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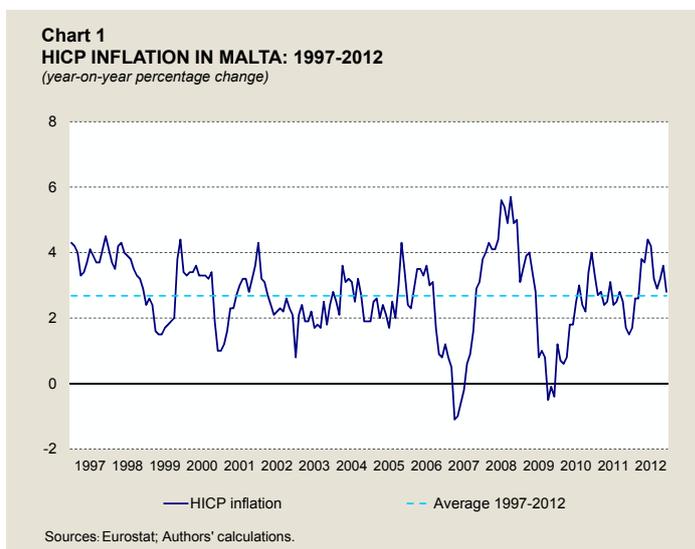
ESTIMATING INFLATION PERSISTENCE IN MALTA

ESTIMATING INFLATION PERSISTENCE IN MALTA[1]

The topic of inflation persistence has received a lot of attention in recent years, especially within the context of the European Central Bank's (ECB) Inflation Persistence Network (IPN). The IPN defined persistence as "the tendency of inflation to gradually return to its long-term mean following a shock".[2]

A full understanding of the underlying patterns and determinants of inflation persistence is crucial for policy makers as they have important consequences for the conduct of monetary policy. The appropriate response of monetary policy to a shock depends on the degree to which the effect on inflation is persistent. In the euro area, monetary policy is determined by the Governing Council of the ECB with the aim of ensuring price stability in the area as a whole. However, a good understanding of Malta's inflation persistence is still very relevant for domestic policy makers. In particular, 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.

Chart 1 plots the annual growth rate of consumer prices in Malta between 1997 and 2012, as measured by the HICP. During this period, various factors have influenced the inflation rate and pushed it away from its long-run mean. Examples include oil and commodity price shocks, exchange rate movements, the removal of levies on a range of imported products in the run-up to EU membership and fiscal measures such as VAT changes. Inflation is also influenced by the cyclical position of the economy, with periods of weak economic activity usually associated with lower inflation, and vice versa. Despite these occurrences, inflation in Malta appeared to have remained remarkably stable over the past decade, fluctuating around a mean of 2.7%, as can be seen in Chart 1.

The dominant theoretical framework for inflation in the literature, the so-called New Keynesian Phillips Curve (NKPC), identifies three possible sources of inflation persistence.

Chart 1
HICP INFLATION IN MALTA: 1997-2012
(year-on-year percentage change)

— HICP inflation   – – Average 1997-2012

Sources: Eurostat; Authors' calculations.

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[2] Altissimo, F., Ehrmann, M. and Smets, F., "Inflation persistence and price setting behaviour in the euro area: A summary of the IPN evidence", *Occasional Paper Series* No. 46, ECB, June 2006.

First, persistence could arise from the degree of inertia or backward-looking methods in the price formation mechanism. This form of persistence is commonly referred to as intrinsic persistence. Second, the way economic agents form their expectations about future inflation determines another type of persistence, which is referred to as expectations-based persistence. The third source of persistence could be due to persistent fluctuations in the determinants of inflation, such as real marginal costs, which incorporate elements like wages and productivity that affect the cost structure of firms. This form of persistence is known as extrinsic persistence. Each of these three sources is associated with one of the three terms of the NKPC, which is one of the core equations in today's structural models used for forecasting and policy analysis by policy institutions and academia.

In the NKPC,

$$\pi_t = \gamma_1 \pi_{t-1} + (1 - \gamma_1)E_t\pi_{t+1} + \gamma_2 mc_t \tag{1}$$

π_t stands for inflation, E_t for expectations and mc_t for real marginal costs. γ_1 and $(1 - \gamma_1)$ determine the weight of inertia and expectations in the price formation process: these are assumed to add up to unity to ensure no long-run trade-off between inflation and economic activity.[3] γ_2 measures the sensitivity of inflation to cost conditions, which are typically assumed to vary according to the cyclical position of the economy.

