Aaron George Grech, B. M. (2015). Assessing potential output growth of the maltese economy using a production function approach. *Xjenza*, 3(1):57–63.

Xjenza Online - Journal of The Malta Chamber of Scientists
www.xjenza.org
DOI: 10.7423/XJENZA.2015.1.08

Research Article

Assessing potential output growth of the Maltese economy using a production function approach

Aaron George Grech, Brian Micallef
Modelling and Research Office, Central Bank of Malta and London School of Economics and Political Science

Abstract. After outlining the various methods used to estimate potential output, this article presents estimates for Malta, the smallest member of the euro area, derived from one of the most commonly used methods, the production function approach. Given the uncertainty surrounding these kinds of estimates, these estimates are compared with those made for Malta by other institutions using different methods. Based on this analysis and on a cross-country comparison with other euro area economies, a number of observations are made that would enable potential growth to accelerate and result in a faster economic convergence.

1 Introduction

Malta is the smallest member of the euro area, comprising less than 1 % of the monetary union's economic size. It also has one of the lowest levels of GDP per capita among euro area members and is located in a region, the Mediterranean, which has been characterised by political unrest and severe economic distress in recent years. To be able to surmount these difficulties and converge to the higher relative economic standards of its fellow monetary union members, Malta faces the challenge of achieving relatively higher rates of growth in its potential output. The latter is usually defined as the highest level of output achievable without generating inflationary pressures in factor markets.

Estimating potential output has always been a challenge to policy makers, especially in economies undergoing structural changes (like Malta, which is moving from a manufacturing and tourism-based economy to a more diversified and higher value-added services based economy) or in the aftermath of wars, natural disasters or financial crises (Malta is surrounded in the north by economies embroiled in the sovereign debt crisis and in the south by countries who have gone through the economic turmoil of the Arab Spring). Conceptually, potential output is often defined as the sustainable production capabilities of an economy determined by the structure of production, the state of technology and available resources. A closely related concept is the output gap, defined as the difference between actual and potential output. Measures of the output gap provide an indication of the overall balance between demand and supply conditions in the economy. This is generally considered useful information by policy makers, for example to determine and predict price pressures, and to gauge progress in fiscal consolidation.[1]

A number of studies have documented that financial and economic crises have a sizeable impact on the level of potential output and that, following their occurrence, output does not revert to its previous growth trend but rather remains permanently below it.[2] There are several factors that can affect the economy's supply capacity after a recession. On the production side, examples include the scrapping of existing capital stock owing to business failure, a slowdown in investment due to high uncertainty about future prospects and tight credit con-

[1] For a comprehensive review of the various policy applications of potential output measures, see, for instance, De Masi (1997)

[2] For instance, European Commission (2009) identifies three possible scenarios in which the crisis could affect potential output. All three scenarios assume a short-run decline in the level of potential output but differ in terms of its long-run impact on the growth rate. In the first scenario, potential output growth accelerates after the crisis, therefore allowing the economy to recover all lost output and hence, the level of potential output returns to its initial trajectory. The second scenario assumes that potential growth rate returns to its pre-crisis rate in the long-run but there is a permanent downward shift in the level of potential output. The third scenario assumes that the growth rate of potential output will be permanently lower after a crisis, which implies an increasing loss of potential output over time compared with the pre-crisis level.

Correspondence to: Aaron George Grech(grechga@centralbankmalta.org)

ditions to firms. This state of events can, in turn, depress the growth rate of total factor productivity, especially if it leads to lower spending on research and development. On the labour market front, in addition to the erosion of skills, some workers who lose their jobs may become discouraged in finding alternative work and leave the labour force entirely.

The implications of the global recession that was triggered by the financial crisis of 2009 for the growth rate of potential output and whether the world (and in turn, the Maltese) economy will settle on a lower growth path are still open issues. Apart from the crisis, demographic developments will adversely affect potential output growth in a number of countries in the coming years owing to the shrinkage of the workforce because of an ageing population. The assessment of such effects on the growth path of medium-term potential output remains a key issue for economic policy analysis.

