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AN UNOBSERVED COMPONENTS MODEL FOR POTENTIAL OUTPUT IN MALTA

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BOX 1: AN UNOBSERVED COMPONENTS MODEL FOR POTENTIAL OUTPUT IN MALTA[1]

This box introduces a multivariate filter approach to estimate potential output, combined with a Cobb-Douglas production function (PF) in an unobserved components model (UCM-PF).[2] The concept of potential output can be defined from different angles.[3] Using a purely statistical approach, it can be seen as the trend component of actual output. This ignores underlying economic reasons for the divergence between trend and actual output. Alternatively, and allowing for economic reasoning, potential output can be seen to characterise the sustainable aggregate supply abilities of an economy. This is determined by the structure of production, the state of technology and the available inputs.[4] Going beyond this level of output results in higher factor utilisation, leading to pressure on factor input costs and, eventually, on consumer prices. Changes to potential output growth are driven by factors such as capital accumulation (investment), labour and total factor productivity (TFP). The latter relates to a number of factors such as technological innovation, capital vintage and efficiency, and labour quality.

Potential output is not measured exactly or published as an official time series. Its nature as an unobservable variable implies that it may only be estimated under uncertain conditions. There are a number of methods which can be used to compute potential output estimates using observed data. Irrespective of the method used, however, the figures for potential output will remain subject to considerable uncertainty. Moreover, they tend to be subject to significant revisions over successive vintages of the underlying data. A major caveat of supply side analysis remains the cautionary interpretation of estimates.

The method presented here differs from the pure production function approaches, which usually derive from the separate univariate filtering of single variables, which are then combined in a production function. A major concern in univariate filtering methods is the end-point bias problem. The main critique of this method is that the resulting output shifts the concerns relating to the filtering of output to the level of the input subcomponents (Anderton et al., 2014).[5] The UCM-PF presented here solves this problem by estimating trends for each respective input simultaneously in a system of equations. This trend-cycle decomposition is also subject to a number of important reduced-form economic relationships, such as Okun's Law, and a wage and a price Phillips curve.

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[1] Prepared by Reuben Ellul. The author is a Principal Economist within the Economic Analysis Department at the Central Bank of Malta. The views expressed are those of the author and do not necessarily reflect those of the Central Bank of Malta. The author thanks Mr Brian Micallef for his comments and suggestions. Any errors are the author's own.

[2] The model was developed by Mr. Máté Tóth at the ECB Directorate General Economics (Supply Side, Labour and Surveillance Division), with feedback and suggestions from a Task Force on Potential Output made up of Eurosystem economists. The specification for Malta, and its modelling were carried out by the author of this Box. For an overview of the methodology, see Andersson, M., Szörfi, B., Tóth, M. and Zorell, N. (2018), "Potential output in the post crisis-period," ECB Economic Bulletin, Issue 7/2018.

[3] For a discussion on three basic ways of looking at, and measuring, potential output see Mishkin, F.S. (2007), "Estimating potential output," remarks by Mr Frederic S. Mishkin, Member of the Board of Governors of the US Federal Reserve System, at the Conference on Price Measurement for Monetary Policy, Federal Reserve Bank of Dallas, Dallas, 24 May 2007.

[4] See European Central Bank (2000). "Potential output growth and output gaps: concept, uses and estimates," *Monthly Bulletin*, ECB, October 2000.

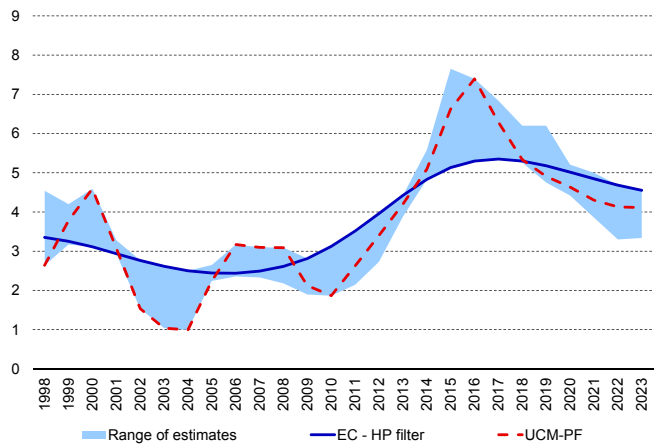
[5] See Anderton et al. (2014). "Potential output from a euro area perspective," *Occasional Paper Series,* No. 156, ECB, November 2014.