A large body of literature has emerged on inflation persistence over the past decade, mostly in the context of the IPN, focusing on these three sources of inflation persistence. This empirical work analysed a wide variety of data, including aggregate time series for the euro area and its member countries, micro-consumer and producer prices as well as firm-level surveys. In general, however, econometric estimates of persistence are still surrounded by a considerable degree of uncertainty, possibly due to different methodological approaches, sensitivity to the choice of sample period and the price indices used.

Most studies in the literature estimate intrinsic or inertial inflation persistence using a univariate time series approach, mainly an autoregressive process.[4] In these models, inflation persistence is commonly measured as the sum of autoregressive coefficients.[5]

A common finding in this literature is that a high degree of reported inflation persistence is related to the neglect of breaks in the mean of inflation. For instance, when applying univariate regressions over a long sample, typically starting from 1970s or 1980s, most studies report highly persistent inflation processes for both the euro area and the United States. However, when structural breaks in the inflation mean are taken into account, most studies point to moderate degrees of inflation persistence.

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[3] For technical details, see Berg, A., Karam, P. and Laxton, D., "Practical model-based monetary policy analysis: A how-to guide", *Working Paper Series* WP/06/81, IMF, March 2006.

[4] See for instance Levin, A.T. and Piger, J.M., "Is inflation persistence intrinsic in industrial economies?", *Working Paper Series* No. 334, ECB, April 2004; Gadzinski, G. and Orlandi, F., "Inflation persistence in the European Union, the Euro area, and the United States", *Working Paper Series* No. 414, ECB Nov 2004; Lünnemann, P. and Mathä, T.Y. , "How persistent is disaggregate inflation? An analysis across EU 15 countries and HICP sub-indices", *Working Paper Series* No. 415, ECB Nov 2004; O'Reilly, G. and Whelan, K., "Has euro area inflation persistence changed over time?", *Working Paper Series* No. 335, ECB, April 2004.

[5] Another branch of the literature use structural or multivariate analysis to study persistence, thereby being able to estimate all the three sources of persistence. See Dossche, M. and Everaert, G., "Measuring inflation persistence: a structural time series approach", *Working Paper Series* No. 495, ECB, June 2005.

Another common finding is the considerable degree of heterogeneity in persistence across countries and sectors. In general, most studies show that unprocessed food and energy exhibit a low degree of persistence, while industrial goods and services exhibit higher persistence. This difference across sectors most likely reflects different price-setting practices, which, in turn, depend on the market structures in which firms operate (e.g. market determined vs. administered prices).

A number of studies also report evidence of aggregation effects, with persistence in disaggregated price indices being different from the aggregate series. This phenomenon could be attributable to idiosyncratic shocks in certain sub-indices cancelling each other out but also possibly because the more persistent series receive a larger weight.[6]

Estimates of inflation persistence in Malta are relatively scarce. Demarco (2004) applies a first-order autoregressive model to sectoral RPI sub-indices to construct a measure of core inflation for Malta.[7] In this study, food and energy sub-indices were found to exhibit low persistence while certain sub-indices in services and industrial goods were found to have a moderate degree of persistence.[8] Two other studies compare aggregate inflation persistence in the euro area and the new Member States.[9] Both these studies report low estimates for Malta and that inflation persistence in Malta is broadly comparable with that of other euro area countries and lower than the estimates for most Eastern European Member States of the European Union.

Theoretical framework

Following Lünnemann and Mathä, we focus on inertial inflation and measure persistence as the sum of auto-regressive coefficients.[10] The following equation was estimated for all price indices:

$$\pi_{i,t} = c_{i,t} + \sum_{k=1}^{K^*} \beta_{i,k}\pi_{i,t-k} + \varepsilon_{i,t} \text{ with } \rho_i = \sum_{k=1}^{K^*} \beta_{i,k} \tag{2}$$

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, with K^* standing for the optimal lag length identified by the Akaike information criterion.[11]

This equation is useful for the assessment of inflation persistence, particularly because the assumption that the mean rate of inflation has remained constant over time is a reasonable one for the period under consideration, as can be seen in Chart 1.

