Estimating the output gap for the Maltese economy

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Abstract

An attempt is made in this paper to arrive at an estimate of the output gap for the Maltese economy on a quarterly and annual basis. Two approaches are adopted, namely the Hodrick-Prescott filter and the aggregate production function method, with their results being benchmarked with the results of two other studies. The methods adopted in this paper indicate that the Maltese economy passed through three separate business cycles during the last three decades, with the size of the fluctuations moderating over time. Potential output growth is estimated to have declined significantly during the nineties, as factors of production are growing by a smaller margin. This indicates the importance of carrying out structural reforms that would boost productivity growth.

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CONTENTS

1.0 Introduction

Modern economics assumes that in the long run an economy can develop in a balanced way, with full employment of resources and a constant inflation rate. The output level there achieved is called 'potential output' as it is the highest output level achievable without accelerating inflation, i.e. without introducing disequilibria in the production factor markets. The 'potential growth rate' is defined by the existing resources, labour and capital, and the exogenous growth of labour productivity. The business cycle can be described in relation to the potential output. The percentage difference between the observed output and the potential one is called 'the output gap'. The latter measures the deficient or excessive production of output compared to the equilibrium level.[1]

Potential output is unobservable and hence needs to be estimated. A number of standard of methods have been developed in this regard, with two main branches emerging in the literature. On the one hand, atheoretical statistical de-trending methods attempt to extract potential output using past values of the real GDP series. The line of reasoning underlying these methods is essentially neo-classical as the economy's dynamics are assumed to gravitate towards equilibrium, so that past values give a good indication of potential output. By contrast, the other category of models is based on the Keynesian precept that the economy can deviate from equilibrium for long periods of time. As a result, past observations of real GDP provide little indication of the extent of the output gap, and a structural model, most frequently a production function, must be developed to estimate the potential capacity of the economy.

Despite its importance, there has been only a limited amount of research on the output gap for the Maltese economy.[2] This paper describes estimates of the output gap made on a quarterly and an annual basis utilising two methods, namely the Hodrick Prescott (HP) filter and the Production Function approach. At the outset it must be stressed that estimates of the output gap tend to be quite sensitive to the assumptions and the

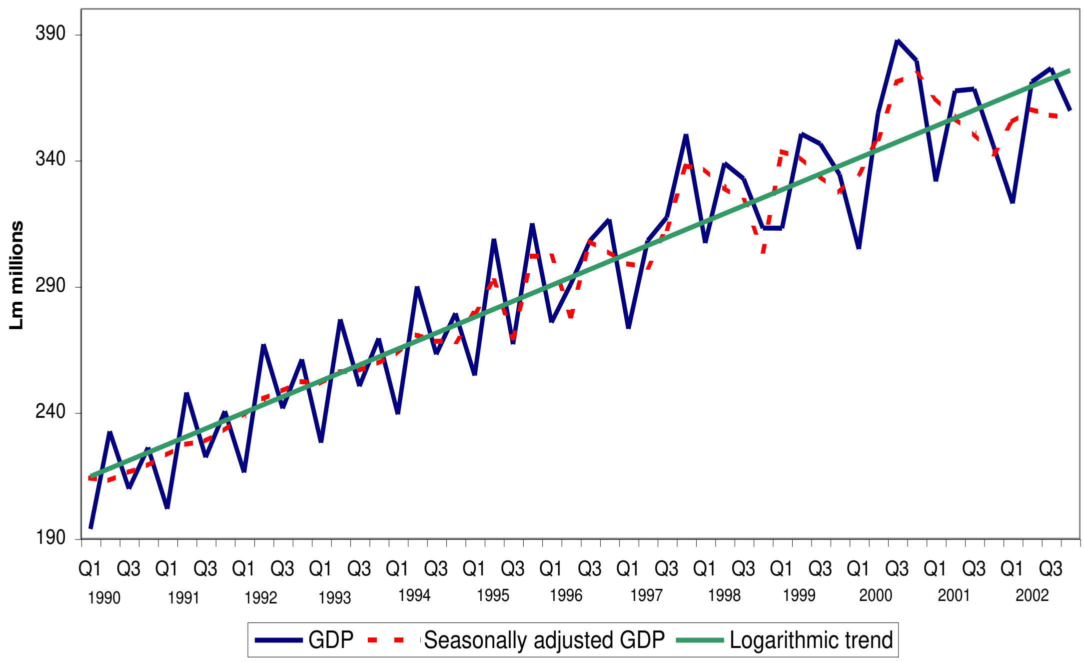
[1] Nelson & Nikolov (2001) and Stone & Wardrop (2002) explain the importance of this indicator.
[2] The most extensive research on this topic can be found in Cassar (2002).

time horizon taken by the modeller.[3] Moreover, when undertaken with respect to Malta, this exercise is further complicated by the lack of adequate data for factors of production and the large irregular component evident in quarterly data.[4]

2.0 Statistical de-trending

The simplest way of estimating potential output is to define it as the trend line of the real GDP.[5] As can be seen from Chart 1, Malta's real quarterly GDP series exhibits a pronounced seasonal pattern.[6] When this pattern is extracted using the X-11 Census method, fluctuations in the series become more moderate. A log-linear trend reveals that, on average, quarterly growth amounted to 1.1%, or 4.4% on an annual basis.

Chart 1: Quarterly Real GDP



The log-linear trend method postulates a deterministic trend in the GDP. An alternative assumption is that potential output is a random walk, i.e. the stochastic trend in the GDP series. The most popular method in this case is the HP filter.[7] The

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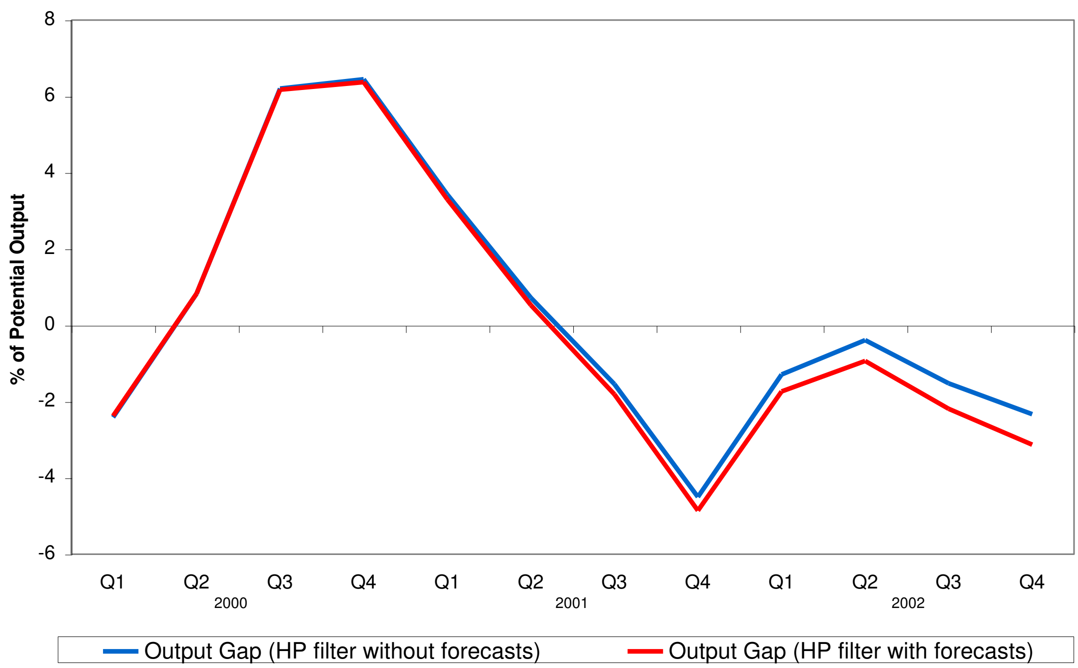
[3] See Chagny & Dopke (2001).
[4] The latter inevitably results from the small size of the economy.
[5] The data utilised have been constructed by the Central Bank of Malta (CBM). See Appendix 1.
[6] Tourism, a highly seasonal industry, in fact constitutes around 30% of overall activity.
[7] The filter is defined as: $\min \Sigma^{T}_{t=1} (y_t - y^*_t) + \lambda \; \Sigma^{T-1}_{t=2}[(y^*_{t+1} - y^*_t) - (y^*_t - y^*_{t-1})]^2$, where y^* is the estimate of potential GDP.

latter includes a smoothing parameter λ. If λ is set to zero, the trend will be the same as the actual series, while if it is set at infinity the trend reduces to the earlier described linear form. The European Commission sets the smoothing factor at 1600 and 100 for quarterly and annual data frequencies respectively, citing academic literature on real business cycles.[8]

In spite of its wide usage, this filtering method has been quite controversial mainly on account of its mechanistic nature. The arbitrary choice of the smoothing parameter influences the size of potential output estimates and some studies have argued that the commonly used λ's are only applicable for the normal business cycle of the United States.[9] On a more practical level, the filter suffers from an 'end-of-sample' problem. Using a sample of 128 observations, for example, St Amant and van Norden (1997) show that observations at the centre of the sample receive a six percent weight while the last observation accounts for 20 percent of the weight. Thus estimates of the gap for recent periods tend to change substantially as new (or revised) data are available.