After outlining the various methods used to estimate potential output, this article presents estimates for Malta derived from one of the most commonly used methods, i.e. the production function approach. Given the uncertainty surrounding these kinds of estimates, they are compared with those made for Malta by other institutions using different methods. Based on this analysis and on a cross-country comparison, a number of policy recommendations and final observations are made.

2 Methods

2.1 Alternative methods to estimate potential output

There are various methods available in the literature to estimate potential output.[3] These can be grouped into three broad categories: the production function or growth-accounting exercises, statistical approaches and measures computed from dynamic stochastic general equilibrium (DSGE) models. The first approach attempts to create an explicit model of the supply side of the economy using economic theory. The second simply attempts to break down real GDP directly into a trend and a cyclical component. The third approach, although founded in economic theory like the first, is conceptually different. It recreates the level of output of the economy that would prevail in the absence of the structural rigidities that form part of the underlying model.

The production function framework is generally considered a useful way to explain the key economic forces underlying developments in output and growth in the medium term.[4] This approach provides a comprehensive framework for estimating potential output, with a clear link between output and its long-term fundamental determinants. Thus, it may be used to assess the impact on potential output of structural changes and individual policies. Nevertheless, this approach has certain disadvantages. First, it raises important data problems. In particular measures of capital stock are often not available and data on hours worked are not very reliable. Second, it requires measures of the trend components of the factor inputs. Different assumptions about these trend components can lead to different estimates of potential output.

Statistical methods of estimating potential output are based on extracting the trend from the output series using statistical techniques. These methods can be divided into two categories. Univariate methods extract the trend from the information contained in the output series in isolation, without using the information contained in other variables. A widely used approach in such a univariate estimation of potential output is the Hodrick-Prescott (HP) filter. This filter extracts a trend component by trying to balance a good fit to the actual series with a certain degree of smoothness in the trend. While such filters are relatively easy to use, they have a number of drawbacks, the most important being the poor reliability of the end-of-sample estimates and the arbitrary choice of the smoothing parameter. In addition, these methods take no account of economic theory or of information involving other series, which may help to separate the trend from the cycle. The filter will also smooth structural breaks, even if these take the form of clear shifts in the level or the growth rate of the series and, therefore, it generates misleading estimates of potential output around these periods. Moreover, this simple filter is ill adapted to handle the high degree of volatility manifested in the time series of very small open economies (Grech, 2013).

Multivariate filters attempt to extract the trend using the information in the output series in conjunction with information contained in other variables, most notably inflation or the unemployment rate. These techniques typically attempt to take into account empirical relationships, such as the Phillips curve or Okun's Law.[5] They too, however, suffer from drawbacks, such as the sensitivity of these estimates to the modelling spe-

[3] For a non-technical overview of these alternative methods and policy implications, see Mishkin (2007) or Cotis, Elmeskov and Mourougane (2005).

[4] The European Commission, for instance, adopts this method as it considers it is the only one that can "underpin a comprehensive economic assessment of the outlook" and is the most "satisfactory instrument to frame economic policy discussions or explain policy decisions to the public". See Economic Policy Committee (2001). A sectoral production function approach is also used by the Congressional Budget Office (CBO) in the US, details of which are available in (Congressional Budget Office, 2001).

[5] See Micallef (2014) for an application of a multivariate filter for Malta to estimate potential output and NAIRU.

cification of these relationships, including the treatment of expectations and estimates of equilibrium concepts, like the non-accelerating inflation rate of unemployment (NAIRU) (Carnot, Koen & Tissot, 2005).

Finally, measures of potential output can also be derived using DSGE models. The latter are micro-founded models in which certain rigidities, such as wage and price stickiness, are used to match developments observed in macroeconomic data. Removing these rigidities offers a natural way to define a measure of potential output in a model-consistent way. This measure of potential output is thus defined as the output level that would be realised in equilibrium if prices and wages were perfectly flexible. The drawback of this approach is that, without rigidities, output – identified as "potential output" in this framework – adjusts more rapidly than observed in the data. This gives rise to more volatile measures of potential output than usually obtained by other methods.[6] Furthermore, DSGE estimates of potential output are considered to be more model-dependent than the alternatives.