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 $0 < |\rho_i| < 1$.[12] On the other

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[6]   Refer to footnote 2.

[7]   Demarco, A., "A New Measure of Core Inflation in Malta", Central Bank of Malta, *Quarterly Review 2004:2.*

[8]   The persistent categories were the following: housing, household equipment and maintenance, personal care, recreation and culture and other goods and services.

[9]   Vladova, Z. and Pachedjiev, S., "Empirical analysis of inflation persistence and price dynamics in Bulgaria", *Discussion Paper Series* DP/70/2008, Central Bank of Bulgaria; Franta, M., Saxa, B. and Smidkova, K., "The role of inflation persistence in the inflation process in the new EU member states", *Czech Journal of Economics and Finance*, 60, 2010, no. 6.

[10]   Lünnemann, P. and Mathä, T.Y., "How persistent is disaggregate inflation? An analysis across EU 15 countries and HICP subindices", *Working Paper Series* No. 415, ECB, November 2004.

[11]   The optimal lag-length for each regression is determined separately for each sub-index. The equation also includes a constant term.

[12]   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.

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
$(1-\rho)$ is called the speed
of mean-reversion. A com-
mon 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
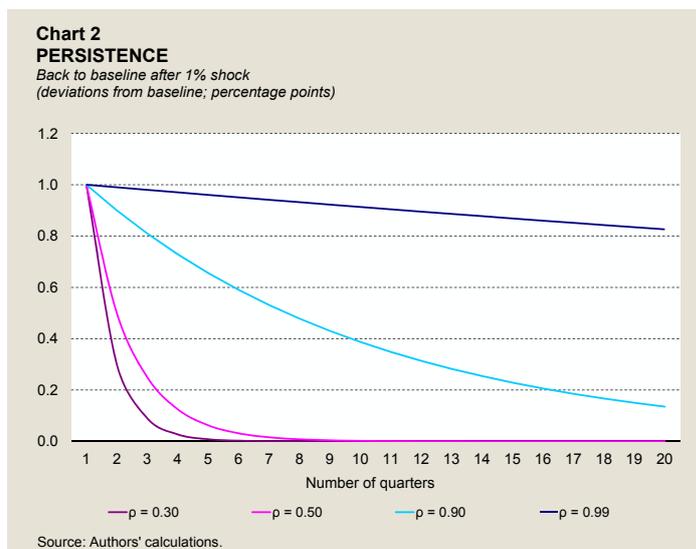which the effect of a shock
remains above half its ini-
tial impact.[13]

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

Source: Authors' calculations.

Chart 2 illustrates graphi-
cally the concept of persis-
tence and mean-reversion in a first-order autoregressive process. The time it takes for a
process to return to its mean following a shock depends on the autoregressive coefficient ρ:
the lower the value of ρ, the faster it returns to its mean value and vice versa. For instance,
the half-life associated with a persistence parameter of 0.3 and 0.5 is around seven months
and one year, respectively. At the other end of the spectrum, a highly persistent process
with an autoregressive parameter of 0.9 has a half-life in excess of 6.5 years.

Methodology

To estimate inflation persistence, we use disaggregated HICP indices, published by Euro-
stat and covering the period from January 1996 to December 2011. The analysis focuses
on year-on-year inflation rates measured at a quarterly frequency. This method is very simi-
lar to the one used by Demarco (2004). The main differences concern the use of the HICP
instead of the RPI, a quarterly instead of a monthly frequency and an optimal lag-length
chosen on the basis of an information criterion instead of being restricted to one. These
changes facilitate a comparison of the current findings with those of the IPN.

At the outset, it is important to highlight two points. First, data quality is more problematic in
more disaggregated series, as the latter tend to be subject to significant structural breaks
– such as price liberalisation in some sectors, changes in the composition of the indices
and changes in data collection methods. One-off events also tend to have a more pro-
nounced 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.

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[13] Half-life measured in years is computed as $\ln(0.5)/(\ln(|\rho_i|))$.

For the purposes of this study, we applied a uniform estimation approach based on equation (2) above. Estimates were computed at high and intermediate levels of aggregation for the euro area, Malta, a number of small and open economies that share similar characteristics with Malta and for countries with significant trade links with the local economy. The countries covered include Cyprus, Estonia, Ireland, Italy, Luxembourg, Slovenia, the United Kingdom, as well as the euro area as a whole. The persistence parameter was calculated for the overall HICP inflation, the five main HICP components and the 12 HICP sub-categories.[14]

Results

Table 1 shows the estimates of the autoregressive coefficients at various levels of aggregation and across a number of economies. The persistence parameter for the overall HICP inflation in Malta is estimated at 0.27. The half-life associated with this parameter is slightly more than six months.