Chart 2: HP Filter Approach (Effect of Forecasts)

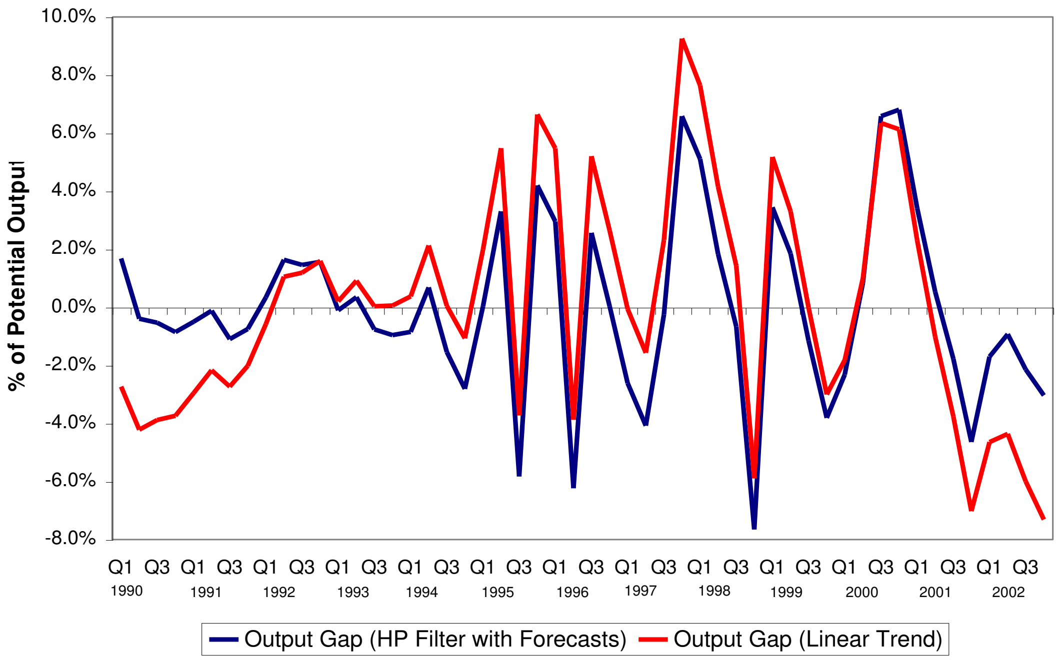


To offset this effect, the GDP series is usually extended forwards by means of forecasts. The significance of this procedure can be visualised from Chart 2, which

[8] See Economic Policy Committee (2001).

shows two estimates of the quarterly output gap for Malta computed by means of the HP filter, one of which was computed on a real GDP series with forecasts running to 2004. These forecasts were made using an auto-regressive model of differences in real GDP with four lags[10], and their inclusion, in this case, yields a larger output gap for 2001 and, especially, 2002. The HP filter approach, similarly to the linear trend method as can be seen in Chart 3, appears to indicate that practically throughout 2001 and 2002, the Maltese economy was performing significantly below its potential capacity. However, the size of the output gap on a quarterly basis appears to fluctuate considerably. Thus from a positive peak of 6.8% in the fourth quarter of 2000, the gap became a negative 4.6% in the same quarter of 2001.

Chart 3: Output Gap on a Quarterly Basis (HP Filter and Linear Trend)



However this extreme volatility disappears when the output gap is computed using an annualised series, as can be seen from Table 1. Here the quarterly output gap series is annualised and fluctuations range between a positive 3.2% and a negative 1.9% during the twelve-year period. By contrast the original quarterly series had fluctuated within a much wider band, namely a positive 6.8% and a negative 7.7%.

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[9] See for example Chagny & Dopke (2001).

[10] This AR (4) model forecasts GDP growth during 2003 and 2004 to be slightly below average compared with the previous ten years.

Table 1
OUTPUT GAP (HP FILTER METHOD)[1]

		%
	HP Filter On Annual Series	HP Filter On Quarterly Series (Annual Average)
1990	0.2	0.0
1991	1.0	-0.6
1992	0.4	1.4
1993	-0.5	-0.3
1994	-2.4	-1.0
1995	1.7	0.6
1996	1.1	-0.2
1997	1.5	0.1
1998	0.9	-0.5
1999	1.0	0.0
2000	3.7	3.2
2001	-1.0	-0.7
2002	-3.0	-1.9

[1] A positive figure implies that output was above potential and vice versa.

As was explained above, the results from de-trending methods are susceptible to the time periods taken under consideration. This can be verified from Table 1, which compares the annualised quarterly series with results derived by running the HP filter on the annual real GDP series for the period 1973 to 2002. The two measures differ significantly in some years, though the pattern of the business cycle implied by both of them is very similar in recent years. The annual series is derived from a longer time series and avoids the noise introduced by the quarterly series. However the size and cycle of the gap may still have been affected by structural breaks. Thus for example in 1995 real GDP rose at an exceptionally high pace, not on account of an actual acceleration in activity but rather because of the introduction of the value-added tax system. The latter induced a significant number of enterprises to emerge from the informal economy. This artificial boost to GDP is depicted as a substantial positive output gap in 1995 and may have affected the extent of the negative gaps estimated for the previous two years.

3.0 Production function approach

Even when these statistical issues are taken care of, de-trending methods can still be subjected to the criticism that they rule out a priori a long lasting negative (or positive) output gap. If one believes, for example, that actual GDP has drifted away from its potential path for, say, a decade or more, the filter will not show this development as a negative output gap but as a lower growth of potential GDP. Thus many institutions, such as the EU Commission and the IMF, complement statistically-determined output gaps with estimates derived from explicit models of the supply side of the economy. The latter usually take the form of Cobb-Douglas type production functions.[11] These methods have the advantage that potential output growth can be explained in terms of increases in factors of production or productivity, while estimates derived from a de-trending technique are virtually inexplicable. Furthermore forecasts of future growth can be computed by making assumptions about the future time path of the chosen determinants of potential output.

Estimating a production function for the economy as an aggregate, however, presents the researcher with a number of major problems. First of all, this approach imposes a common functional form of the production technology across all firms operating throughout the different sectors of the economy, an assumption that can possibly lead to model mis-specification. This problem, applied to Malta, is particularly relevant in that there is a clear dualistic structure with export-oriented firms operating in a significantly different manner than locally-oriented establishments. Accounting for Malta's large public sector is also problematic. Furthermore assumptions have to be made on several unobserved economic variables, such as the degree of returns to scale, trend technical progress, and potential employment. Data on the size of factors of production is also fairly restricted. In the case of Malta, for example, no data on the capital stock or the number of hours worked exist, let alone measures of changes in the quality of capital and labour over time. Consequently, the results presented in this paper are largely dependent on the assumptions taken.

[11] See Denis, Mc Morrow & Roger (2002) and De Masi (1997).