Given the advantages and drawbacks of various approaches used in the literature, analysts do not usually depend exclusively on a single estimate of potential output. The most common approach is to rely on a production function approach and then compute alternative estimates, most likely from a statistical model, as a cross-check. Disparities across potential output estimates and comparison with those published by international institutions, like the International Monetary Fund (IMF) and the European Commission, are often used as an indication of the uncertainty surrounding these estimates. When available, survey data on the degree of capacity utilisation can also be used either as a check on output gap estimates or as complementary information to inform policy makers on the current state of the economy.

2.2 The production function approach applied for the Maltese economy

In line with the approach taken by international institutions, in this article the benchmark approach is taken to be a production function meant to model the supply side of the local economy. This production function relates output to the level of technology and factor inputs, namely labour and capital, by means of a constant-returns-to-scale Cobb-Douglas specification, namely:

$$Y_t = TFP_t \times K_t^{\alpha} \times L_t^{(1-\alpha)} \qquad (1)$$

where Y_t denotes output at time t, L_t the labour input, K_t the capital stock and TFP_t the total factor productivity. TFP is derived as the HP-filter of the Solow residual, using the standard smoothing parameter of 1600 for quarterly data. The Solow residual is that part of economic growth that cannot be explained through growth in the capital stock or in the labour supply and is a proxy for productivity gains.

In the Maltese case the share of labour income is calibrated at 0.58, based on the share of compensation of employees in gross value added (GVA) between 1995 and 2012, adjusted for the proportion of the labour force that consists of self-employed. The stock of capital is calculated using the perpetual inventory method.[7] Housing investment is excluded from the measurement of the capital stock. The capital stock thus includes both public investment and non-housing investment by the private sector.

In more detail, labour input comprises several key variables of the labour market:

$$L_t = WAP_t \times \overline{PR_t} \times (1 - \overline{UNR_t}) \times \overline{HRS_t} \qquad (2)$$

where WAP_t denotes the working-age population, $\overline{PR_t}$ the trend participation rate, $\overline{UNR_t}$ the NAIRU and $\overline{HRS_t}$ the trend hours worked. To help derive potential labour utilisation, the trend participation rate and hours worked are obtained using the HP filter. NAIRU is computed from a multivariate filter, which is based on well-established relationships in economic theory, such as the Phillips Curve and Okun's Law Benes et al. (2010).

3 Estimates of potential output growth for Malta

Chart 1 plots potential GDP growth and its decomposition between 1995 and 2014, using the production function approach.[8] According to this method, Malta's potential output growth declined from above 4 % in the late 1990s to a trough of around 2 % in 2003, primarily owing to both a downward trend in productivity and a slowdown in investment, with the latter leading to a slower accumulation of capital.[9] Potential output growth recovered slightly during the cyclical upswing between 2004 and 2008, peaking at around 2.6 % in 2006. This increase was driven by a rebound in investment and a stronger contribution from labour, due to a combination of favourable demographics, an increase in the participation rate and a decline in NAIRU. On

[6] For a discussion of alternative notions of potential output in DSGE models used in ESCB central banks, see (Vetlov, Hledik, Jonsson, Kuscera & Pisani, 2010).

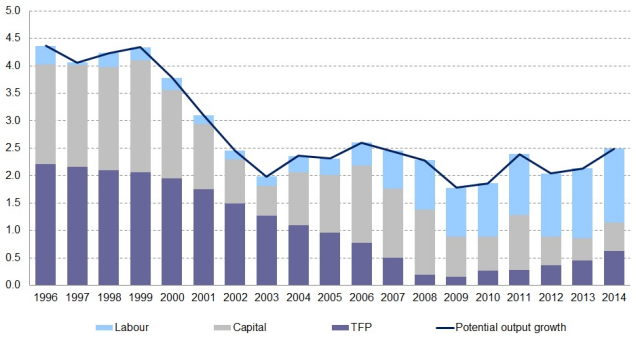
[7] The perpetual inventory method is based on the following formula: $K_t = (1-\delta)K_{t-1} + I_t$, where K_t is the level of the capital stock, I_t is real investment and δ represents the depreciation rate.