Table 1
ESTIMATES OF THE DEGREE OF INFLATION PERSISTENCE (ρ): 1997-2012

	MT	EA[1]	LU	CY	EE[2]	SI [3]	UK	IT
Overall HICP	0.27	0.59	0.70	0.17	0.73	0.91	0.90	0.59
Food and non alcoholic beverages	0.69	0.75	0.77	0.38	0.69	0.81	0.81	0.83
Alcoholic beverages, tobacco and narcotics	0.79	0.88	0.77	0.78	0.75	0.78	0.98	0.80
Clothing and footwear	0.58	0.53	0.71	0.49	0.89	0.82	0.80	0.69
Housing, water, electricity, gas and other fuels	0.69	0.77	0.53	0.35	0.78	0.74	0.76	0.75
Furnishings, household equipment and routine maintenance of the house	0.49	0.82	0.54	0.25	0.84	0.85	1.00	0.68
Health	0.78	0.77	0.81	0.68	0.76	0.90	0.58	0.70
Transport	0.53	0.45	0.66	0.61	0.72	0.89	0.70	0.66
Communications	0.86	0.82	0.71	0.86	0.85	0.85	0.88	0.85
Recreation and culture	0.74	0.73	0.67	0.58	0.75	0.87	0.87	0.85
Education	0.74	0.62	0.73	0.63	0.91	0.87	0.84	0.63
Restaurants and hotels	0.51	0.92	0.86	0.79	0.85	0.78	0.72	0.91
Miscellaneous goods and services	0.52	0.91	0.75	0.76	0.75	0.91	0.68	0.73
Energy	0.39	0.54	0.53	0.40	0.32	0.48	0.73	0.73
Unprocessed food	0.47	0.59	0.78	0.18	0.57	0.44	0.67	0.79
Processed food	0.59	0.81	0.81	0.69	0.73	0.85	0.88	0.78
Industrial goods excluding energy (NEIG)	0.59	0.63	0.76	0.72	0.83	0.91	0.94	0.45
Services	0.72	0.85	0.82	0.67	0.81	0.94	0.63	0.85
Services - Communication	0.86	0.82	0.71	0.86	0.85	0.80	0.88	0.85
Services - Housing	0.62	0.90	0.58	0.77	0.89	0.93	0.85	0.83
Services - Recreation	0.68	0.82	0.81	0.79	0.75	0.90	0.80	0.93
Services - Transport	0.64	0.77	0.82	0.77	0.83	0.91	0.53	0.56
Services - Miscellaneous	0.59	0.88	0.67	0.68	0.71	0.87	0.86	0.72

[1] For the euro area, miscellaneous services are unavailable for 1999.

[2] For Estonia, the indices for NEIG, overall services and housing services are only available from December 1997. Data for energy, recreational services and miscellaneous 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.

Source: Authors' calculations.

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[14] The main HICP components are unprocessed food, processed food, energy, non-energy industrial goods, as well as services overall and the services sub-components.

Inflation persistence is lower in Malta than in the euro area as a whole and lower than in any of the other countries listed in Table 1, with the exception of Cyprus. For the euro area as a whole, the persistence parameter is estimated at 0.59, which is within the range of estimates of between 0.4 and 0.8 reported by Altissimo et al (2006).

A closer look at the disaggregated series for Malta indicates a degree of aggregation bias, as most sub-components of the HICP yield higher estimates of persistence than the overall HICP. Aggregation bias is also evident in the estimates for Cyprus.

There is a large degree of similarity across countries in particular components, as also shown in several previous studies.[15] In general, services and non-energy industrial goods exhibit a higher degree of persistence than energy and unprocessed food. On the contrary, prices for the latter two categories are changed more often, mostly in response to frequent changes in input prices.