CHART 4: MEASURING POTENTIAL OUTPUT VIA THE PRODUCTION FUNCTION APPROACH

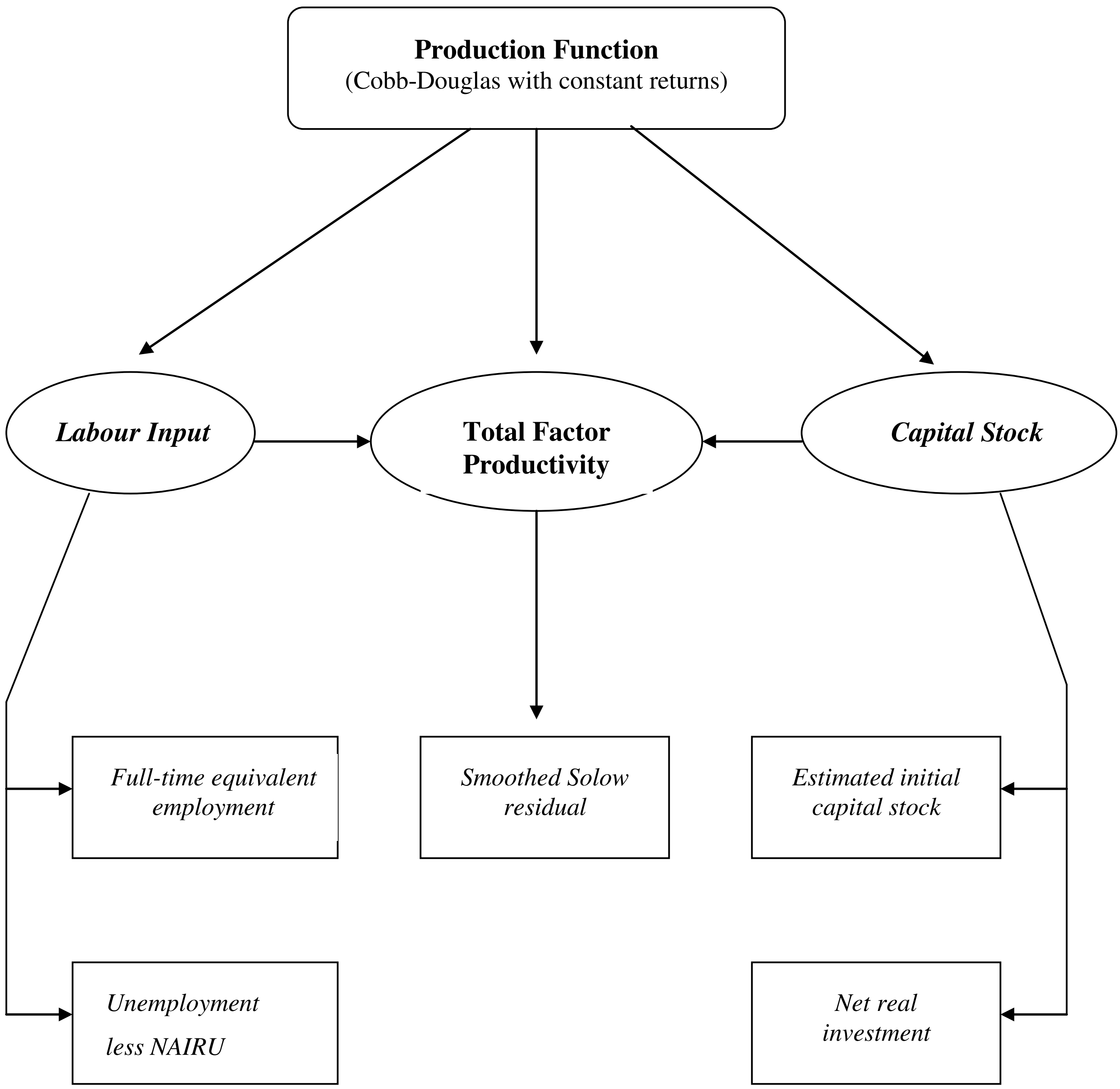


Chart 4 illustrates the methodology adopted in the computation of potential output via an aggregate two-factor Cobb-Douglas production function with constant returns to scale.[12] Essentially this comprises the estimation of measures of capital stock, potential labour supply, the non-accelerating inflation rate of unemployment (NAIRU), and total factor productivity. Given the assumptions underlying these estimates, they were subjected to sensitivity analysis, in order to ascertain the degree

[12] Unless stated the methodology used to compute the quarterly and the annual output gap is the same.

to which their values affected the final measure of the output gap. The latter, in fact, essentially reflects two factors, namely the degree of utilisation of labour resources as shown by the divergence between actual unemployment and the NAIRU, and the extent to which actual total factor productivity deviates from its secular trend.

3.1 The degree of utilisation of labour resources

Determining the size of available human resources requires reasonably consistent and lengthy labour market time series, which unfortunately are unavailable in Malta.[13] Labour Force Surveys, compiled according to internationally recognised standards and concepts, have been carried out only since 2000, while the data on hours worked derived from these surveys have yet to be published. Labour market data covering the years preceding 2000 are confined to a regular monthly headcount of full-time employed and registered unemployed compiled by the state employment agency. These data, however, suffer from a number of defects, the principal being the absence of part-time employment, which in recent years has grown substantially. To remedy these problems, two labour market series were constructed in Grech (2003), the first showing the total number of employed (both full-time and part-time), whereas the second converted the first series into full-time equivalent terms. In lieu of data on the actual hours worked, the second time series can act as a proxy for the actual labour input employed in the Maltese economy.

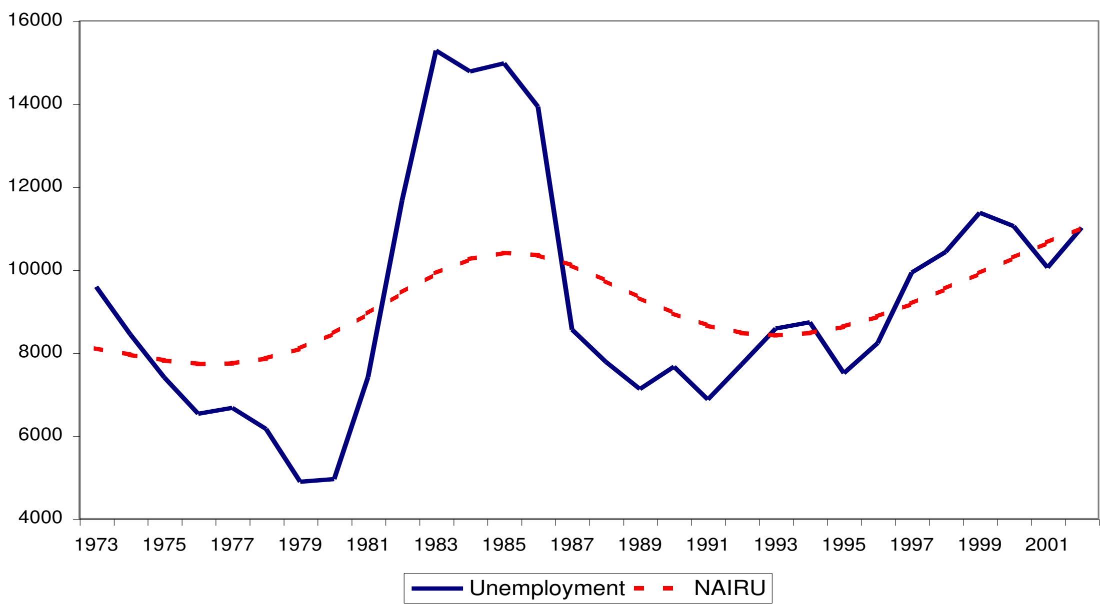
To assess the degree of labour utilisation, one then has to compare the actual labour input with the potential supply. It is customary to arrive at the latter by multiplying the working age population by the trend participation rate,[14] and then subtract the NAIRU. The idea behind this approach is that in an economic downturn, not only does unemployment rise but people also become discouraged from participating in the labour market, thus reducing the participation rate. However, this assumes that any change in the participation rate can be traced to variations in the state of economy and not to shifts in social conditions or behaviour. This hypothesis is quite debatable. For example, in Malta, the female participation rate has exhibited a clearly upward trend in recent years due to better education, smaller family size and greater availability of

[13] See Grech (2003) for further details.
[14] See Denis, Mc Morrow & Roger (2002) and De Masi (1997).

part-time opportunities rather than to accelerating economic growth. Contrariwise, male participation has declined as a result of early retirement and longer periods of study, factors that cannot be linked directly with worsening economic conditions. Moreover while the discouraged worker effect might be significant in prolonged recessions, it can also be offset by the additional worker effect, with females trying to supplement the income of the main breadwinner during economic downturns.