[8] Estimates in this paper are based on ESA2010 methodology. Minor differences from the results presented in Central Bank of Malta (2013) are due to the use of ESA1995 statistics.

[9] Similar results are reported in Grech (2004).

the contrary, the contribution from TFP maintained its downward trend.

Chart 1
ESTIMATES OF POTENTIAL OUTPUT GROWTH
(annual growth rate; contribution to potential growth)



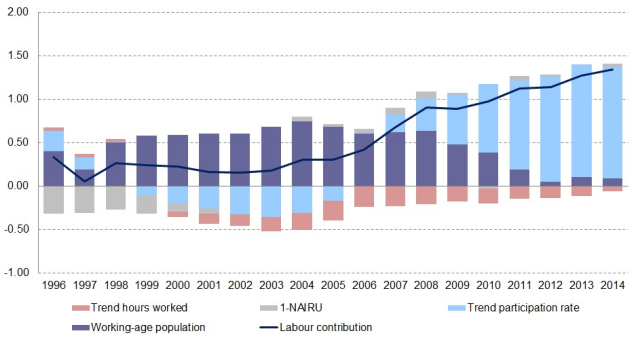
Source: Authors' calculations

The recession of 2009 had an adverse effect on potential output growth, which declined to around 1.8 % per annum between 2009 and 2010. The slowdown was mainly due to a sharp contraction in the contribution of capital, while, that of TFP remained at very low levels by historical standards. The contribution of capital to potential output growth declined from an average of 1.2 percentage points in the cyclical upswing before the recession to around 0.6 percentage point between 2009 and 2014. This was due to a slowdown in investment, with the investment-to-GDP ratio declining from a historical average of 22 % before 2009 to 18 % afterwards. The decline in investment was broad-based, affected not only by contraction in the construction sector in recent years, but also in other industrial categories, such as machinery and equipment.

After reaching a trough in 2009, with a contribution of less than 0.2 percentage points, TFP growth has been gradually rising after the crisis. The contribution of TFP to potential output growth, however, is still a fraction of that experienced in the late 1990s and early 2000s. From a longer-term perspective, the slowdown in TFP growth started before the crisis and could be a reflection of structural changes in the Maltese economy, such as the reallocation of resources to sectors, for instance, from manufacturing to services, where productivity growth is slower (Dabla-Norris et al., 2015). More generally, a striking feature of the evolution of TFP in Malta is the absence of procyclicality – productivity, whether measured in terms of labour or total factor productivity, generally tends to rise during booms and falls during recessions – that is usually observed in other economies (Basu & Fernald, 2001).

The contribution of labour to potential output growth increased significantly in recent years (see Chart 2). In the years before the recession, the main source was an increase in the working-age population and, to a lesser extent, the downward trend in NAIRU. On the contrary, both the trend participation rate and hours worked contributed negatively. The latter coincides with the increase in part-time employment, which lowers the hours worked per person. Since 2009, the unfavourable effects of an ageing population started to weigh in, with a gradual decline in the contribution of the working-age population. However, these effects have been outweighed by the rising participation rate. This was mainly driven by the rise in the female participation rate, which went up by 9.8 percentage points since 2008, by far the largest increase among EU countries, though it remains relatively low at 50.2 % in 2013. Moreover, the slight increase in NAIRU during the recession proved to be temporary, as the rise in the domestic unemployment rate started to be reversed as early as 2010.

