL AND PERSISTENCE-WEIGHTED HICP WEIGHTS**

*Percentage points; 2007-2013 averages*

	HICP Official	PW Estimates	Difference
Energy	6.5	3.6	-2.9
Unprocessed food	7.9	4.2	-3.7
Processed food	13.6	16.2	2.7
Non-energy industrial goods	31.0	39.1	8.1
Services	41.0	36.9	-4.2
	<b>100.0</b>	<b>100.0</b>	

Sources: Eurostat and author's calculations.

<sup>14</sup> Although the first observation in the HICP database is for January 1996, 12 monthly observations were used to calculate year-on-year growth rates, and another 12 observations were “lost” in the estimation of the AR model due to the lagged component. Therefore, data available for the first estimate of persistence were for the period 1998-2002.

<sup>15</sup> See, *inter alia*, Marques, C.L. and Mota, J.M., “Using the asymmetric trimmed mean as a core inflation indicator”, *Economic Bulletin*, Banco de Portugal, September 2000, pp.85-95, and Vega, J.L & Wynne, M.A., “An evaluation of some measures of core inflation for the euro area”, *Working Paper* No. 53, European Central Bank, April 2001.

<sup>16</sup> Bryan, M. F. and Cecchetti, S. G., “Measuring core inflation”, in *Monetary Policy*, The University of Chicago Press, 1994, pp. 195-219.

<sup>17</sup> This argument holds even in the case when inflation is a weighted average of inflation rates across the various sub-components, such as is the case for the HICP.

A way of overcoming this is to remove part of the distribution that lies at the tails, such that the average inflation rate is calculated from a less dispersed distribution. How much to trim is an empirical question; trimming too little will not improve the measure of inflationary trends by much, while trimming too much runs the risk of throwing away important information.<sup>18</sup> At the same time, measures of core inflation are expected to

be less volatile than the official inflation rate. Therefore, the trade-off is handled such that, while a significant proportion of the distribution is used, the resulting time series must be reasonably less volatile than headline inflation. With these considerations in mind, the 30% TM was used as a suitable measure of core inflation, a level of trimming which is frequently used in practice.<sup>19</sup> This means that 15% of both the upper and lower parts of the distribution were removed each month from the calculation.<sup>20</sup> Chart 2 shows the 30% TM, along with the PW measure of core inflation.

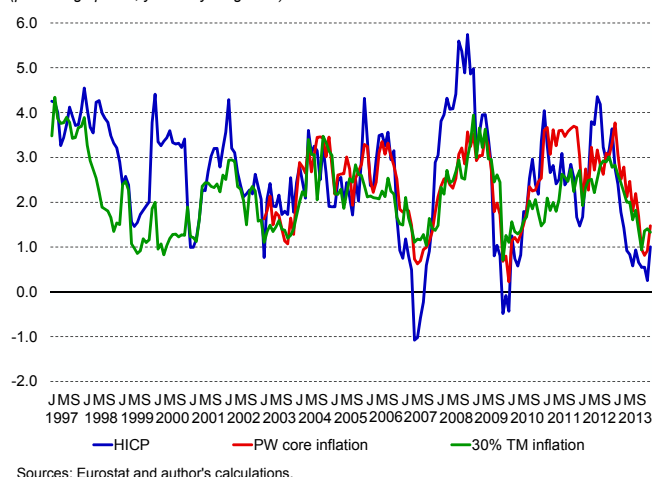
The TM measure correlates strongly with the PW measure. This confirms the robustness of these measures, and their success in removing the noise from the data, and better track underlying inflation. These two core inflation indicators are less volatile than headline HICP inflation, resulting in dampened peaks and troughs, especially during the period 2007-2010, in which inflation was particularly volatile.