Ignoring the discouraged worker effect, one can arrive at the potential labour supply by adding to the actual labour input, any surplus of unemployment over the NAIRU. Vice versa when the NAIRU is higher than actual unemployment, one would need to reduce the actual labour input by this element to determine the potential or equilibrium labour resources of the economy. This approach has the benefit of not introducing deviations between actual and trend participation as a source of the output gap, and furthermore is based on actual individual behaviour (the indicated willingness to work) rather than on the assumption of the presence of the discouraged worker phenomenon.

Chart 5: The NAIRU in Malta



The NAIRU was estimated via a simple model that tries to extract information on this unobserved variable from the time path of wage inflation.[15] If the NAIRU is

[15] This model is adapted from Giorno, Richardson, Roseveare & van den Noord (1995). The wage rate was computed by dividing the wage bill by full-time equivalent employment.

relatively stable over time, one can link any acceleration in wage inflation to unemployment falling below the NAIRU and vice versa.

Namely:

$$D^2 \log W = -\phi(U - NAIRU) \;\ldots.(1) \qquad \phi > 0$$

Where *D* is the first-difference operator, ϕ is the degree of responsiveness, and *W* and *U* are the levels of wages and unemployment, respectively. Given the assumption of stability of the NAIRU, an estimate of ϕ can be found by taking:

$$\phi = -D^3 \log W / DU \quad \ldots..(2)$$

From the above, the NAIRU is derived as:

$$NAIRU = U - (DU / D^3 \log W) * D^2 \log W \quad \ldots.(3)$$

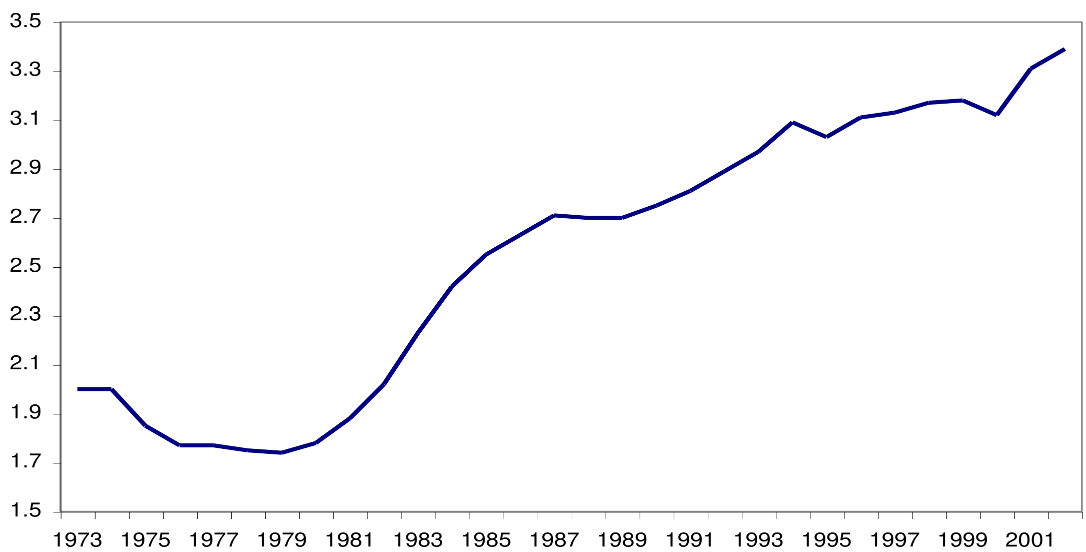
The resulting series is then smoothed by means of an HP filter to eliminate movements which may result, for example, if wage inflation is affected, not only by the level of unemployment, but also by its year-to-year changes.

As can be seen from Chart 5, the number of unemployed in Malta exhibits a cyclical pattern. In the early seventies, the fast expansion of manufacturing and tourism led to a sharp drop in unemployment, which fell significantly below the NAIRU. The international recession of the early eighties reversed this trend and unemployment surged to record levels. In reaction, Government acted as an employer of the last resort, through direct employment rather than by adopting active labour market progress, and unemployment fell back nearly to its pre-crisis' level. The liberalisation reforms enacted in the late eighties led to a significant recovery in economic activity, such that unemployment remained below the NAIRU for seven consecutive years. Thereafter, except for 1995 and 2001, unemployment hovered around or exceeded the NAIRU, even though the latter appears to have risen substantially over the last years.

This increase in the NAIRU can be attributed to several factors, such as the substantial restructuring of labour-intensive industries like construction and manufacturing and the increasing skills shortage lamented upon by many local entrepreneurs.[16] Unemployment data confirm that the proportion of persons who remain on the register for more than a year, and who are older than 40, has increased significantly over the last years. At the same time, wage inflation has remained relatively high notwithstanding that the number of unemployed persons willing to work has continued to increase.[17] This evidence suggests that the pool of employable persons is shrinking, and firms have to accommodate any increase in demand by trying to extract more work effort from their existing complement by awarding higher wage rises.

3.2 The deviation of total factor productivity from its secular trend

Chart 6: Capital-Output ratio



Total factor productivity can only be gauged indirectly in Malta, via the computation of the Solow residual from the aggregate production function. Having chosen the aforementioned full-time equivalent employment series as representative of the labour

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[16] Cassar (2002) also suggests that the NAIRU has risen in Malta during recent years.

[17] Thus while average unemployment rose by 1,000 over the five-year period (1993-98), wages rose by 25%. Furthermore despite an increase in average unemployment of 2,000 over the next five-year period (1998-2002) average wages still rose by 15%.

input, the next step was to come up with a measure of the capital stock.[18] The CBM used to publish a capacity utilisation index in the early nineties.[19] The initial level (1980) of capital stock was based on an assumed capital/output ratio of 1.5 and excluded private investment in dwellings. Its growth was determined by investment (excluding that in private dwellings) with a half-year gestation period and a constant depreciation rate of 5%. Cassar (2002) developed another measure of the capital stock, by assuming that in 1990 the return on capital amounted to 20%. This series was then extrapolated backwards and forwards using annual net fixed capital formation for the business sector, deflated by means of the implicit gross fixed capital formation deflator. This method yielded a capital output ratio of 1.59 for 1980.

In view of this research, it was decided to adopt an initial capital-output ratio of 2 for 1973.[20] This initial stock was then augmented by net private investment (excluding dwellings)[21] deflated by the investment deflator. Depreciation data was taken from the National Accounts of the Maltese Islands. In line with CBM (1990), investment was assumed to become fully productive over a two-year period. As can be seen from Chart 6 this method yielded a capital-output ratio that fell initially up to 1979, and then grew sharply in subsequent years. This indicates that economic activity has become steadily more capital-intensive, maybe on account of the subsiding importance of sectors such as textiles, construction and Government administration. Both CBM (1990) and Cassar (2002) report an increasing capital-output ratio.[22] To further verify the reliability of this capital stock time series, its annual growth was compared with the yearly increase registered in the amount of electricity generated, as the latter can be taken as a proxy of the use of capital. During this thirty-year period, electricity generated rose on average by 6.6%, while the computed capital stock measure increased by 8%.[23]