Chart 2
CONTRIBUTION OF LABOUR TO POTENTIAL GROWTH
(annual growth rate; contribution to growth in percentage points)



Source: Authors' calculations

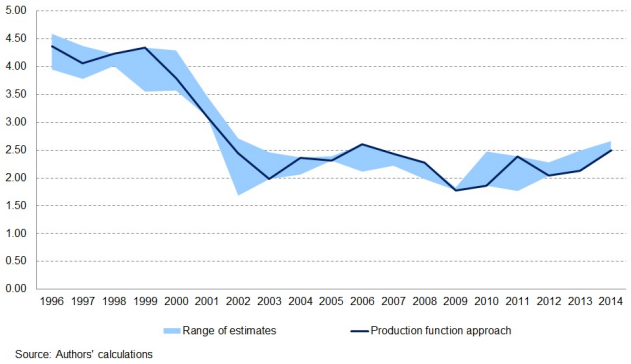
4 Comparison with estimates by other institutions

As already mentioned, estimates of potential output are surrounded by a considerable degree of uncertainty. This stems from a number of factors, such as the unobservable nature of this variable and the sensitivity of the results to the chosen method. The uncertainty surrounding the estimates of potential output is especially pronounced during a period of structural change in the economy or after a recession, when it is difficult to disentangle transitory effects from permanent ones.

One way of quantifying this uncertainty is by comparing the results of the production function approach with alternative estimates, computed for instance from a statistical model, or with those published by international organisations. This section compares the estimates made in the previous section of Maltese potential output and the output gap with four alternative estimates. These include a standard HP filter and the estimates published by the Ministry of Finance and the European Commission. Estimates by the European

Commission, which are based on a production function approach similar to the one presented in the previous section, refer to those published in the 2014 Autumn Economic Forecasts.[10] Estimates of potential output from DSGE models are not available for Malta.

Chart 3
RANGE OF ESTIMATES FOR POTENTIAL OUTPUT GROWTH
(annual growth rate)

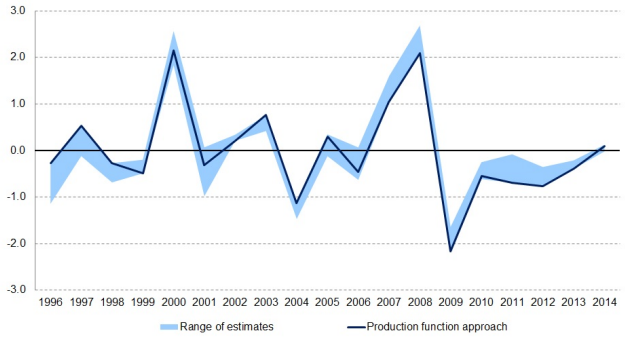


Source: Authors' calculations

Chart 3 plots a range of estimates of potential output growth around the estimates derived using the production function approach as outlined above. Despite some disparities across the various point estimates of potential output, the different models point to a similar story. Potential output slowed down significantly between the late 1990s and the early years of the last decade. Moreover, despite the moderate increase in the supply capacity during the cyclical upswing before the 2009 recession, potential output growth had not recovered to the rates prevailing in the late 1990s. The weakness in economic activity following the 2009 recession led to a slowdown in the growth rate of potential GDP, which however started to recover in recent years, with some estimates even pointing to growth rates in 2014 that exceed those registered in the pre-crisis period.

Building upon the various estimates for potential output, Chart 4 plots the range of estimates for the output gap. Allowing for some degree of uncertainty in point estimates, all the indicators are broadly consistent in the analysis of the business cycle fluctuations of the Maltese economy over the past 15 years. Between 1996 and 2014, there were two clear periods when the economy was operating above potential. The first one was in 2000, driven in part by a large (temporary) increase in activity in Malta's semi-conductor industry in the context of the international technology boom. The second one occurred between 2007 and 2008, before the global recession.

Chart 4
RANGE OF ESTIMATES FOR THE OUTPUT GAP
(percent of potential output)



Source: Authors' calculations

This recession, which led to a fall in domestic output in 2009, also pushed output below its potential and led to a negative output gap in the range of $-1\,\%$ to $-2\,\%$. The subsequent recovery in economic activity led to a relatively quick correction of the output gap, especially when compared to other EU economies. The output gap worsened slightly in 2012 owing to the slowdown in GDP growth due to the sovereign debt crisis in Europe but, following two years of above average GDP growth, the gap between actual and potential GDP was broadly in balance by 2014.