Core inflation can also be considered as the long-term trend in inflation. To this end such a measure, which is an unobservable variable, can be inferred by performing a trend-cycle decomposition of headline inflation using an Unobserved Components Model, a univariate time-series technique given by:

$$\pi_t = \tau_t + c_t + i_t$$

whereby  $\pi_t$  is headline inflation,  $\tau_t$  is the long-run trend of inflation,  $c_t$  is the cyclical variation of inflation and  $i_t$  is an irregular component, which absorbs short-term volatility in

**Chart 2**  
HICP INFLATION AND MEASURES OF CORE INFLATION IN MALTA  
(percentage points; year-on-year growth)



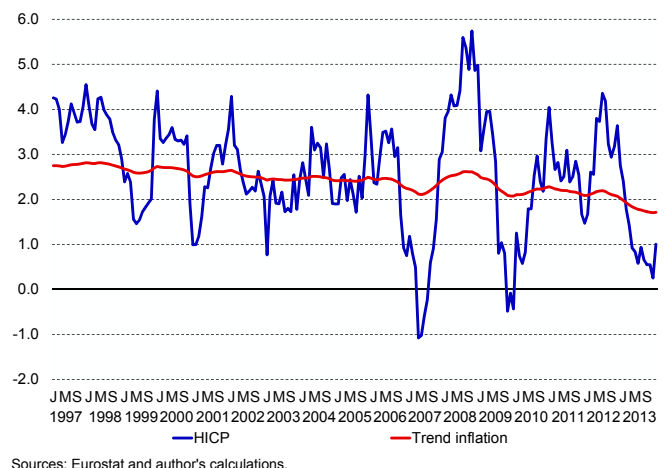
<sup>18</sup> Despite this risk, the weighted median inflation rate, which is composed only of the inflation rate that happens to fall at the median of the distribution (the 50th observation across the cross-section), is also used by some central banks with success. See Clark, T. E., "Comparing measures of core inflation", *Economic Review*, Vol. 86 (2), Federal Reserve Bank of Kansas City, 2001, pp. 5-32.

<sup>19</sup> See, for example, "Methodology of calculating core inflation measures published by Narodowy Bank Polski", *National Bank of Poland*, April 2014.

<sup>20</sup> This implies that 12 indices from each end of the distribution are removed each month. Since this method does not require data to initialise the sequence, the estimate can be calculated as from the first observation for the year-on-year growth rate, which is January 1997.

the data which do not relate either to the trend or the cycle.<sup>21</sup> The long-term trend is modelled as a variable that can change smoothly over time, while the cycle is allowed to fluctuate with some persistence around an average of zero. The results of this decomposition can be seen in Chart 3, which shows the long-term evolution of inflation with respect to headline HICP inflation. The results show that long-term underlying inflation has followed a slow downward trajectory, from around 3% in the late 1990s to around 2% in the recent past.

**Chart 3**  
**HICP INFLATION AND TREND INFLATION IN MALTA**  
 (percentage points; year-on-year growth)



### Reconciling trends in Malta's underlying inflation with euro area inflation

The results for long-run, trend inflation may be used to examine the extent of convergence in consumer price inflation over time in Malta with those in the euro area. As shown below, core inflation in Malta has converged with the headline inflation rate in the euro area, implying an improvement in the competitiveness of the local economy. This convergence can be attributed to many factors. This Box highlights two developments affecting goods markets and also labour markets, respectively.

After becoming a member of the European Union in 2004, and subsequently adopting the euro in 2008, the Maltese economy experienced an increase in the number of suppliers for tradable goods, and households could perform a better search, at a lower cost, for products. The rapid penetration of internet access in households (whereby the proportion of households with internet access almost doubled, from 41% in 2005 to just under 80% in 2013) also assisted this increase in trade via e-commerce.<sup>22</sup>

Indeed, as can be seen in Chart 4, whereas only 34% of Maltese households with internet access had made an online purchase during the previous 12 months in 2005, this percentage rose to 65% by 2013, overtaking the average in the euro area. This implies downward pressure on price mark-ups in the Maltese economy and, hence, on underlying inflation.

Meanwhile, domestic price pressures were also reduced as a result of efficiency gains in the supply side of the economy via improvements in the functioning of labour markets.