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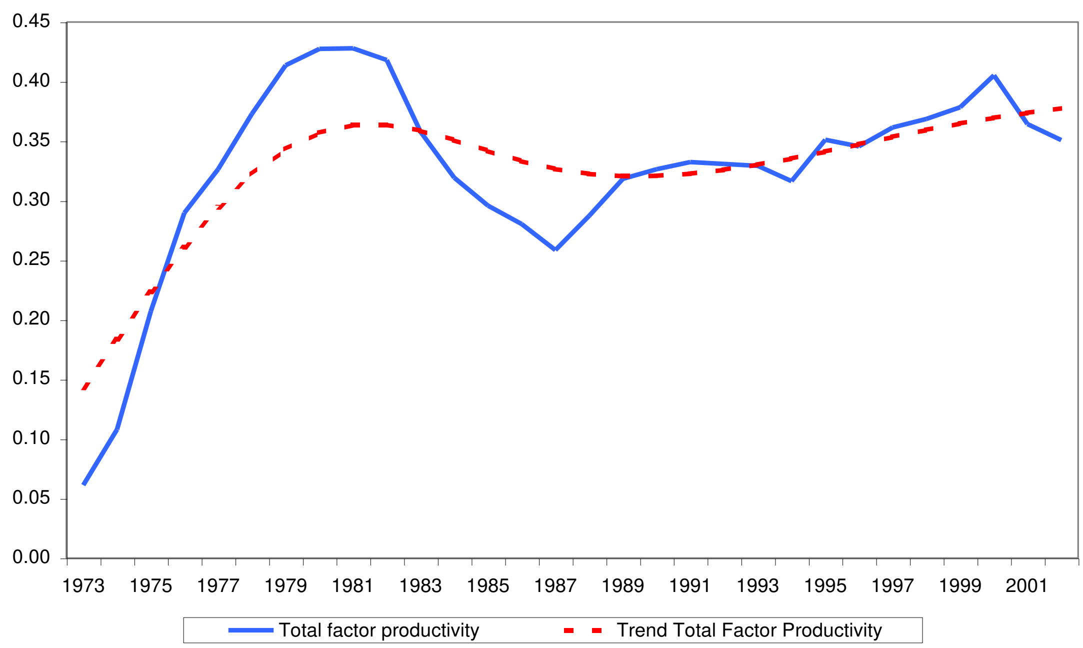
[18] Data on capital stock are notoriously hard to find internationally. However there is a lot of literature on how to try to make up for data unavailability. See for instance Abadir & Tailman (1998) and Hernandez & Mauleon (2002).
[19] Refer to Central Bank of Malta (1990).
[20] The quarterly gap series, which starts in 1990 Q3, has an initial capital-output ratio of 2.5.
[21] In the absence of recent data, the latter is assumed as comprising 12% of nominal investment from 1999 onwards.
[22] The adopted measure yields a capital-output ratio of 1.78 for 1980, compared with the imposed 1.5 ratio of CBM (1990) and Cassar's (2002) 1.59 for the same year.
[23] Year-on-year percentage changes in the two series exhibit a correlation coefficient of 0.58.

Regressing real GDP on the computed capital stock and full-time equivalent employment, under the assumption of constant returns to scale, yielded an elasticity of 0.55 and 0.45, respectively. Trend total factor productivity was then derived as the smoothed Solow residual resulting from the imposition of these parameters on the production function. This residual is positively related to labour productivity and inversely related to the capital intensity ratio.[24] As can be seen from Chart 7, total factor productivity rose sharply throughout the seventies. During this period, though capital intensity increased substantially, mainly reflecting investment by Government enterprises and manufacturing, the expansion in labour productivity was much more pronounced. However in the eighties productivity slowed down significantly, while firms continued to become more capital intensive, explaining the drop in total factor productivity during this period. This trend was reversed in the nineties, when growth in labour productivity accelerated, while the capital intensity ratio expanded at a slower pace. However, total factor productivity fell below trend in 2001 and 2002, as labour productivity dropped significantly.

Chart 7: Total Factor Productivity



[24] $Y = AK^{\beta}L^{1-\beta}$

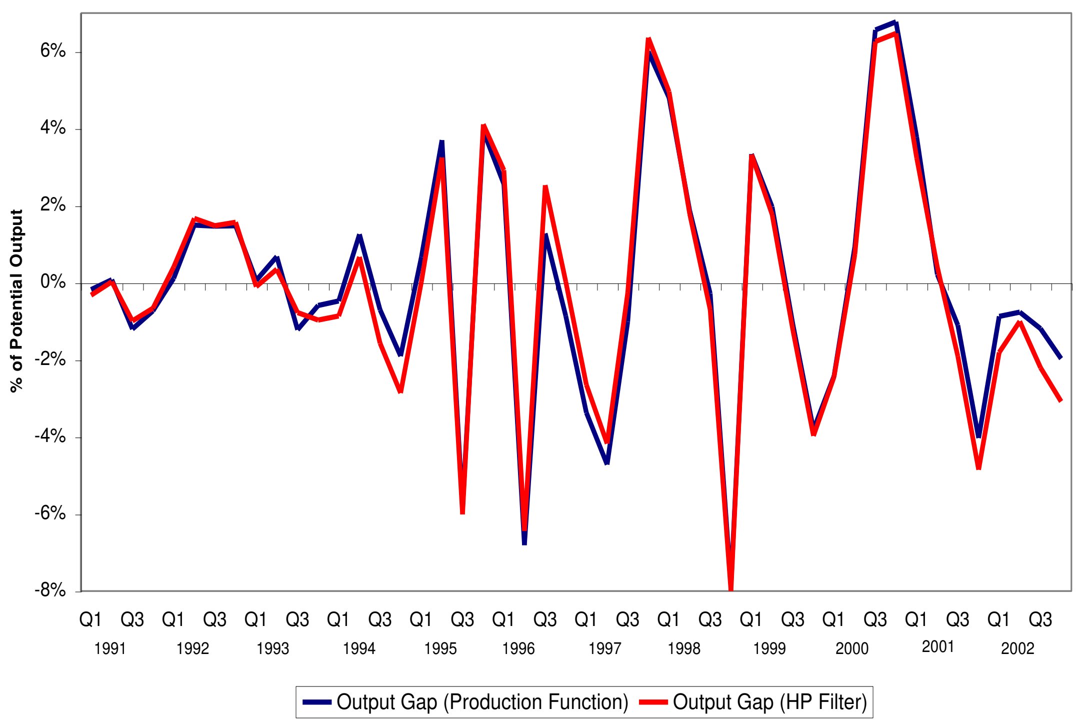
$Y/L = A(K/L)^{\beta}$

$A = (Y/L)/(K/L)^{\beta}$

3.3 Output gap resulting from the production function approach

Chart 8 compares the output gap on a quarterly basis derived using the above-described production function with that previously computed via a HP filter. The two methods yield very similar results, both in terms of turning points and size of the output gap. The production function method, thus, also gives an output gap series exhibiting high volatility on a quarterly basis, confirming the presence of a large irregular component in the quarterly real GDP data. Consequently, the quarterly estimates of the output gap must be interpreted with caution, as the methods used to compute it implicitly assume '*that the irregular (high frequency) fluctuations play little role*'.[25]

Chart 8: Output Gap on a Quarterly Basis (Two approaches)

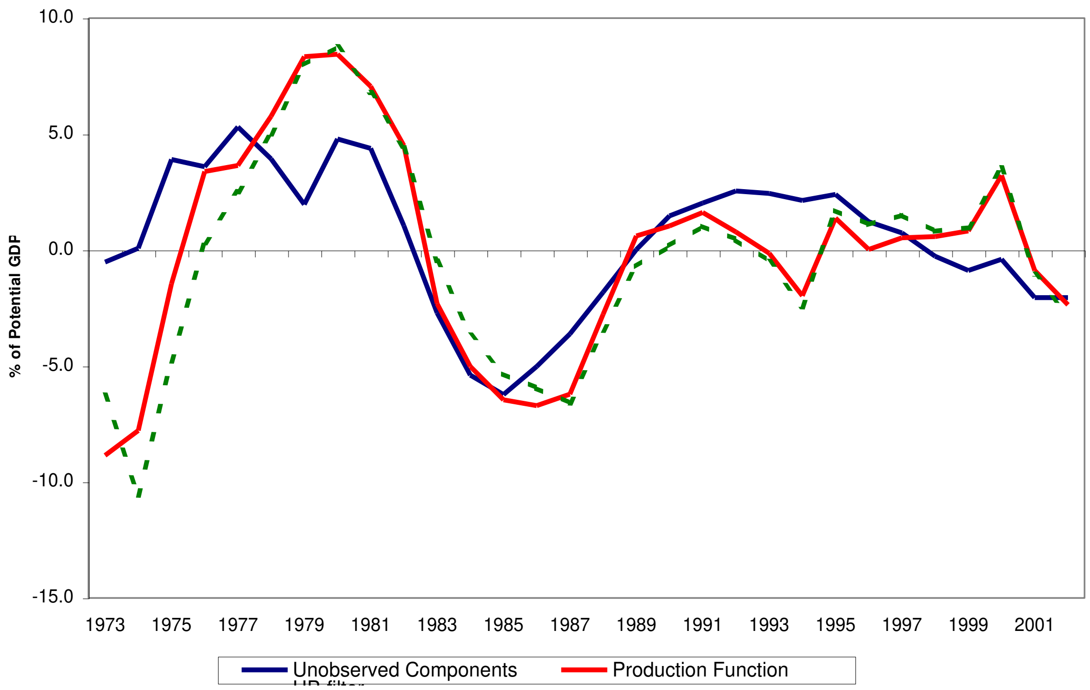


Unemployment figures show that the number of jobless fluctuated around the NAIRU during this period, but this variation was not large on a quarter-on-quarter basis. By contrast the deviation of the Solow residual from its trend was relatively sharp and volatile. This suggests the presence of a pronounced degree of labour hoarding in the Maltese economy. Given the lack of skilled workers, many firms, in fact, opt to keep their complements stable in spite of changes in activity. This results in large

[25] See Canova (1998).

variations on a quarterly basis in productivity. Since the importance of industries with highly skilled workers has increased considerably in recent years, the quarterly output gap series is becoming ever more volatile.