5 Cross-country comparisons within the European Union

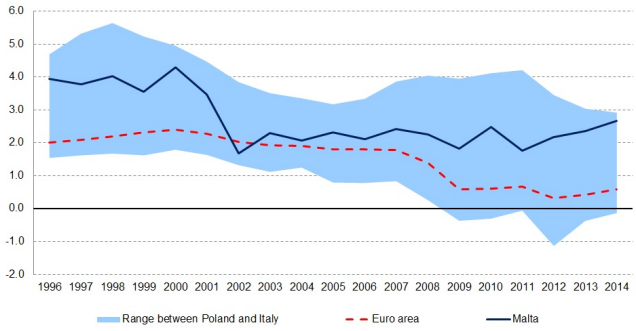
The impact of the great recession on Malta's potential output growth was more muted than in the rest of the European Union (EU). Chart 5 plots selected potential growth rates across the EU between 1996 and 2014. Poland, which is shown at the top of the range, had the most consistently positive potential output path in the EU, with growth averaging $4.1\,\%$ per year, while Italy had the lowest, at just $0.7\,\%$ on average. Note, however, that in some countries, potential output has exhibited boom and bust dynamics, with relatively high growth rates before the crisis, as in Ireland and Latvia, but shrinking potential since 2008. Italy and Poland have, in fact, been selected on the basis of the consistency and stability of their growth path, in order to ascertain the main contributing factors behind success or failure.

The relatively strong growth of potential output in Poland appears to be driven by a consistent decline in structural unemployment, supported by a relatively stable, albeit moderate investment to GDP ratio. The long-term decline in Italian growth potential, from

[10] For details of the Commission's production function approach, see (D'Auria et al., 2010) and (Havik et al., 2014). The Commission's approach is very similar to the one used in this paper with two main differences: (i) the labour share in the Commission's production function is assumed to be the same for all EU countries whereas in our case, it was calculated from the data i.e. the average share of labour in Gross Value Added adjusted for the share of self-employed for the period 1995-2012 and (ii) differences in extracting the structural components of some inputs in the production function, such as TFP and NAWRU.

around 2.3 % in 1980s to less than 1 % in the 2000s, is driven by the downward trend in total factor productivity. Recent studies have attributed this slowdown to a combination of deteriorating competitiveness and resource misallocation, the latter most likely a result of out-dated management practices and limited penetration of information and communication technologies (Hassan & Ottaviano, 2012).

Chart 5
SELECTED POTENTIAL GROWTH RATES ACROSS THE EU
(annual growth rate)



Source: European Commission Autumn 2014 Economic Forecats, authors' estimates

Malta has been closer to the top of the range, especially in the late 1990s and in the last two years, and has outperformed the average for the euro area, except during the period of economic restructuring that preceded EU accession in 2004. This bodes well for the pace of real convergence of the Maltese economy. The gap between the two economies has widened in recent years given the divergent path in economic growth experienced after the crisis. In particular, growth in the euro area seems to have stabilized at a lower level after 2009, although this picture masks considerable heterogeneity in the constituent countries. On the contrary, potential growth in Malta has already reached and, according to some estimates, even surpassed, the growth rate experienced in the cyclical upswing before the crisis.

Finally, as the sizeable changes in Malta's potential growth rates show, the business cycle in Malta is more volatile than in the euro area, as would be expected for a very small open economy, but, with the exception of the last few years, it is quite synchronised with that in the rest of the monetary union.

6 Conclusion

As in other euro area countries, in Malta the impact of a slowdown in population growth has so far been offset by rising participation rates. In contrast, as in other countries with a better-than-average potential output path, Malta has been spared the large rise in the structural unemployment rate that has affected many euro area economies. However, the Maltese economy has also witnessed a significant decline in the investment ratio, which is towards the bottom of the range among EU countries. Moreover, TFP growth has been on a declining trend, especially when seen from a longer term perspective and, despite the pick-up in recent years, its contribution to potential output growth is only a fraction of that observed in the late 1990s.