In Malta inflation in services exhibits a high degree of persistence compared with the other HICP categories, with a parameter estimate that is slightly above 0.7. This finding is shared by four out of the seven countries listed in Table 1. In general, the services index demonstrates a narrow range of relatively high estimates for inflation persistence across the countries covered in this study. In fact, the services index and its five sub-components all have a persistence parameter in excess of 0.6 in all countries considered.[16]

The persistence in the prices of services may be due to this category's high dependence on wage costs. Since wages do not tend to be volatile and are changed rather infrequently, inflation persistence is apt to be more pronounced in cases where the labour content is higher. Another possible explanation is that prices in various service categories are subject to some form of price regulation and hence, not immediately responsive to demand and supply conditions.[17]

Persistence in energy inflation in Malta is estimated at around 0.4, somewhat lower than in the euro area. The low persistence of energy prices is a common finding in the literature and is mainly associated with the frequent changes in input commodity prices.

Persistence in non-energy industrial goods and processed food in Malta is estimated at around 0.6. Both are at the lower end of the range estimates across the countries in the study. At 0.5, the lower degree of persistence in the unprocessed food category can be associated with a pronounced seasonal pattern of some of the indices in this category, as also observed in a number of other countries covered in this study.[18]

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, one observes an increase in the degree of inflation persistence, with all sub-indices having

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[15]   Refer to footnote 6.

[16]   With the exception of transport services in the United Kingdom.

[17]   The prices of the following categories in the services index are considered as administered: Postal services (cp0810); Other services in respect of personal transport equipment (cp0724); Passenger transport by road (cp0732) and Passenger transport by sea and inland waterway (cp0734). In 2012 these four categories had a weight of 7.6% in the services index and 3.2% in the overall HICP index.

[18]   This is confirmed by estimating persistence parameters for the individual components of the Food and non-alcoholic beverages sub-index (results are not shown). Within this category, the lowest persistence parameters were registered for Vegetables (CP0117), Fish and seafood (CP0113) and Fruits (CP0116), all of which contain a strong seasonal pattern.

a persistence parameter above 0.5. In Malta's case, the highest persistence is recorded in Communications (CP08), Alcoholic beverages, tobacco and narcotics (CP02) and Health (CP06). In general, sub-indices whose prices are heavily influenced by government policy (e.g. tobacco and spirits) exhibit a high degree of persistence.

Policy implications and avenues for further research

Estimates of intrinsic persistence for the headline HICP inflation in Malta are lower than in the euro area. Differences in sectoral estimates are, however, less pronounced, suggesting that aggregation effects play an important role. Our findings are broadly in line with those of the IPN studies for other countries, which show that persistence estimates in services tend to be higher than in other categories, especially energy and unprocessed food. These results have a number of implications for both researchers and policy makers.

An improved understanding of the underlying process and determinants of inflation in Malta, both at the aggregate and sectoral level, will allow researchers to enhance existing macro-econometric models. This should eventually lead to improved tools for forecasting and simulation analysis.

A broad consideration is the IPN finding that more competition tends to reduce price stickiness. Survey results in fact suggested that firms in highly competitive markets tend to respond more strongly to contemporaneous changes in underlying factors. Hence, structural reforms that increase competition in the product and labour markets could help to reduce price stickiness.

The low estimate of persistence reflects the fact that inflation in Malta fluctuated around a broadly constant mean during the period considered in this study. However, the mean inflation rate of 2.7% is higher than the concurrent rate of 2.0% in the euro area. Structural reforms, as suggested in the previous paragraph, can make prices more responsive to changes in underlying factors, which should narrow the gap.

A further conclusion is that within the context of the NKPC, the relatively low weight of intrinsic persistence assigns an important role to inflation expectations and cost considerations in the price formation process. In this regard, a more in-depth analysis on the cost structure of domestic firms and its relationship with their price setting behaviour constitutes an interesting area of research.

Another interesting avenue for future research is to deepen our understanding of price and wage changes using micro-statistics or through the use of surveys. Concerning the latter, the findings of the Wage Dynamics Network (WDN) provided a number of interesting insights on the price and wage formation process in Malta and the adjustment of wages to economic shocks.[19] The participation of the Central Bank of Malta in the 3rd Wave of the WDN Survey in 2014 should further add to our understanding of the price and wage formation process in Malta.

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[19]   *Wage Dynamics Report,* Central Bank of Malta, 2011. Available on http://www.centralbankmalta.org/updates/Downloads/pdfs/wage_dynamics_report.pdf.