Chart 9: Output Gap on an Annual Basis (Three Approaches)



When applied on annual data, the production function approach yields the typical business cycle pattern, with a succession of booms and slumps. Chart 9 graphs the annual output gap for the period 1973-2002 resulting from the application of the HP filter and the production function approaches. These results were also benchmarked with a measure of the output gap derived using the multivariate unobservable components method.[26] The latter approach decomposes the real GDP series into a permanent, a transitory and a random noise element, where the first two represent potential output and the output gap, respectively. The transitory (or trend-reverting cyclical) component is assumed to be related to an underlying cycle in the economy, which is also present in another variable.[27] In this case, inflation was used to derive information on this 'unobserved' cycle.

[26] The author is indebted to Mr. J. Alsterlind, who provided these estimates. Refer to Appendix 2.
[27] Chagny & Dopke (2001) and Claus, Conway & Scott (2000) present a comprehensive explanation of this approach to output gap measurement.

4.0 Comparing and evaluating the results

The implied size and duration of the economic cycle resulting from the two methods adopted in this paper were compared with those of the unobserved components approach. Cassar (2002) did not present data on the size of the output gap, but her results on the growth in potential output were used as a benchmark.

4.1 Economic cycles: Size and duration

As can be seen from the Chart 9, according to the HP filter and the production function methods, the Maltese economy passed through three cycles during these three decades. The first one spanned the period 1974/75 to 1989, with a notable acceleration in economic growth during the second half of the seventies. This reflected the increase in productivity brought about the rapid capital accumulation of the early seventies, which, in turn, contributed to raise labour demand sharply such that unemployment in 1979 fell to half the 1973 level. This boom was, however, short-lived, and the Maltese economy fell in recession in the early eighties. The recovery from this sharp downturn started in the mid-eighties, with the economy returning to its potential by 1989. The results of the unobserved components method broadly mirror those of the other two approaches for this first cycle, except that the fluctuations are rather less pronounced.

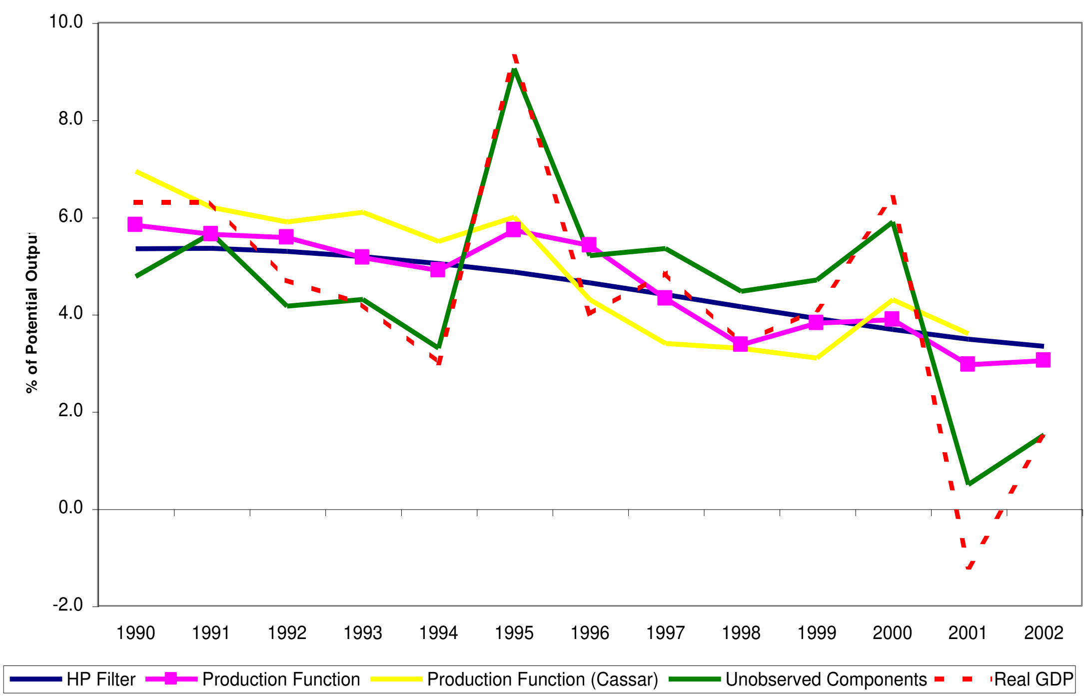
By contrast whereas the HP filter and the production function approach indicate that a shorter cycle occurred between 1989 and 1994/1995, the third method shows that throughout most of the nineties the economy was always operating above its potential. This result must, however, be interpreted with caution as during this period inflation, which as previously explained was used to derive the path of the output gap under the unobserved components method, was probably boosted upwards by a policy shock, the 1992 devaluation, rather than because of above-potential GDP growth.

The three methods also provide conflicting evidence for the second half of the nineties. The unobserved components approach indicates that the performance of the Maltese economy worsened gradually from 1995 onwards, with the output gap turning negative in 1998. In 2000, the negative gap narrowed significantly, as the method picked up the spike in inflation that characterised that year.[28] Then in the following two years the output gap rose to over 2%, as inflation slowed down significantly. The HP filter and the production function approaches also indicate that real GDP fell below capacity in 2001 and 2002. However, the two methods, in contrast with the unobserved components approach, indicate that the Maltese economy operated slightly above potential in 1998 and 1999. Furthermore in 2000, the positive output gap implied by the HP filter and the production function approaches exceeded 3% of potential output, on account of a large expansion project that was carried out by Malta's largest electronics manufacturer.

To sum up, the two methods adopted in this paper indicate that the fluctuation in the economic cycle, both in terms of size and duration, has moderated substantially in the nineties. This probably reflects the maturing of the Maltese economy, and possibly the influence of better macroeconomic management.

4.2 Growth in potential output

Chart 10: Growth in Potential Output (Various Methods)



[28] This spike was, however, caused by an extraordinary rise in food prices resulting from bad local agricultural harvests and the collapse of a number of major discount stores. Once again these can hardly be deemed to be indicative of excessive demand pressures.

Chart 10 plots the actual expansion in real GDP, together with the growth in potential output derived from the two approaches presented in this paper, that derived from the unobserved components method and the estimates made in Cassar (2002). From this Chart, it is evident that the growth in potential output implied by the unobserved components method follows closely the actual growth in real GDP, and is therefore rather volatile. By contrast, the HP filter approach yields a smooth downward sloping growth path. The two estimates derived from aggregate production functions, that presented in this paper and the one put forward in Cassar (2002), show an even sharper deceleration in potential output growth and follow each other closely.