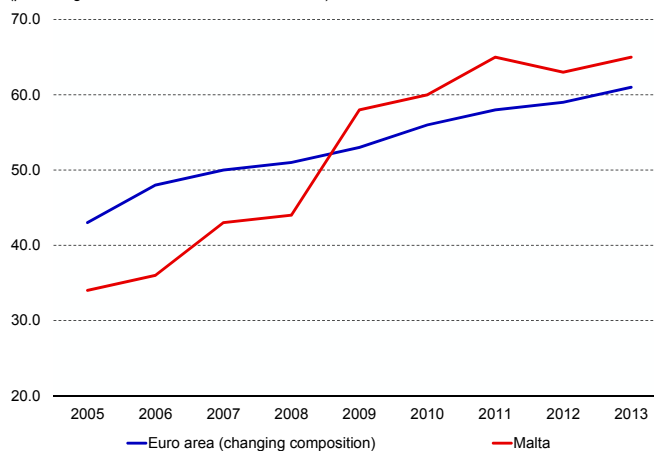
<sup>21</sup> This is a Beveridge-Nelson decomposition, which is estimated as a state-space model using the Kalman filter. See also Stock, J.H. and Watson, M.W., "Why has U.S. inflation become harder to forecast?" *Journal of Money, Credit and Banking*, Vol. 39, (S1), 2007, pp. 3-33, and Ascari, G. and Sbordone, A.M., "The macroeconomics of trend inflation", *Journal of Economic Literature*, Vol.52 No.3, The American Economic Association, September 2014, pp. 679-739.

<sup>22</sup> Source: Eurostat.

An increase in female participation rates, as well as an increase in part-time and temporary work, contributed to improve labour-market matching. Furthermore, the shift of workers from manufacturing to other more competitive sectors in the economy possibly also contributed to better allocation of labour resources.<sup>23</sup> The increase in labour resources, wage-bargaining at firm level and a more flexible, qualified labour force are all favourable supply side factors, which improved the competitiveness of the economy and hence reduced domestic production cost pressures.

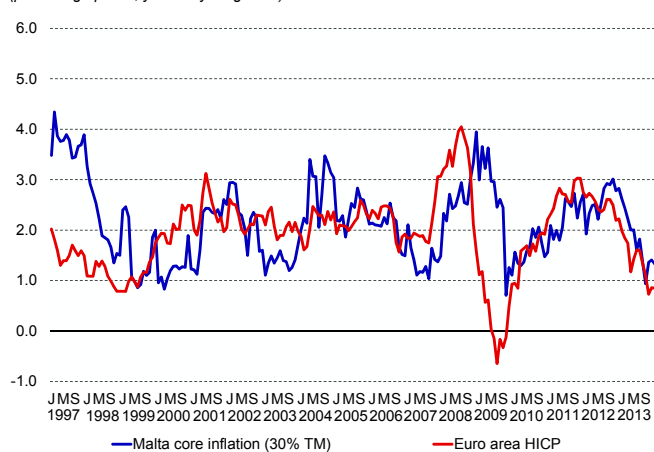
Taken together, these developments go some way to explaining the apparent increased synchronisation between underlying growth in price pressures in Malta, measured by the 30% TM inflation rate, and overall inflation in the euro area - the latter being the key indicator influencing the conduct of euro area monetary policy(see Chart 5). Indeed, econometric tests confirm that euro area HICP inflation is a good predictor of core inflation in Malta, lending more support to the synchronisation hypothesis.<sup>24</sup> These findings motivate further studies on the relationship between core inflation in Malta and inflation in the euro area, which can be analysed from various aspects of the economy.

**Chart 4**  
**INTERNET USE FOR ONLINE PURCHASES**  
(percentage of households with internet access)



Source: Eurostat.

**Chart 5**  
**CORE INFLATION IN MALTA AND EURO AREA HICP INFLATION**  
(percentage points; year-on-year growth)



Sources: Eurostat and author's calculations.

<sup>23</sup> See Micallef, B., "Box 4: Labour market resilience in Malta", *Quarterly Review* 2013:1, Central Bank of Malta, 2013, pp. 41-46, and Micallef, B., "Box 2: Estimating Okun's Law for Malta", *Quarterly Review* 2013:3, Central Bank of Malta, 2013, pp. 36-43.

<sup>24</sup> Euro area headline HICP was found to "Granger-cause" underlying inflation in Malta at several lags, a result which is robust across the choice between the PW and 30% TM measures of core inflation.