The model used here is a backward-looking state-space model, which uses a Kalman filter decomposition on real GDP, a measure of core inflation, wage inflation and the unemployment rate. This approach splits series into cyclical and trend components.[6] These are in turn derived from several economic relationships, such as a Cobb-Douglas production function, an Okun's law relationship and a wage and a price Phillips curve. Some observed variables, such as the working age population or capital stock feature exogenously in the model, while other variables, like average hours worked and the participation rate, are decomposed endogenously into trend and cyclical components. Import prices and a measure for external demand, which are seen as important factors in the Maltese economy, are also included in the price Phillips curve. These two variables are seen to provide a richer story to supply-side analysis, and are seen as important features of the model in an open economy context. The trends would then be inputs to the model's production function. A closed output gap in the model would imply a lack of excessive wage or price pressures, that is, inflation would be at its long-run trend. Inflation in wages would also be compatible with trend inflation and the productivity growth trend. Another important feature of this model is the ability to provide confidence intervals around point estimates.

The estimates of potential output and the output gap derived from the model are compared with estimates produced by the Economic Policy Department within the Ministry for Finance (MFIN), the European Commission (EC),[7] the International Monetary Fund (IMF) and the Bank's pure production function estimates. These estimates are presented as ranges, to highlight the uncertainty around them (see Charts 1 and 2). They are also compared with the respective EC series based on the Hodrick-Prescott (HP) filter.

It is apparent that there are methodological differences which, at times, lead to a comparatively wide range of estimates. The simple univariate HP filter method, which is a statistical method, returns highly volatile potential output and output gap estimates. As noted in Grech (2014), these results are also affected by strong shocks in Maltese data, which reflect the small size of the economy rather than

Chart 1
RANGE OF ESTIMATES FOR POTENTIAL OUTPUT GROWTH
(annual percentage growth)



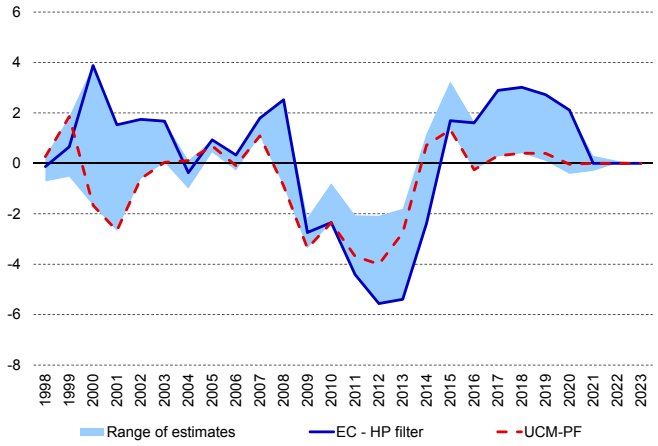
Sources: Central Bank of Malta; EPD-MFIN; EC; IMF.

[6] For an interesting application of multivariate filters to the Maltese economy employing a similar methodology, see Micallef, B. (2016). "A multivariate filter to estimate potential output and NAIRU for the Maltese economy," *International Journal of Economics and Finance*, Vol. 8, No. 5.

[7] These include both the EC's production function approach and a Hodrick-Prescott univariate filter to GDP.

actual changes in potential output.[8] This simpler method may be out of step with the estimates from production functions. The estimates of potential output based on production functions tend to be rather similar. Having a number of similar estimates, however, may play down the uncertainty around potential output estimates; the latter should always be discussed as an imperfect estimate of an unobservable variable.

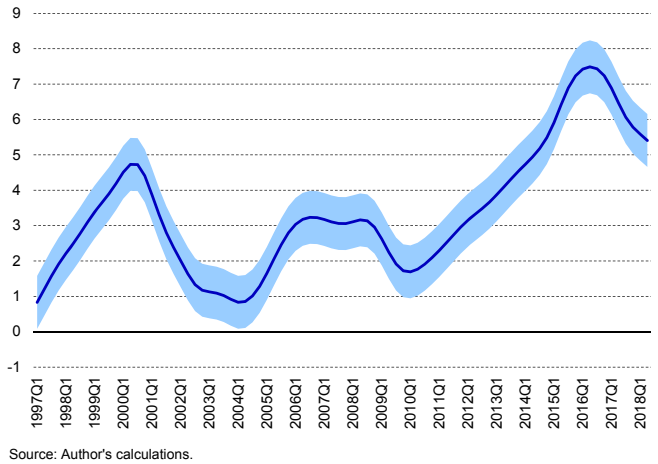
Chart 2
RANGE OF ESTIMATES FOR THE OUTPUT GAP
(per cent of potential output)



Sources: Central Bank of Malta; EPD-MFIN; EC; IMF.