Table 2
GROWTH IN POTENTIAL OUTPUT (VARIOUS METHODS)

%

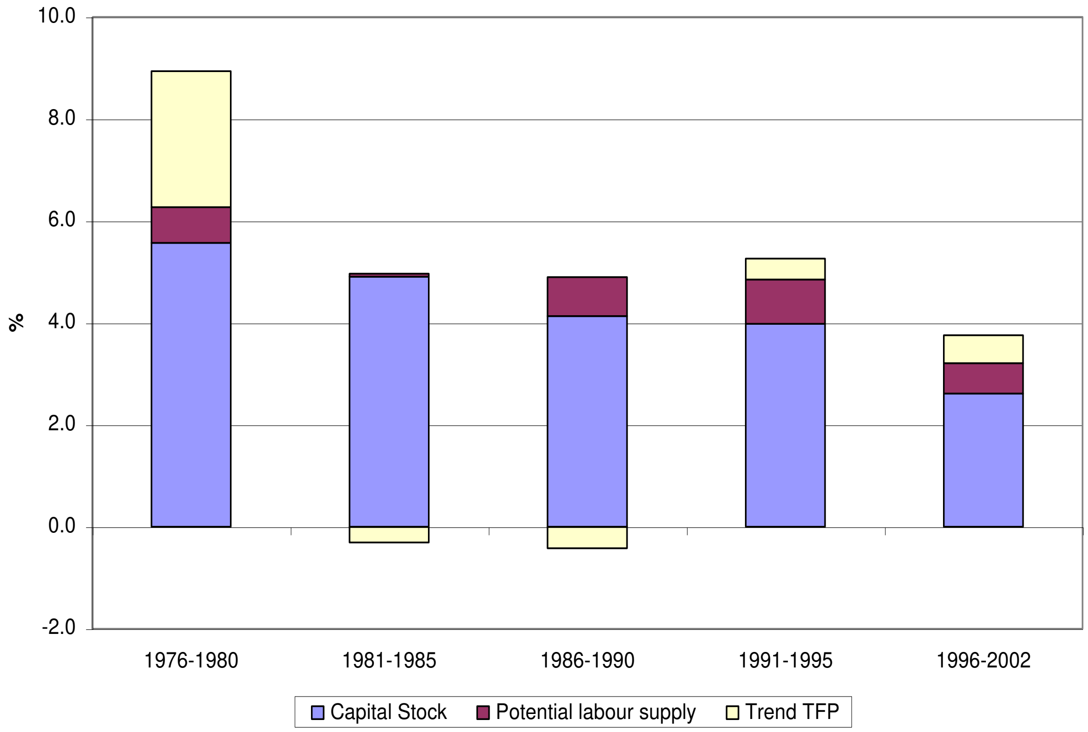
	HP Filter	Production Function	Production Function (Cassar)	Unobserved Components	Real GDP
1990	5.3	5.8	6.9	4.8	6.3
1991	5.4	5.6	6.2	5.7	6.3
1992	5.3	5.6	5.9	4.2	4.7
1993	5.2	5.2	6.1	4.3	4.2
1994	5.0	4.9	5.5	3.3	3.0
1995	4.9	5.7	6.0	9.1	9.3
1996	4.6	5.4	4.3	5.2	4.0
1997	4.4	4.3	3.4	5.4	4.9
1998	4.2	3.4	3.3	4.5	3.4
1999	3.9	3.8	3.1	4.7	4.1
2000	3.7	3.9	4.3	5.9	6.4
2001	3.5	3.0	3.6	0.5	-1.2
2002	3.3	3.0	N.A.	1.5	1.5
Average					
1990-1995	5.2	5.5	6.1	5.2	5.6
1996-2002	3.9	3.8	3.7	3.9	3.3

This slowdown in the underlying growth of the Maltese economy's capacity becomes even more evident from Table 2. The latter shows that the four methodologies indicate that the average growth in potential output slowed down from between 5.2% and 6.1% in 1990-1995 to a range of 3.7% to 3.9% in the 1996-2002 period. However this deceleration was significantly smaller than that which was actually registered in real GDP. This explains why all methods show that the output gap became gradually negative from the late nineties onwards.

4.3 Decomposing the deceleration in potential growth

Though as an economy matures, growth in potential output is bound to slow down, on account of diminishing marginal productivity of capital and slower population growth, the deceleration observed in Malta may have been partly caused by negative developments.[29]

Chart 11: Decomposition of Potential GDP Growth



The Chart above illustrates the sources of growth in potential output, as indicated by the production function approach adopted in this paper. This suggests that in the early eighties, the potential labour supply grew only marginally, while total factor productivity actually declined. By the late eighties, the labour supply resumed its growth, but productivity continued to fall, most probably on account of the surge in public sector employment. This negative trend was reversed in the early nineties, when productivity growth accelerated, leading to a higher rate of potential growth. The potential labour supply also rose at a slightly faster pace, reflecting an increase in the female participation rate.

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[29] See Senhadji (2000) for a comprehensive study covering the sources of growth for a large sample of countries in various stages of development.

However, this gain in potential output growth was reversed in the late nineties. To a large extent this reflected a smaller increment in the capital stock. The ratio of investment (excluding that in dwellings) to GDP fell from an average of 28% in 1991-1995 to an average of 22% in 1996-2002. Though in part this reflected lower outlays on public sector project, which fell from an average of 7.9% of GDP between 1991 and 1995 to 6.5% in 1996-2002, the bulk of the decline was registered in the private sector, mainly transport and communications. Net investment in manufacturing remained broadly unchanged as a share of GDP during these two periods, but gross fixed capital formation was mainly concentrated in electronics.

At the same time, potential employment expanded more slowly during the second half of the nineties. This was mostly on account of an increase in the NAIRU, which is estimated to have risen from an average of 6.2% of the potential labour supply between 1991 and 1995 to 6.5% in 1996-2002. This increase appears to be the result of a growing skills mismatch between the demands of industry and the characteristics of the pool of unemployed. Data on the profile of the registered job seekers, compiled by the Employment and Training Corporation (ETC), show that whereas in 1991, 42% of the unemployed had been registering for more than 48 weeks, by 2002 this proportion had risen to 47%. The share of job seekers aged over 49 years also grew from 11% to 16% during the same period. Whereas between 1991 and 1995, the number of unemployed seeking manual employment had fallen slightly, in the following seven years there was an increase of over 1,400 persons, or 37%.

The ETC's capability to successfully find employment for the registered unemployed also seems to have declined significantly over the last few years.[30] While vacancies grew from 6,330 in 1995-96 to 6,591 in 1999-2000, placements fell from 3,317 to 2,564. As a result, the ETC's placements to vacancies ratio dropped from 52% to just 39% during this period, even though the number of submissions for every vacancy rose from 6 in 1995-96 to 18 in 1999-2000. Furthermore placements in the private sector fell by nearly a thousand, to 1,814 during the same time frame, while those with the public sector rose by around 250, to 750.

[30] These data were taken from Employment and Training Corporation (2001).

During the second half of the nineties, trend growth in total factor productivity also decelerated from a peak of 1.8% in 1996 to 1% in 2002. Eurostat data, in fact, show that while Malta's labour productivity per person employed relative to the average of the EU-15 rose by 6 percentage points between 1995 and 1998, in the subsequent four years there was a drop of around 2 percentage points.[31]

The potential output measures developed in this paper suggest that in the early eighties the Maltese economy passed through a similar phase, with growth in capacity decelerating considerably. This slowdown persisted until widespread structural reforms were introduced in the late eighties, which reinvigorated the economy and contributed to increase the rate of capital accumulation, labour market participation and productivity. The deceleration seen in potential output since the mid-nineties may call for similar actions.

5.0 Conclusion

Like with many other unobservable economic variables, such as the NAIRU, there is little consensus on how to actually measure the output gap. In this light, this paper presented the results of two very different approaches, the HP filter and the production function methods. Whereas the first approach simply comprises a statistical de-trending exercise, the second attempts to model the supply-side of the economy in order to be able to decompose and explain changes in potential output in terms of deviations from the NAIRU or from trend total factor productivity. When applied on quarterly data, both of these methods yielded a very volatile output gap. On the other hand, the results achieved using annual data exhibit the typical business cycle pattern.

Both the HP filter and the production function approaches, in line with the results from the unobserved components method and Cassar (2002), suggest that growth in potential output has slowed down considerably since the mid-nineties. This reflects an increase in the NAIRU, probably attributable to a growing skills mismatch between those held by the pool of jobless and those demanded by industry, a lower

[31] See Eurostat (2004).

rate of capital accumulation and a deceleration in total factor productivity. Despite this slowdown in potential output growth, the output gap still turned negative in recent years since the actual expansion in real GDP decelerated at an even faster pace. A negative output gap implies that existing capacity is being unutilised, raising the prospects of a slowdown in future investment or, if the situation persists, the possibility of firms actually disinvesting and/or persons leaving the labour supply. Such a situation arose in the Maltese economy in the early eighties, and was only resolved when a comprehensive set of market-oriented reforms was launched. Halting the deceleration in potential output growth seen in recent years may require similar decisions that could provide firms with an incentive to invest more, whilst enhancing the productivity of labour and capital.