To facilitate the recovery in potential output, it is crucial to create a better business environment and generate the conditions to sustain more start-ups, while attracting new businesses to Malta. The ageing Maltese population limits the possible increases in participation rates, so that potential output growth is unlikely to be sustained only through higher labour inputs. That said, policymakers need to continue to put in place the right incentives for more people to join and remain longer in the labour force, while pursuing structural reforms to reduce unemployment. Given the increased share of very competitive high value-added service activities, it is also essential to have further investment in education to improve the quality of human capital and increase labour market flexibility. This must be supported by adequate investment in the supporting physical, communications and information technology infrastructure of the country. Finally, policymakers need to continue to pursue structural reforms that lead to an improvement in productivity.

References

Basu, S. & Fernald, J. (2001). Why is productivity procyclical? Why do we care? In C. R. Hulten, E. R. Dean & M. Harper (Eds.), *New dev. product. anal.* (Chap. 7). Chicago, U.S.: University of Chicago Press.

Benes, J., Clinton, K., Garcia-Saltos, R., Johnson, M., Laxton, D., Manchev, P. & Matheson, T. (2010). Estimating potential output with a multivariate filter. *Int. Monet. Fund Work. Pap. WP/10/285.*

Carnot, N., Koen, V. & Tissot, B. (2005). *Economic Forecasting*. London: Palgrave Macmillan.

Central Bank of Malta. (2013). *Assessing the Supply Side of the Maltese Economcy using a Production Function Approach* (tech. rep. No. 4). Central Bank of Malta. Valletta, Malta.

Congressional Budget Office. (2001). *CBO's method for estimating potential output: an update*. The Congress of the United States, Congressional Budget Office. Washington D.C.

Cotis, J. P., Elmeskov, J. & Mourougane, A. (2005). Estimates of potential output: Benefits and pitfalls from a policy perspective. In L. Reichlin (Ed.), *Euro area bus. cycle stylized facts meas. issues.* London: Centre for Economic Policy Research.

Dabla-Norris, E., Guo, S., Haksar, V., Kim, M., Kochhar, K., Wiseman, K. & Zdzienicka, A. (2015).

The new normal: a sector-level perspective on productivity trends in advanced economies. *Int. Monet. Fund Staff Discuss. Notes, SDN/15/03.*

D'Auria, F., Denis, C., Havik, K., McMorrow, K., Planas, C., Raciborski, R., ... Rossi, A. (2010). The production function methodology for calculating potential growth rates and output gaps. *Eur. Econ. Econ. Pap. 420.*

De Masi, P. R. (1997). IMF estimates of potential output: Theory and practice. *Int. Monet. Fund Work. Pap. 97/177.*

Economic Policy Committee. (2001). *Report on potential output and the output gap.* European Commission. Brussels.

European Commission. (2009). Impact of the current economic and financial crisis on potential output. *Eur. Econ. Occassional Pap. 49.*

Grech, A. G. (2004). Estimating the output gap for the Maltese economy. *Univ. Libr. Munich MPRA Pap. no.33663.*

Grech, A. G. (2013). Adapting the Hodrick-Prescott filter for very small open economies. *Int. J. Econ. Financ. 5*(8), 39–53.

Hassan, F. & Ottaviano, G. (2012). Productivity in Italy: the great unlearning. *VoxEU.*

Havik, K., McMorrow, K., Orlandi, F., Planas, C., Raciborski, R., Roger, W., ... Vandermeulen, V. (2014). The production function methodology for calculating potential growth rates and output gaps. *Eur. Econ. Econ. Pap. 535.*

Micallef, B. (2014). A multivariate filter to estimate potential output and NAIRU for the Maltese economy. *Cent. Bank Malta Work. Pap. WP/05/2014.*

Mishkin, F. (2007). *Estimating potential output.* Federal Reserve Bank of Dallas.

Vetlov, I., Hledik, T., Jonsson, M., Kuscera, H. & Pisani, M. (2010). Potential output in DSGE models. *Eur. Cent. Bank Work. Pap. 1351.*