An advantage of the UCM-PF method over the classical production function method is that it allows the computation of less volatile quarterly estimates of potential output without resorting to moving averages. Furthermore, it enables the construction of uncertainty bands around the point estimates (see Chart 3). A disadvantage of this method, however, is that as more variables are added, the number of trends and cycles (and implicitly 'gaps') to be computed increases. This may introduce noise into the estimates – leading to wide confidence bands. Moreover, in most cases, the modeller has to calibrate the signal-to-noise ratio of the various elements in the model.

Chart 3
QUARTERLY POTENTIAL OUTPUT GROWTH (UCM)
(annual percentage growth)



Source: Author's calculations.

Compared with the other production function method at the Central Bank of Malta, the UCM-PF appears to suggest higher total factor productivity growth in the years 2004-2013, and slightly lower TFP contributions over the medium term horizon (see Table

[8] See Grech, A.G., (2014). "Investigating potential output using the Hodrick-Prescott filter: An Application for Malta," *Working Paper Series*, No. 02/2014, Central Bank of Malta.

Table 1
AVERAGE CONTRIBUTIONS TO POTENTIAL OUTPUT GROWTH

	Traditional production function			UCM-PF		
	TFP	Capital	Labour	TFP	Capital	Labour
2004-2008	1.05	0.67	0.55	1.13	0.64	0.72
2009-2013	0.74	0.71	1.36	1.65	0.69	0.47
2014-2018	2.13	1.59	2.78	1.96	1.57	2.44
2019-2023	1.51	1.42	1.22	1.09	1.37	1.86

Sources: Central Bank of Malta; author's calculations.

1).[9] The UCM has a lower contribution of labour in the years 2009-2013, but this contribution exceeds that in the Bank's other method in later years. This is attributable to higher participation rates over the medium term in the UCM-PF framework. TFP is seen to slow down to its long-run average in the traditional production function method, while the UCM sees a sharp slowdown. Taken together, this information highlights the prudent assumptions underpinning the Bank's current production function methods.

In any case, all measures show that potential growth in Malta increased substantially since around 2011. In fact, by 2014, it is seen to have exceeded the estimates for the late 1990s. As discussed in Micallef and Ellul (2017)[10] and in Grech and Borg (2018),[11] potential growth accelerated further in recent years moving closer to the historic high growth rates estimated for the 1980s. The negative output gap which opened in the aftermath of the global financial crisis and the sovereign crisis shrunk gradually and largely disappeared by 2015. As domestic supply constraints became increasingly binding, high growing industries absorbed factor inputs from other economies. This was particularly the case for the labour input, with a sharp increase in immigration of foreign workers. In that sense, concerns about labour market tightness in Malta should be framed in the context of slack in neighbouring labour markets.[12]

Looking ahead, the UCM-PF confirms the trends for potential output estimated by other institutions, and joins other measures as a further tool in the analysis of the supply-side in Malta. Its inclusion of import prices and world demand allows for a richer analysis of price pressures, which are very important in a small open economy, and augments the existing annual potential output assessments with more stable quarterly estimates.

[9] The two models are estimated using the same basic dataset, including identical series for the capital stock and basic labour market variables such as hours worked, participation rates and working age population. However, over the projection period, the UCM-PF diverges from the traditional PF approach, as its dynamics govern the development of underlying trends in key variables, such as hours worked, participation rates, etc. These may be pinned down by more conservative assumptions in the PF method.

[10] See Micallef, B. and Ellul, R. (2017), "Medium-term Estimates of Potential Output Growth in Malta", in Grech, A. G. and Zerafa, S. (Eds.), Challenges and Opportunities of Sustainable Economic Growth in Malta: the Case of Malta, Central Bank of Malta, https://www.centralbankmalta.org/books.

[11] See Grech, A. G. and Borg, I. (2017), "Revisions in population projections and their implications for the growth of the Maltese economy", *Annual Report* 2017, pp. 46-51, Central Bank of Malta.

[12] See Ellul, R. (2019), "Labour market slack," *Quarterly Review* 2019:1, pp. 37-41, Central Bank of Malta.