Appendix 1: Construction of Quarterly GDP data

When the NSO publishes its official annual estimates of GDP, it computes an annual deflator and imposes it on all quarters, revising in the process its original quarterly GDP data based on quarter-on-quarter changes in the deflators. This process smoothens price movements across the different quarters and thus makes the sum of the four quarterly GDPs add up to the annual figure. In order to maintain the movement in the quarterly deflators, whilst still having the sum of quarterly real GDPs add up to the annual GDP figure, one needs to constrain the average of the quarterly deflators for a particular year to reflect the official annual GDP deflator published by the NSO.

One approach able to achieve this objective can be mathematically formulated as follows.

$$\frac{Q^{1N}}{d^1} + \frac{Q^{2N}}{d^2} + \frac{Q^{3N}}{d^3} + \frac{Q^{4N}}{d^4} = \frac{A^{iN}}{d^a} = T \quad \ldots\ldots\ldots\ldots\ldots(1)$$

where d^1, d^2, d^3, d^4, d^a are the unknown quarterly deflators, Q^{1N},Q^{2N}, Q^{3N}, Q^{4N} are the nominal quarterly figures, A^{iN} is the annual nominal figure, d^a is the annual deflator and T is the annual real value.

The quarterly deflators can be re-arranged as:

$$d^2 = d^1\,(1 + \sigma^{2\text{-}1}) = d^1\,x$$
$$d^3 = d^2\,(1 + \sigma^{3\text{-}2}) = d^2\,y = d^1\,xy$$
$$d^4 = d^3\,(1 + \sigma^{4\text{-}3}) = d^3\,z = d^1\,xyz$$

Using this definition, (1) may be re-written as

$$\frac{Q^{1N}}{d^1} + \frac{Q^{2N}}{d^1\,x} + \frac{Q^{3N}}{d^1\,xy} + \frac{Q^{4N}}{d^1xyz} = T \quad \ldots\ldots\ldots\ldots(2)$$

Which becomes:

$$Q^{1N} + \frac{Q^{2N}}{x} + \frac{Q^{3N}}{xy} + \frac{Q^{4N}}{xyz} = d^1T \quad \ldots\ldots\ldots\ldots(3)$$

Therefore:

$d^1 = 1/T\ [(xyz\ Q^{1N} + yz\ Q^{2N} + z\ Q^{3N} + Q^{4N})\ /xyz]$ ………… (4)

from which the remaining deflators can be derived.

Another alternative is a two step adjustment procedure. Firstly the levels of the preliminary quarterly deflators (PQ) are adjusted using a constant factor of proportionality between their average value (AVVAL) for the year and the annual deflator published by NSO (ANVALUE). Then as a second step, the obtained deflators are adjusted to give the same real GDP level as the official annual real GDP. Mathematically these steps can be depicted as follows:

STEP#1

$$PQRESi = PQi * (ANVALUE/AVVAL)$$

Where PQRES is the resulting quarterly deflator in quarter "I" adjusted by the proportionality of the annual deflator and the average of the preliminary quartely deflators for each year.

STEP#2

$$PQFINALi = PQRESi * (REALSUM/REALGDP.A)$$

Where REALSUM is the summation of the quarterly nominal GDP deflated by the adjusted deflators PQRESi, and REALGDP.A is the official real GDP for the year.

In view that quarterly deflators prior to 1996 are unavailable, a longer series had to be created to estimate the CBM model. To achieve this, the quarterly pattern observed from the 1996-2001 period was imposed on the period from 1990 to 1995. This was done by observing the variation of the quarterly deflators in relation to their average throughout the period for which data was available.

Appendix 2: Unobservable components method

The results of the unobservable components method commented upon in this paper are based on a model constructed by Mr. Jan Alsterlind of Sweden's National Institute of Economic Research. Mr. Alsterlind applied this method to Maltese data, in order to present an independently generated estimate of the output gap that could be used to benchmark the results of the two methods presented in this paper.

This model contains the following equations:

$$\pi_{t+1} = \mu_{\pi} + {}^{n}\Sigma_{I=1}\, \alpha_i\, \pi_{t-i+1} + \beta z_t + \varepsilon^{\pi}_{t+1} \quad (1)$$

$$z_{t+1} = \varphi_1 z_t + \varphi_2 z_{t-1} + \varepsilon^{z}_{t+1} \quad (2)$$

$$yp_{t+1} = \mu_{yp} + yp_t + \varepsilon^{yp}_{t+1} \quad (3)$$

$$y_t = yp_t + z_t \quad (4)$$

where π is inflation, y is GDP, yp is potential output, and z stands for the output gap.

The first equation describes a Phillips curve relation. The second and third equations, in turn, explain the output gap and potential output as the result of auto-regressive processes. The final equation is the constraint equation, which makes the sum of potential output and the output gap equal the observed GDP. As a result, the size of the output gap is determined on the basis of the observed change in GDP and the change in inflation.

Appendix 3: Results presented in this paper

Quarterly estimates of the Output gap (% of Potential GDP)

		Production Function	HP Filter
1991	Q1	-0.2	-0.3
	Q2	0.1	0.0
	Q3	-1.2	-1.0
	Q4	-0.7	-0.7
1992	Q1	0.1	0.4
	Q2	1.5	1.7
	Q3	1.5	1.5
	Q4	1.5	1.6
1993	Q1	0.1	-0.1
	Q2	0.7	0.4
	Q3	-1.2	-0.8
	Q4	-0.6	-1.0
1994	Q1	-0.5	-0.9
	Q2	1.3	0.7
	Q3	-0.7	-1.6
	Q4	-1.9	-2.9
1995	Q1	0.7	0.0
	Q2	3.7	3.3
	Q3	-5.8	-6.0
	Q4	3.9	4.1
1996	Q1	2.6	2.9
	Q2	-6.8	-6.4
	Q3	1.3	2.5
	Q4	-0.9	0.0
1997	Q1	-3.4	-2.7
	Q2	-4.7	-4.2
	Q3	-1.0	-0.3
	Q4	6.0	6.4
1998	Q1	4.8	5.0
	Q2	1.9	1.8
	Q3	-0.3	-0.7
	Q4	-7.9	-8.0
1999	Q1	3.3	3.3
	Q2	2.0	1.8
	Q3	-1.1	-1.2
	Q4	-3.8	-4.0
2000	Q1	-2.4	-2.4
	Q2	0.9	0.7
	Q3	6.6	6.3
	Q4	6.8	6.5
2001	Q1	3.8	3.2
	Q2	0.2	0.4
	Q3	-1.1	-1.9
	Q4	-4.0	-4.9
2002	Q1	-0.9	-1.8
	Q2	-0.8	-1.0
	Q3	-1.2	-2.2
	Q4	-2.0	-3.1

Annual estimates of the Output gap (% of Potential GDP)

	Unobserved Components	**Production Function**	**HP-filter**
1973	-0.5	-8.9	-6.3
1974	0.1	-7.8	-10.6
1975	3.9	-1.5	-4.8
1976	3.6	3.4	0.3
1977	5.3	3.7	2.5
1978	3.9	5.8	5.0
1979	2.0	8.3	8.0
1980	4.8	8.4	8.8
1981	4.4	7.1	6.8
1982	1.1	4.5	4.4
1983	-2.7	-2.3	-0.5
1984	-5.4	-5.0	-3.7
1985	-6.2	-6.5	-5.3
1986	-5.0	-6.7	-6.0
1987	-3.6	-6.2	-6.6
1988	-1.8	-2.8	-3.5
1989	0.0	0.6	-0.7
1990	1.5	1.0	0.2
1991	2.0	1.6	1.0
1992	2.6	0.8	0.5
1993	2.4	-0.1	-0.5
1994	2.1	-2.0	-2.5
1995	2.4	1.4	1.7
1996	1.2	0.0	1.1
1997	0.7	0.5	1.5
1998	-0.3	0.6	0.8
1999	-0.9	0.8	1.0
2000	-0.4	3.2	3.6
2001	-2.1	-0.9	-1.1
2002	-2.1	-2.4	-2.8

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